STATE OF INDIANA

INDIANA UTILITY REGULATORY COMMISSION

VERIFIED PETITION OF SOUTHERN INDIANA GAS & ELECTRIC COMPANY D/B/A VECTREN ENERGY DELIVERY OF INDIANA, INC. REQUESTING APPROVAL TO OFFER CERTAIN ENERGY EFFICIENCY AND DEMAND SIDE MANAGEMENT PROGRAMS IN 2015 AND TIMELY RECOVERY OF COSTS THROUGH THE DEMAND SIDE MANAGEMENT ADJUSTMENT, INCLUDING PROGRAM COSTS, LOST REVENUES, AND PERFORMANCE INCENTIVES AND AUTHORITY TO INCUR AND DEFER FOR FUTURE RECOVERY PLANNING COSTS FOR DSM PROGRAMS TO BE OFFERED 2016 AND BEYOND	)	**CAUSE NO. 44495**

FILED
May 29, 2014
INDIANA UTILITY
REGULATORY COMMISSION

SUBMISSION OF CASE-IN-CHIEF

Southern Indiana Gas and Electric Company d/b/a Vectren Energy Delivery of Indiana, Inc. ("Vectren South" or "Petitioner") hereby submits its case-in-chief in this proceeding.

Respectfully submitted,

/s P. Jason Stephenson

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CERTIFICATE OF SERVICE

The undersigned certified that a copy of the Petitioner's Case-in-Chief was served this 29th day of May 2014, via hand delivery, on the Office of Utility Consumer Counselor, PNC Center, 115 W. Washington Street, Suite 1500 South, Indianapolis, Indiana 46204.

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SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
d/b/a VECTREN ENERGY DELIVERY OF INDIANA, INC.

(“VECTREN SOUTH”)

I.U.R.C. CAUSE NO. 44495

DIRECT TESTIMONY

OF

ROBERT C. SEARS

VICE PRESIDENT,

ON

DEMAND SIDE MANAGEMENT POLICY

SPONSORING PETITIONER’S EXHIBIT RCS-1 THROUGH RCS-7

VERIFIED DIRECT TESTIMONY OF ROBERT C. SEARS

INTRODUCTION

Q. Please state your name and business address.

A. My name is Robert C. Sears. My business address is One Vectren Square, Evansville, Indiana 47708.

Q. What position do you hold with Petitioner Southern Indiana Gas and Electric Company d/b/a Vectren Energy Delivery of Indiana, Inc. ("Vectren South" or the "Company")?

A. I am Vice President of Marketing and Conservation for Vectren Utility Holdings, Inc. ("VUHI"), the immediate parent company of Vectren South. I hold the same position with two other utility subsidiaries of VUHI—Indiana Gas Company, Inc. d/b/a Vectren Energy Delivery of Indiana, Inc. ("Vectren North") and Vectren Energy Delivery of Ohio, Inc. ("VEDO").

Q. Please describe your educational background.

A. I earned a Bachelor of Science degree in electrical engineering technology from the University of Southern Indiana in 1986.

Q. Please describe your professional experience.

A. I have been employed with VUHI or its predecessor companies since 1987 in a variety of positions. Previously, I was Director of Conservation, responsible for managing all aspects of gas and electric efficiency and demand side management ("DSM") programs for all three VUHI utilities. In 2006, VUHI established the Conservation Connection to provide customers with options to manage their energy bills. Customers can obtain information regarding DSM programs, including current rebate programs offered by Vectren South and its affiliated companies. As part of my role as Director of

Conservation, I was responsible for overseeing management of the Conservation Connection efforts.

In addition, during the course of my tenure as Director of Conservation, I was involved in the design, development and implementation of four annual electric DSM portfolios and eleven annual gas DSM portfolios in Indiana and Ohio. I have worked closely with the Vectren Oversight Boards and third party consultants to design Company-administered, cost effective DSM portfolios that have performed well. My experience with designing, implementing and evaluating DSM programs dates back to 1992 at Southern Indiana Gas and Electric Company, Vectren South's predecessor company, where I managed both gas and electric energy efficiency and DSM programs.

Prior to assuming the role of Director of Conservation, I was Director of Revenue Administration, with responsibility for the management of all aspects of revenue cycle operations, including meter reading, billing, remittance, credit and collection, customer accounting, margin analysis, and customer billing system administration. Prior to that, I was Director of Customer Service, with responsibility for customer service, billing and customer systems support for all VUHI utility operations. I have also held other positions including Manager of Energy Services and Manager of DSM Services, with responsibility for the development, delivery and evaluation of DSM and demand response ("DR") programs.

Q. What are your present duties and responsibilities as Vice President of Marketing and Conservation?

A. I have primary responsibility for the overall planning and operation of the Company's energy marketing/sales initiatives, DSM and conservation programs, economic development activities and revenue cycle operations. In this position, I oversee all aspects of marketing natural gas and electricity, economic development, and DSM/conservation for VUHI's energy delivery operations.

Q. Have you previously testified before the Indiana Utility Regulatory Commission ("Commission" or "IURC")?

A. Yes. I most recently testified in Cause No. 44318, where Vectren South sought approval of its 2014 DSM program portfolio and have testified in numerous proceedings where Vectren South sought approval of a Demand Side Management Adjustment ("DSMA") for electric service. Also, I testified in Cause No. 43839, the Company's most recent electric base rate case and have testified in several other DSM, energy efficiency, net metering and AMI/Smart Grid proceedings.

<u>PURPOSE</u>

Q. What is the purpose of your testimony in this proceeding?

A. The purpose of my testimony is to provide support for approval of the Company's 2015 Plan. To that end, I discuss Vectren South's commitment to DSM and conservation, explain what the Company's DSM goals are and describe how the Company set those goals. In addition, I will address proposed changes to the Company's current Oversight Board structure as well as performance incentives.

Q. Are you sponsoring any exhibits?

A. Yes. I am sponsoring the following exhibits:

- <u>Petitioner's Exhibit RCS-2</u>, which is the presentation Vectren South made during its first public meeting for the 2014 Integrated Resource Plan ("IRP") session;

- Petitioner's Exhibit RCS-3, which is the updated governance document;
- Petitioner's Exhibit RCS-4, which is a copy of the November 19, 2008 resolution from the National Association Regulatory Utility Commissioners regarding energy efficiency;
- Petitioner's Exhibit RCS-5, which is a copy of the National Action Plan for Energy Efficiency;
- Petitioner's Exhibit RCS-6, which is a copy of the National Action Plan for Energy Efficiency report " Aligning Utility Incentives with Investment in energy Efficiency; and
- Petitioner's Exhibit RCS-7, which is a copy of the July 13 State Electric Efficiency Regulatory Framework Report issued by the Edison Foundation's Institute for Electric Innovation.

Q. Were your exhibits prepared by you or under your direction?

A. Yes.

Q. Are there any other Vectren South witnesses sponsoring testimony in this proceeding?

A. Yes. Vectren South's other witnesses discuss the following topics:

1. Petitioner's Witness Michael P. Huber, Manager, Electric DSM & Conservation describes the 2015 Plan, including estimated costs, benefits, load impacts and participation.
2. Petitioner's Witness Richard A. Morgan, President, Morgan Marketing Partners, LLC ("MMP") offers testimony to support development of Vectren South's 2015

Plan, including a detailed discussion of the cost benefit analysis which was developed by MMP under the direction of Vectren South.

Q. Please summarize the relief Vectren South is seeking in this proceeding.

A. Vectren South is requesting authority to offer the DSM portfolio of programs defined in the 2015 Plan beginning January 1, 2015 through December 31, 2015 with the goal of reducing residential and commercial and industrial ("C&I") customer energy usage by 44 million kWh. This level of energy savings is roughly equal to a one percent (1%) reduction in energy consumption from current usage levels of customers, excluding approximately fifty percent (50%) of the large C&I customers Vectren South expects to will elect to opt out of participation in the DSM programs pursuant to Ind. Code § 8-1-8.5-9(f). The 2015 Plan consists of eight (8) residential and four (4) C&I DSM programs. Apart from Plan approval, the Company seeks to recover all costs associated with offering the 2015 Plan, which includes recovery of DSM Program costs, including net lost revenues related to the DSM programs, program delivery and administrative costs, performance incentives and costs associated with evaluation, measurement and verification ("EM&V"). In addition, the Company is seeking approval of certain changes to the Vectren South Electric Oversight Board ("VSEOB") and authority to incur and defer for future recovery costs associated with planning a DSM portfolio to be offered in 2016 and beyond.

HISTORY OF VECTREN SOUTH'S COMMITMENT TO DSM & CONSERVATION

Q. Please describe Vectren South's commitment to energy efficiency, DSM and conservation.

A. Vectren South is committed not only to offering programs designed to reduce energy usage by its customers, but also to educating its customers about the benefits of energy efficiency, DSM and conservation. VUHI's Conservation Connection was established eight years ago and is solely focused on helping customers take advantage of available programs designed to reduce energy usage and provide information to customers so that they can make informed decisions about their energy usage and management of their energy bill. Vectren South made the investment in Conservation Connection, in large part, because the Company recognizes the benefits that accrue to customers who wisely use energy.

Q. Please describe Vectren South's current portfolio of electric DSM programs.

A. Vectren South's current portfolio of electric programs includes the following core and core plus programs:

Core Programs

- Residential Lighting
- Residential Home Energy Assessment
- Residential Low Income Weatherization
- School Energy Efficiency
- Commercial & Industrial Prescriptive

Core Plus Programs

- Residential Refrigerator & Window A/C Recycling
- Residential HVAC
- Residential Behavioral Savings
- Residential Multi-Family Direct Install
- Residential New Construction
- Commercial & Industrial Audit & Custom Efficiency
- Commercial & Industrial New Construction
- Small Business Direct Install

Core programs are those DSM programs required by the Order issued by the Commission on December 9, 2009 ("Phase II Order") to be offered by all of the jurisdictional electric utilities throughout the state of Indiana to all classes of customers, including large C&I customers. The Phase II Order required core programs to be administered by a third party administrator ("TPA") selected by the Demand Side Management Coordination Committee ("DSMCC"), which was also established by the Phase II Order. After completing a competitive bidding process in 2010, GoodCents was selected by the DSMCC's TPA subcommittee to be the administrator of core programs and each of the participating utilities entered into a two-year contract with the TPA to implement core programs in Indiana over a two year period beginning in January 2012. On January 2, 2012, the TPA launched core programs and, with a one year contract extension through December 31, 2014, has continued to run core programs in Indiana since their launch in January 2012. All TPA activities will cease on December 31, 2014 and management of those programs will either be transferred to the individual utilities for administration or the programs will end.

Core plus programs are those programs implemented by the jurisdictional electric utilities in Indiana designed to fill the gap between savings achieved by the core programs and the savings targets established by the Commission in the Phase II Order. Core plus programs are administered by the utilities.

In addition, the Phase II Order established a 2% savings target applicable to all jurisdictional electric utilities in Indiana. The savings goals are based on the average of weather-normalized electric sales over the prior three year period. The Phase II Order also requires all jurisdictional electric utilities in Indiana to make DSM programs available to all classes of customer.

Q. Does Vectren South make DSM programs available to all customer classes?

A. Yes. Vectren South offers programs to all customer classes, including large C&I customers.

<u>IMPACT OF SENATE ENROLLED ACT 340 ("SEA 340")</u>

Q. Please describe the key elements of SEA 340.

A. SEA 340 was championed by the Indiana Manufacturers' Association and other trade groups that represent large C&I customers, many of whom have appeared in various DSM proceedings before the Commission requesting authority to opt-out of participation in utility sponsored DSM programs. Those customers have consistently maintained that based on global competition and their own in-house expertise regarding their particular manufacturing processes, they are appropriately incented to invest in energy efficiency and other conservation measures that reduce their energy usage and drive down their operating costs. The passage of SEA 340 allows large C&I customers who meet certain criteria ("Qualifying Customers") to opt-out of participation in utility sponsored DSM programs. Furthermore, the statute goes on to prohibit the Commission from requiring jurisdictional electric utilities to meet the Phase II Order energy savings targets after December 31, 2014 and prohibits jurisdictional electric utilities from renewing or extending an existing contract or entering into a new contract with a statewide third party administrator for an energy efficiency program as established in the Phase II Order.

Q. Does Vectren South currently have a process in place to allow large C&I customers to opt-out of participation in its DSM programs?

A. With the passage of SEA 340, Qualifying Customers are allowed to out-out of participation in Company sponsored energy efficiency programs. As a result, Vectren South recently submitted a proposed opt-out process to the Commission for approval in Cause No. 44441 and is working to implement a process to comply with the requirements of SEA 340 to allow Qualifying Customers to opt-out.

<u>VECTREN SOUTH'S 2015 PLAN</u>

Q. Why is Vectren South seeking approval of a one year DSM plan?

A. The energy efficiency landscape in Indiana is changing and Vectren South's decision to seek approval of a one year plan is driven, in part, by that change. SEA 340 requires the Commission to file a status report with the General Assembly's regulatory flexibility committee and legislative council on all energy efficiency programs by August 15, 2014. In addition, Governor Pence has requested the Commission to make recommendations to assist the administration in formulating DSM/Energy Efficiency policy for Indiana. As a result, the Commission has solicited input on those policy matters through its General Administrative Order (GAO) 2014-1. Cause No. 44441 is pending at the Commission and its outcome will also impact the DSM landscape in Indiana. Further, the impact opt out will have on program participation and savings opportunities is unknown at this time. The state of DSM in Indiana is currently in flux, which means a short-term, one-year commitment is appropriate until all of the pending issues are resolved. For now, Vectren South's main goal in filing for a one year plan is to ensure continuity of DSM program offerings on January 1, 2015, as the Company's authorization to offer electric DSM programs ends on December 31, 2014. The landscape will settle once Cause No. 44441 has concluded and the Commission has not only submitted its report to the regulatory flexibility committee but also provided recommendations to Governor Pence on the direction of DSM in Indiana. Once those issues are resolved, Vectren South can finalize plans to offer DSM programs beyond 2015.

Q. Does Vectren South have the capacity to manage an entire portfolio of electric DSM progams on its own without the assistance of a statewide third party administrator?

A. Yes. Vectren South has been offering gas conservation programs since 2009 in Ohio without the assistance of a statewide third party administrator. In addition, the Company managed all of Vectren South's electric DSM offerings in 2010 and 2011 and offered the electric core plus programs with success over the last few years without the assistance of a statewide administrator. Table RCS-1 illustrates Vectren South's success to date with the delivery of the electric core plus programs in contrast with the delivery of the state-wide core programs administered by the third party administrator in Vectren South's service territory.

Table RCS-1 – Vectren Electric DSM Program Performance

Vectren Electric DSM Program Performance		
Program Year	Percent of Core Goals Achieved	Percent of Core Plus Goals Achieved
2010 (Evaluated)	N/A	142%
2011 (Evaluated)	N/A	183%
2012 (Evaluated)	71%	98%
2013 (Evaluated)	78%	129%

Furthermore, Vectren South made a significant investment in Conservation Connection, which is an established brand that consumers are familiar with and a known place to go for energy efficiency programs and information. Vectren South has the bandwidth to manage its entire electric DSM portfolio on its own without the use of a statewide third party administrator.

Q. What advantages exist with elimination of the statewide third party administrator?

A. The elimination of the statewide third party administrator allows Vectren South to work closely with its oversight board to design a portfolio of electric DSM programs based upon the specific needs of customers in Vectren South's service territory. Vectren South consistently has met the goals established for core plus programs, at least in part, because the Company has designed core plus programs specific to the needs of its customers, without being concerned about what program designs will work well on a statewide basis. While there are economies of scale to be gained from the use of a statewide third party administrator, the Company can administer programs cost effectively and with more of a personal touch than a third party administrator. Vectren South's name recognition and reputation garner a level of credibility with large C&I customers that took a long time to establish and would be difficult to replicate with a statewide third party administrator. Vectren South maintains established relationships with its large C&I customers and will partner with those large C&I customers who choose to continue participating in the Company-sponsored DSM programs. That partnership will be essential in helping the Company to reach its goals. In addition, the elimination of core programs will allow Vectren South to more efficiently use its human resources. I played an active role in the DSMCC, which required a significant investment of time and other resources from me and other members of my staff. Eliminating the TPA and the DSMCC will allow my staff and me to make the most efficient use of our time and resources and focus on implementing DSM programs in Vectren South's service territory that are most beneficial to Vectren South's customers.

Q. Where can the Commission find a description of the DSM programs included in Vectren South's 2015 Plan?

A. A copy of the 2015 Plan is attached to Mr. Hubers' testimony as Petitioner's Exhibit MPH-3. Mr. Huber provides details of the program in his testimony.

VECTREN SOUTH'S GOALS FOR 2015 AND BEYOND

Q. Please describe Vectren South's energy savings goal for 2015 as proposed in the 2015 Plan.

A. Vectren South's 2015 Plan is based upon achieving energy savings equal to 1% of annual retail sales, adjusted for anticipated participation by Qualifying Customers in the Company's opt-out program. This level of savings was included in the IRP load forecast for 2015 – 2019 and assumes that 50% of Qualifying Customers will opt-out of DSM programs. Although Vectren South is experiencing flat to modest load growth in its service territory, the Company considers DSM a fundamental part of what it does to serve its customers and help them manage their energy bills.

Q. Is Vectren South's 2015 Plan consistent with its IRP?

A. Yes. The 2014 Vectren South IRP is under development and the Company presented its plans for incorporating energy efficiency into the IRP process at a Public Stakeholder meeting on March 20, 2014. The Vectren IRP Public Stakeholder meeting presentation is included in my testimony as Petitioner's Exhibit RCS-2. Vectren South's position on DSM is as follows:

- Energy Efficiency and DSM are a fundamental part of what we do to serve customers and help customers manage their energy bills. The Company considers an ongoing level of DSM as part of its base case load forecast. DSM savings levels in the load forecast include DSM energy efficiency programs available to all customer classes, at 1% annual savings target for 2015 – 2019 and 0.5% annually thereafter, assuming that 50% of Qualifying Customers will opt-out of participating in Company-sponsored DSM programs. Because many factors are so dynamic at this time, including the economy, future environmental regulations, the availability of generation in the wake of plant retirements, and the cost of fuel, continuing to engage in DSM makes sense. As these issues become clearer over time, that will impact the level of DSM in Vectren South's resource plan.

- Vectren South considers energy efficiency and DSM as a resource for meeting future generation based upon need as a result of the IRP planning process. The amount of DSM may be adjusted based on need as well as estimates of achievable savings and cost effectiveness of programs.
- The 2014 IRP will allow Vectren South to determine if the savings targets that it has proposed are cost-effective in relation to future load growth and other resource options. The 2014 IRP will not serve as a key input into the 2015 Plan; however, level of savings proposed, which are basically consistent with the current 2014 DSM program savings targets, are prudent for continuation in 2015.

Once completed, the 2014 IRP will provide direction for future filings regarding the appropriate level of DSM program offerings for Vectren South.

Q. Besides the economic outlook predicting flat to modest load growth, what other factors influenced the Company to set a goal of 1% of adjusted retail sales?

A. New appliance efficiency standards and building codes ("Codes & Standards") reduce the amount of energy savings that a utility can achieve through utility-sponsored programs, which results in a need to reduce the goal to a more manageable level. Aggressive new appliance and lighting efficiency Codes & Standards have been implemented recently and experts like the Edison Foundation and ACEEE estimate that these new Codes & Standards will result in 2.3% to 2.5% annual energy savings by 2020, compared to a baseline of energy usage from 2009. Without the changes to the Codes & Standards, those savings would likely have been achieved by utility-sponsored energy efficiency programs, but with their implementation cannot be counted as part of a utility sponsored program.

Furthermore, appliance and equipment efficiency standards have served as one of the nation's most effective policies for improving energy efficiency and saving consumers energy and money. Since 2009, the Obama Administration has issued 24 new or updated appliance standards across more than 30 products, which will help increase annual savings by more than 75% over the next decade, and could save consumers a total of nearly $450 billion dollars off their utility bills between now and 2030.

Q. Does Vectren South anticipate offering DSM programs beyond 2015?

A. Yes. Vectren South has embraced DSM and conservation as key elements of its business strategy on both the gas and electric side of the business. Vectren South is committed to offering customers the opportunity to continue using energy wisely by making energy and demand savings measures available to them. Vectren South's short-term goal is to ensure continuity of program offerings as we transition from 2014 into 2015. Vectren South's current programs are authorized to continue through December 31, 2014. If Vectren South's 2015 Plan is approved as requested herein, then Vectren South's customers will have a smooth transition from one program year to the next and there will not be a gap in coverage. Mr. Huber will discuss Vectren South's DSM plans beyond 2015.

Q. Does the budget for the 2015 Plan include costs related to planning for 2016 and beyond?

A. No. The budget for the 2015 Plan includes only costs related to offering DSM programs in 2015. Vectren South anticipates filing a three year DSM plan for approval later this year and will incur planning costs over the course of the next several months related to offering DSM programs in 2016 and beyond. Vectren South is requesting approval to incur no more than $200,000 in planning costs and defer them for future recovery.

Q. Why should the Commission approve costs for planning a 2016-18 DSM portfolio when Vectren South just recently completed a Market Potential Study ("MPS")?

A. Vectren South's MPS is a necessary tool for determining what the potential is for DSM in Vectren South's service territory. Vectren South will use the MPS and work with an outside consultant to develop an action plan with specific steps for achieving the goals. The MPS serves as the foundation for building the action plan, but it in and of itself is not an action plan. The action plan will be developed over the course of the next several months, in anticipation of a filing for approval for a 2016-18 action plan. The planning costs Vectren South seeks to incur and defer for later recovery are a necessary part of offering DSM in 2016 and beyond.

EVALUATION, MEASUREMENT AND VERIFICATION ("EM&V")

Q. Do EM&V results to date support the 2015 Plan?

A. Yes. EM&V results to date were used to support the gross and net savings estimates for programs included in the 2015 Plan. The 2012 and 2013 statewide core and Vectren South core plus evaluations were utilized to inform the net-to-gross ("NTG") estimates in the 2015 Plan. The core and core plus EM&V ex-post savings results were also applied when savings assumptions provided by potential implementation providers appeared to be overstated or understated from what was currently being offered for a similar program.

In addition to the EM&V results, other sources such as core TPA bids, core plus vendor estimates, and the Indiana Technical Resource Manual ("TRM") were utilized to support the 2015 Plan where appropriate.

Q. Please discuss Vectren South's EM&V plans for the 2015 Plan.

A. Program evaluation will be conducted by an independent evaluator. In general, the independent evaluator will perform two types of evaluations. A process evaluation will be performed to identify how well the programs were implemented. The objective of the process evaluation is to examine the effectiveness and efficiency with which the programs were designed and delivered. An impact evaluation will also be performed to examine the more technical effects of the programs such as energy and demand savings. The goals of the impact evaluation are to verify measure installation, determine participants' free-rider and spillover behaviors (the "NTG ratio"), review the deemed savings values and estimate realized program savings (both kWh and kW).

During the evaluation process, an assessment of the program market affects will also be conducted to determine any changes and trends from the prior year, where applicable. For programs being evaluated for the first time, a baseline will be determined during the evaluation phase and further analysis will be conducted in subsequent years.

COST RECOVERY, LOST REVENUES and PERFORMANCE INCENTIVES

Q. Do energy efficiency programs have a financial impact on Vectren South?

A. Yes. Implementation of energy efficiency programs impacts Vectren South's financial condition in three significant ways:

1. the Company incurs costs to develop and implement the energy efficiency programs;

2. it incurs lost contributions to fixed costs through reduced sales, and
3. it foregoes the opportunity to make supply side investment, which is the means under the current regulatory structure for a utility to make a profit.

Q. Has the Commission previously approved recovery of costs associated with offering DSM programs?

A. Yes. The Commission's December 16, 2009 Order in Cause No. 43427 approved Vectren South's request for authority to offer certain DSM programs to its residential and small commercial customers, recover program costs; and earn a performance incentive upon achieving certain energy and demand savings goals.

The Commission's August 31, 2011 Order in Cause No. 43938 approved Vectren South's request for authority to recover lost revenues associated with participation in DSM programs by large C&I customer, defer up to $1 million in lost margins associated with residential and small customer core and core plus programs for the period of January 1, 2011 through December 31, 2011 and recover, over a two year period, those deferred lost margins in a separately docketed proceeding. The Order in Cause No. 43938 also granted Vectren South's request to continue recovering performance incentives associated with core plus programs.

The Commission's June 20, 2012 Order in Cause No. 43405 DSMA 9 S1 approved Vectren South's request to recover lost revenues through the DSMA associated with participation in DSM programs by residential and small general service customers.

Q. Please describe the mechanism Vectren South uses to recover the financial impacts associated with its DSM portfolio.

A. Vectren South recovers costs related to DSM programs through the Demand Side Management Adjustment ("DSMA"), which includes the following components: Direct Load Control ("DLC"), Inspection and Maintenance ("I&M"), Energy Efficiency Funding Component ("EEFC") which includes the performance incentive, Large Customer Lost Margin Component and Small Customer Lost Margin Component. In addition, Vectren South recently proposed an Opt-Out provision to its DSMA to allow Qualifying Customers to opt-out of participation in Company-sponsored DSM programs. Historically, the Company has filed for approval of its DSMA factors in June for rates effective beginning September 1st and absent issues related to implementation of the op-out process, Vectren South would have filed DSMA 12 in mid-to-late June 2014. However, given the uncertainty related to passage of SEA 340 and implementation of an opt-out process, Vectren South is requesting approval to file DSMA 12 in mid-to-late September for rates effective January 1st and to continue that cycle for future DSMA filings.

Q. Is Vectren South proposing any changes in this proceeding to its current cost recovery mechanism?

A. Yes. The Commission previously authorized a performance incentive structure that Vectren South reconciles through the Energy Efficiency Funding Component. Historically, Vectren South has been authorized to earn performance incentives for the implementation of core plus programs. Given that the TPA will no longer be in charge of implementing core programs after December 31, 2014 and Vectren South will be solely responsible for implementing its entire portfolio of programs, Vectren South proposes to earn a performance incentive on its entire portfolio of DSM programs, except the Income

Qualified Weatherization ("IQW") program. In addition, Vectren South is also proposing to replace the current performance incentive mechanism with a Shared Savings mechanism.

Vectren South supports the use of a Shared Savings mechanism, which is the sharing of the net present value ("NPV") of net benefits created by utilizing cost effective energy efficiency programs to meet utility resource needs), as one component to help remove the inherent disincentives to utilities for implementing energy efficiency programs. Under a Shared Savings mechanism, utility incentives are aligned with the NPV of net benefits delivered to the customer and not solely based on the dollars spent on energy efficiency programs. A percent of overall program budget would be used as a means to cap the level of Shared Savings.

A Shared Savings mechanism is based on net benefits to the customer which provides an incentive for the utility to cost-effectively increase the benefits of energy efficiency by managing costs of energy efficiency programs. Given that Vectren South will be the administrator of the programs, a Shared Savings mechanism provides the VSEOB an added level of assurance that Vectren South is incented to manage the costs of the DSM programs.

Q. Since SEA 340 removed the aggressive savings targets requirements of the Phase II Order are performance incentives still necessary?

A. Yes. Consistent with the policy statements above performance incentives provide the utility the opportunity to recover the lost opportunity costs of investing in traditional rate based assets to serve future energy requirements. The continuance of a performance incentive mechanism encourages the utility to pursue cost effective DSM that is necessary to meet future energy requirements in a cost effective manner.

While program cost and lost margin recovery mechanisms serve to mitigate the utility disincentive to invest in energy efficiency due to a reduction in sales, they do not necessarily provide an incentive for such investment. Even with program cost and lost margin recovery mechanisms in place, investor-owned utilities often still have an incentive to make supply-side investments because of the beneficial effect on stock price.

Q. Why is Vectren proposing a change to the Performance Incentive mechanism at this time?

A. The current performance incentive mechanism has functioned well over the past few years, but a modification to provide greater emphasis on sharing the benefits generated by the program rather than the amount spent to deliver the programs is a better model for customers and the Company. By tying the incentive to the net benefits from the DSM program, Vectren South is encouraged to maximize benefits and to minimize the cost of earning those benefits.

By focusing the utility incentive on the net benefits of the Utility Cost Test, the Shared Savings incentive provides motivation for the utility to control DSM program costs, including administrative, program delivery and customer incentive costs. Given that Vectren South will serve as program administrator for the 2015 Plan, the Shared Savings model appropriately incentivizes Vectren South to manage all programs costs as effectively as possible in order to meet the established program savings targets.

The existing performance incentive has worked well and Vectren South has effectively managed programs costs, but the Shared Savings mechanism provides a greater incentive to not only focus on achieving savings but also to maximize the benefits of DSM programs to customers.

Q. Would the performance incentive be applicable to all programs?

A. No. Vectren South proposes that the performance incentive be applicable to all programs with the exception of the IQW program. In many instances low income programs are offered for reasons other than cost-effectiveness.

Q. How is the Shared Savings Incentive determined?

A. Vectren South proposes a sharing mechanism wherein the Company receives a 15% share of the NPV benefits of the Utility Cost Test. The net lost energy and demand savings are determined by independent EM&V. The net benefit as calculated on a Utility Cost basis is the difference between the costs avoided by implementing the DSM programs (avoided electric capacity and energy) and the utility-incurred costs of the DSM programs. Vectren South proposes to cap the Shared Savings incentive at 12% of the eligible program costs, excluding costs associated with the IQW program. The current performance mechanism is capped at 12% of program costs, so Vectren South is not pursuing a percentage of incentive greater than what is available today.

Q. What program costs are eligible for purposes of calculating the Shared Savings incentive?

A. For purposes of calculating the Shared Savings incentive, the planned energy efficiency budget is defined as the actual incurred 2015 Plan costs, including the administrative, outreach and education costs, not to exceed, by more than ten percent (10%) the total budget for the 2015 Plan, as approved by the Commission. The program costs for the IQW program will not be included in the Shared Savings calculation as stated above.

Q. Please describe Vectren South's EM&V plan, including timing, related to the Shared Savings incentive associated with the 2015 Plan.

A. The Shared Savings incentive will be calculated after the end of the program year and following the independent evaluation of the 2015 Plan. The evaluation will take place in the months following each program year and will be included in the DSMA filing following conclusion of the evaluation and approval of the Shared Savings incentive calculation by the VSEOSB.

Q. Is there an at-risk component to the proposed Shared Savings incentive?

A. Yes. Vectren South proposes that at least 50% of the energy savings proposed in the 2015 DSM Plan, adjusted by the VSEOB for the actual level of customer opt-out, would be required in order to become eligible for the Shared Savings incentive. The Shared Savings incentive itself has an at-risk component also because no incentive can be earned unless net benefits for the customer are produced by the program.

Q. Besides the change to the performance incentive, is Vectren South requesting any other changes to any other components of its DSMA?

A. No. Vectren South is requesting that all other components of its cost recovery mechanism remain in place unchanged. The only change Vectren South is requesting approval to make is the change to the performance incentive, as described above.

Q. Do the Commission's DSM Rules support Vectren South's cost recovery mechanism?

A. Yes. The Commission's Rules found at 170 IAC 4-8-1 *et seq.*, provide support for continuation of Vectren South's recovery mechanism, including the requested modification to the Shared Savings incentive portion of the EEFC. Specifically, 170 IAC 4-8-3(a) states,

> …[T]he commission has developed a regulatory framework that allows a utility an incentive to meet long term resource needs with both supply-side and demand-side options in a least-cost manner and ensures that the financial incentive offered to a DSM program participant is fair and economically justified. The regulatory framework attempts to eliminate or offset regulatory or financial bias against DSM, or in favor of a supply-side resource, a utility might encounter in procuring least-cost resource.

Vectren South's DSM proposal addresses the "regulatory bias" and allows the Company to continue the type of DSM efforts that have been so effective in Vectren South's core plus electric and gas DSM program portfolios.

Q. Is there other support for Vectren South's proposed cost recovery mechanisms?

A. Yes. Vectren South's regulatory proposal is founded upon long standing public policy. Vectren South's program proposal is consistent with the following sections of the Energy Independence and Security Act ("EISA"):

> (17)–electric utility rate structure shall **align utility incentives with the delivery of cost-effective energy efficiency and promote energy efficiency investments.** States shall specifically consider as policy options; removing the throughput incentive and other regulatory and management disincentives to energy efficiency; **providing utility incentives for the successful management of energy efficiency programs**; including the impact on adoption of energy efficiency as one of the goals of retail rate design recognizing that energy efficiency must be balanced with other objectives; adopting rate designs that encourage energy efficiency for each customer class; allowing timely recovery of energy efficiency-related costs; and offering home energy audits, offering demand response programs, and publicizing efficiency-related information. H.R. 6 – Energy Independence and Security Act. - Sec. 532 amends PURPA 111(d) and (17).

Congress and the President recognized the importance of removing disincentives and motivating utilities to pursue energy efficiency through incentive mechanisms in the

EISA of 2007. The Act encourages state regulators to "integrate energy efficiency into electric and natural gas utility, State, and regional plans and adopting policies establishing cost-effective energy efficiency as a priority resource." 16 U.S.C. §2621(d). It goes on to state that, "States shall specifically consider as policy options: removing the throughput incentive and other regulatory and management disincentives to energy efficiency; providing utility incentives for the successful management of energy efficiency programs; [and] allowing timely recovery of energy efficiency-related costs [. . .]." *Id*.

Vectren South's proposal is also supported by a 2004 NARUC Resolution which encourages state commissions to "address regulatory incentives to address inefficient use of gas and electricity" as well as an August 2, 2006, Resolution which supports the EPA's National Action Plan on Energy Efficiency including "[modifying] policies to align utility incentives with the delivery of cost-effective energy efficiency and modify ratemaking practices to promote energy efficiency investments." See National Association of Regulatory Commissioners, Resolution on Gas and Electric Energy Efficiency, July 14, 2004; National Association of Regulatory Commissioners, Resolution Supporting the National Action Plan on Energy Efficiency, August 2, 2006.

In the resolutions, the NARUC Board of Directors expressed support for the five recommendations established by the National Action Plan on Energy Efficiency ("NAPEE"). The NAPEE encouraged energy efficiency policy makers to:

> 1) recognize energy efficiency as a high priority resource;
> 2) make strong, long-term commitments to cost-effective energy efficiency as a resource;
> 3) broadly communicate the benefits of and opportunities for energy efficiency;

> 4) promote sufficient, timely, and stable program funding to deliver energy efficiency where cost-effective; and
> **5) modify policies to align utility incentives with the delivery of cost-effective energy efficiency and modify ratemaking practices to promote energy efficiency investments.**

The November 19, 2008 NARUC Resolution is included in my testimony as Petitioner's Exhibit RCS-4. The NAPEE, August 2, 2006 is included in my testimony as Petitioner's Exhibit RCS-5. Approval of Vectren's South's proposal is consistent with the NAPEE and the Commission should continue to follow NARUC's lead in recognizing the importance of energy efficiency and adopting policies to align utility incentives with the delivery of cost-effective energy efficiency programs. The NAPEE acknowledges the importance of aligning utility incentives with the delivery of cost-effective energy efficiency. Specifically the report says,

> Successful energy efficiency programs would be promoted by aligning utility incentives in a manner that encourages the delivery of energy efficiency as part of a balanced portfolio of supply, demand, and transmission investments. Historically, regulatory policies governing utilities have more commonly compensated utilities for building infrastructure (e.g., power plants, transmission lines, pipelines) and selling energy, while discouraging energy efficiency, even when the energy saving measures might cost less.

The 2007 NAPEE Report " Aligning Utility Incentives with Investment in Energy Efficiency" also acknowledges the importance of aligning utility incentives with investment in Energy Efficiency. See Petitioner's Exhibit RCS-6 for a copy of the NAPEE report "Aligning Utility Incentives with Investment in Energy Efficiency. Specifically the report says,

> Under traditional regulation, investor-owned utilities earn returns on capital invested in generation, transmission, and distribution. Unless given the opportunity to profit from the energy efficiency investment that is intended to substitute for this capital investment, there is a clear

> financial incentive to prefer investment in supply-side assets, since these investments contribute to enhanced shareholder value. Providing financial incentives to a utility if it performs well in delivering energy efficiency can change that business model by making efficiency profitable rather than merely a break-even activity. NAPEE p. ES-3.

In July 2013, The Edison Foundation's Institute for Electric Innovation ("IEE") released a report entitled State Electric Efficiency Regulatory Frameworks ("Report"), which outlines several state approaches to expanding the business environment to support investments in efficiency programs by electric utilities. According to the Report, thirty-two (32) states have approved fixed cost recovery mechanisms, with fourteen (14) authorizing revenue decoupling mechanisms and the other eighteen (18) authorizing lost revenue adjustment mechanisms. In addition, twenty-eight (28) states currently have performance incentives in place, with eleven (11) states authorizing calculation of performance incentives based upon shared savings and the other eight (8) authorizing calculation of performance incentives based upon a percentage of program costs for achieving savings targets. See Petitioner's Exhibit RCS-7 for a copy of the Report.

PROGRAM OVERSIGHT AND GOVERNANCE

Q. Please describe the current composition of the VSEOB.

A. The VSEOB consists of the following voting members: Indiana Office of Utility Consumer Counselor ("OUCC"), Citizens Action Coalition ("CAC") and Vectren South.

Q. Is Vectren South proposing any changes to the composition of the VSEOB?

A. No.

Q. Please describe the current role of the VSEOB.

A. The VSEOB currently oversees the implementation of core plus and, to a more limited extent, core programs in Vectren South's service territory. The VSEOB has authority to add new programs and cease underperforming programs. In addition, the VSEOB can approve the shifting of funds from core to core plus and vice versa and from sector to sector.

Q. Is Vectren South proposing any changes to the governance structure of the VSEOB?

A. Yes. Vectren South is requesting authority to combine the gas and electric oversight boards into one governing body, called the Vectren Oversight Board ("VOB"). Please see Petitioner's Exhibit RCS-3 for a copy of the governance document that would be effective for the 2015 combined oversight boards.

Q. What is the benefit of combining the Vectren South gas and electric oversight boards into one oversight body?

A. Joint delivery of gas and electric programs offers a greater opportunity to lower costs and provides a better customer experience for those with both Vectren South gas and electric service. As a result, it makes sense for one governing body to oversee both gas and electric programs. In addition, discussing both gas and electric DSM issues at one meeting makes the most efficient use of the members' time.

Q. Is Vectren South proposing any changes to the role of the VOB?

A. Yes. Vectren South is proposing is that the VOB have the flexibility to increase budgeted funding by up to 10%, if needed, to support program adoption without having to go back to the Commission to seek additional approval. Vectren South anticipates that the OSB will continue to have the ability to shift funds from sector to sector and program to program, but will not commingle gas and electric funds.

Vectren South is also proposing to modify the process when consensus cannot be achieved by the VOB on a decision. If consensus cannot be reached by the VOB on a decision, Vectren proposes that the issue will be decided by Vectren South, as Vectren South ultimately is tasked with meeting the savings goal set by the Company and approved by the Commission. In this event any voting member of the Oversight Board could present their positions to the Commission for a decision.

<u>VECTREN SOUTH'S 2015 PLAN IS IN THE PUBLIC INTEREST</u>

Q. Does the current regulatory framework in Indiana support Vectren South's 2015 DSM Plan as proposed in this proceeding?

A. Yes. The current regulatory framework, including statutory and administrative code provisions and prior Commission Orders, encourages electric utilities to meet their customers' resource needs through supply and demand side resource options in a least cost manner. The Commission's DSM Rules (170 lAC § 4-B-3(a)) include the statement of purpose to:

> [provide] a regulatory framework that allows a utility an incentive to meet long-term resource needs with both supply-side and demand-side resource options in a least-cost manner and ensures that the financial incentive offered to a DSM program participant is fair and economically justified. The regulatory framework attempts to eliminate or offset regulatory or financial bias against DSM, or in favor of a supply-side resource, a utility might encounter in procuring least-cost resources. The Commission, where appropriate, will review and evaluate the existence and extent of regulatory or financial bias.

The Commission's DSM Rules (170 IAC § 4-B-3(c)) further state that another purpose is:

> ... to ensure a utility's proposal is consistent with acquiring the least-cost mix of demand side and supply side resources to reliably meet the long-term electric service requirements of the utility's customers, the Commission, where appropriate, will review and evaluate, as a package, the proposed DSM programs, DSM cost recovery, lost revenue and shareholder DSM incentive and mechanisms.

These provisions of the Commission's rules are consistent with prevailing national goals and policies regarding energy use.

Q. Is Vectren South's 2015 Plan in the public interest?

A. Yes, approval of the 2015 Plan is in the public interest and approving it will allow Vectren South to continue providing opportunities for customers to reduce their energy usage and make more educated choices about how they consume energy. Vectren South's 2015 Plan promotes the efficient use of energy by better aligning the Company's interests with those of its customers. In addition, it will delay the need to build additional generation, help conserve natural resources and decrease emissions from generating units. Vectren South considers an ongoing level of cost-effective DSM a resource for helping customers to manage their energy bills, as well as a resource for meeting future generation needs.

<u>CONCLUSION</u>

Q. Does this conclude your testimony in this proceeding?

A. Yes, at this time.

VERIFICATION

The undersigned, Robert C. Sears, affirms under the penalties of perjury that the answers in the foregoing Direct Testimony are true to the best of his knowledge, information and belief.

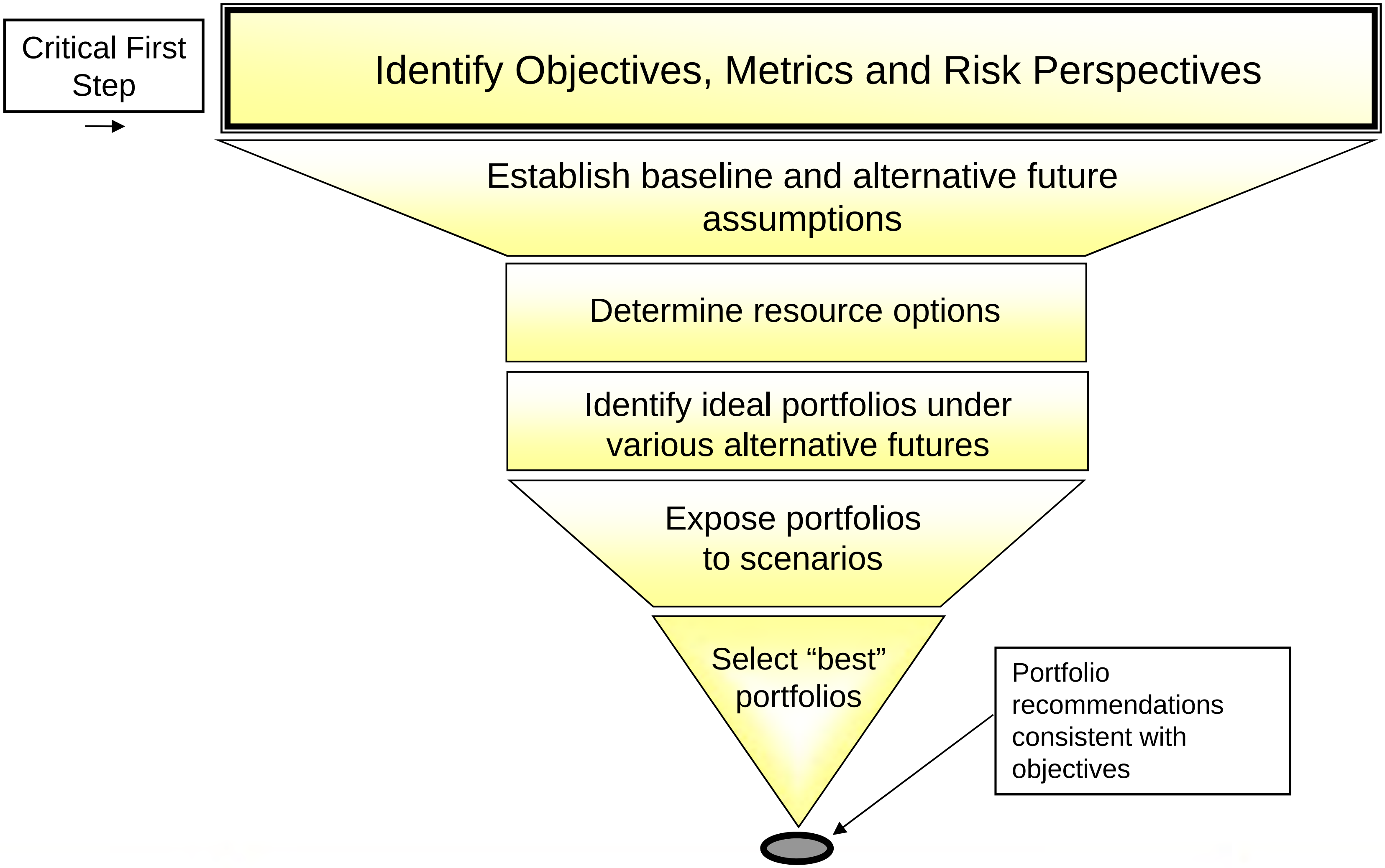
Robert C. Sears

Vectren Integrated Resource Plan (IRP) Stakeholder Meeting

Gary Vicinus – Meeting Facilitator
Managing Director, Pace Global
March 20, 2014

VECTREN
Energy Delivery

Selecting the right portfolio



IRP Timeline

1.	Identify key objectives and metrics	In Process
2.	Gather information on key trends	In Process
3.	List generation and demand side options	In Process
4.	Develop process for evaluating alternatives	In Process
5.	Gather information from stakeholders	In Process
6.	Perform analysis and recommend portfolios	2-3 months
7.	Preview plan with stakeholders	August
8.	File IRP	By Nov. 1st

Agenda

9:30 a.m.	Welcome	Carl Chapman, Vectren President and CEO
9:40 a.m.	Meeting Format and Ground Rules	Gary Vicinus, Pace Global - Vice President and Managing Director
9:55 a.m.	Long-Term Energy and Demand Forecast	Matt Rice, Vectren Manager of Market Research & Analysis and Eric Fox, Itron - Director of Forecast Solutions
10:10 a.m.	Demand Side Management: Energy Efficiency and Demand Response	Robert Sears, Vectren Director of Conservation
10:25 a.m.	Distributed Energy Resources	Josh Pack, Vectren Manager of Energy Technologies
10:40 a.m.	Clarifying Questions	
11:00 a.m.	Generation Overview	Wayne Games, Vectren Vice President of Power Supply and Scott Brown, Vectren Manager of Generation Planning
11:15 a.m.	Environmental Overview	Angila Retherford, Vectren Vice President of Environmental Affairs & Corporate Sustainability
11:30 a.m.	Planning Inputs	Matthew Lind, P.E., Burns and McDonnell Engineering - Senior Project Manager, Business & Technology Services
11:45 a.m.	Clarifying Questions	
12:00 p.m.	Lunch	
1:00 p.m.	Generation Planning Analysis Road Map	Matthew Lind, P.E., Burns and McDonnell Engineering - Senior Project Manager, Business & Technology Services
1:30 p.m.	Open Discussion/Questions	
2:15 p.m.	Adjourn	

Meeting Guidelines

1. Please hold questions until the end of the presentations
2. There will be 15-20 minutes at the end of group presentations for "clarifying questions"
3. There will be a parking lot for items to be addressed at a later time
4. At the end of the afternoon session, there will be approximately 45 minutes for thoughts, ideas and suggestions
5. For those on the phone, we will open the (currently muted) lines for some questions within the allotted time frames
6. We will have an address for additional questions and suggestions open for a period of four weeks after this meeting
7. Questions will be answered here or later

Questions?

Long-Term Energy and Demand Forecast

Presented by Matt Rice , Manager of Market Research & Analysis and Eric Fox, Director of Forecast Solutions Itron

2014 Vectren IRP Stakeholder Meeting

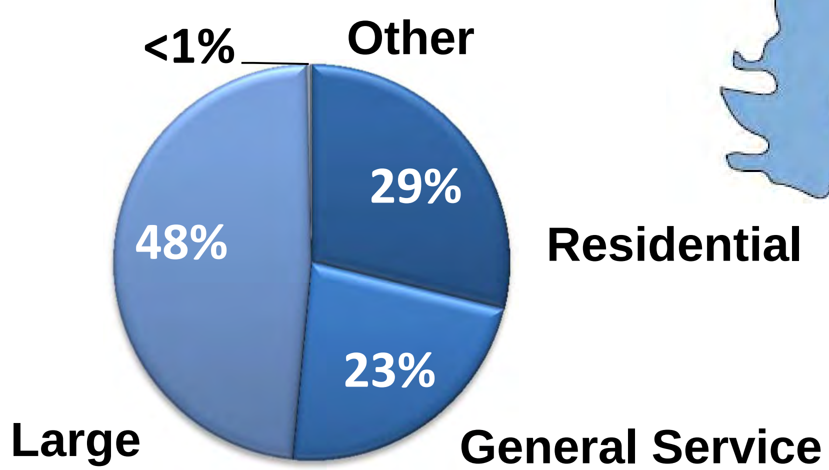
March 20, 2014

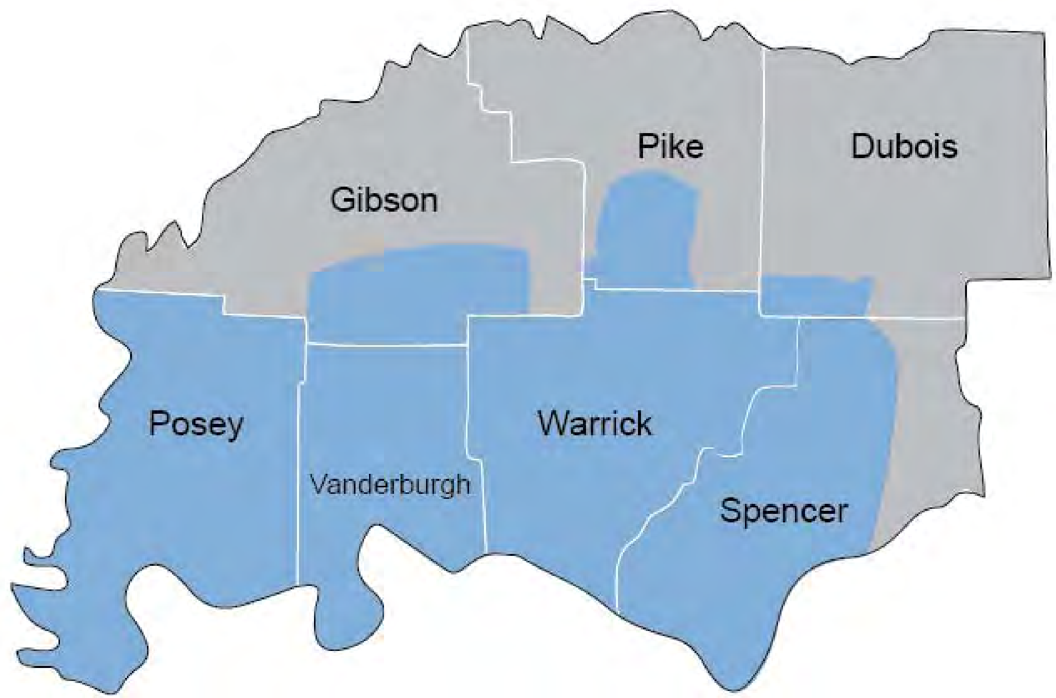
Vectren's Electric Footprint

Vectren Energy Delivery of Indiana – South

- 142,000 electric customers
  - 124,000 Residential
  - 18,000 General Service
  - 100 Large

2013 Customer Type by Energy Usage





Forecast Summary

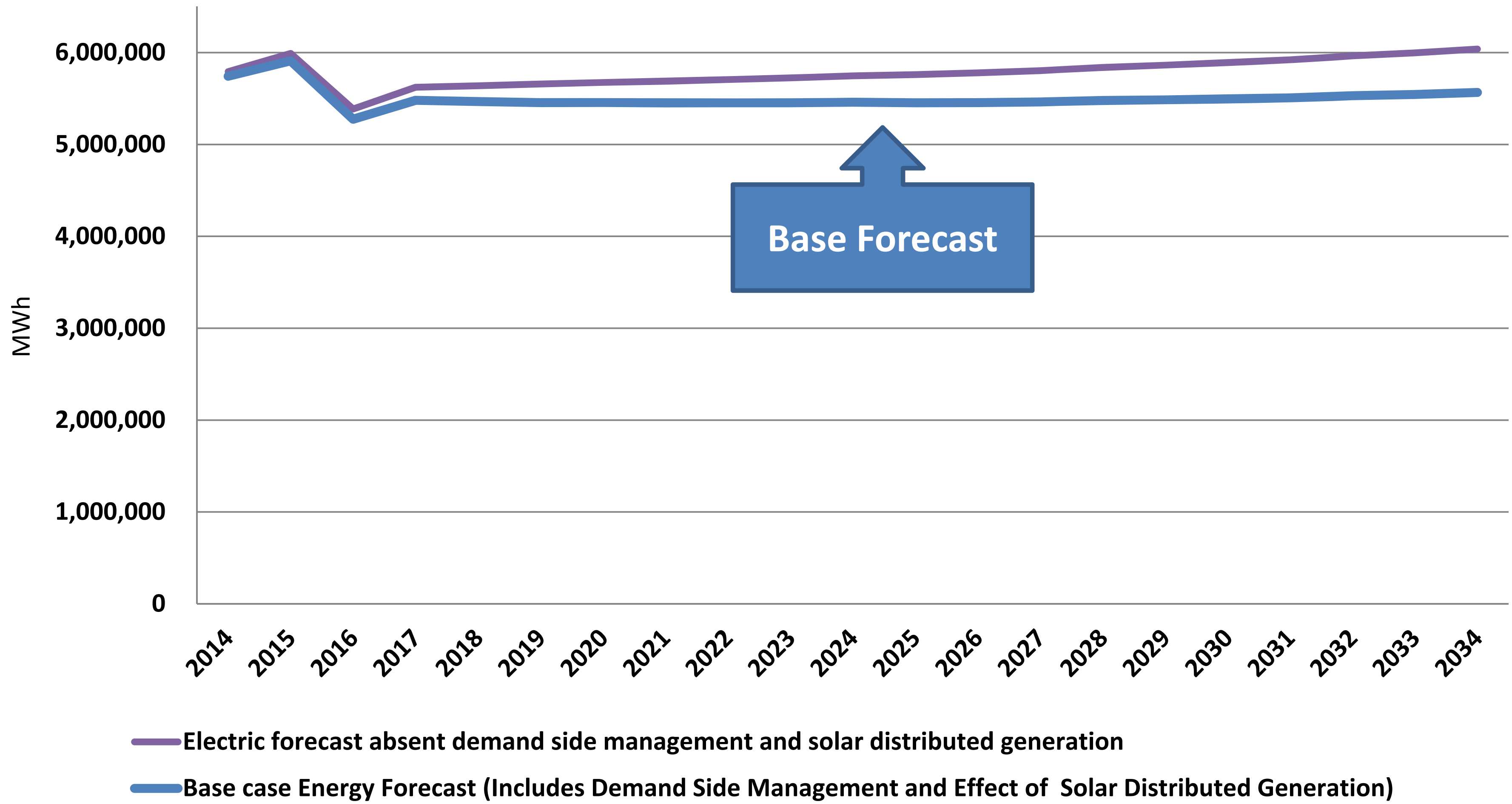
- Expect energy usage to remain relatively flat through the forecast period
  - Slow long-term population growth (0.3% annual growth) & moderate income growth (1% annual growth)
  - Strong end-use efficiency gains reflecting new and existing Federal codes and standards
    - Air conditioning, heating, lighting, refrigeration, cooking, etc. are all becoming more efficient over time
  - Customer owned generation
    - A Large industrial customer adoption of cogeneration
    - Residential and general service adoption of rooftop solar
  - Aggressive conservation program activity
    - Past and future

Demand Side Management (Conservation Programs)

- Vectren point of view on conservation
  - Fundamental part of what we do to serve customers and help customers manage their energy bills
  - Vectren considers an ongoing level of demand side management (DSM) as part of our base case load forecast, which helps mitigate the need for future generation. We will also consider more DSM as a resource as needed
  - Vectren has offered gas DSM programs since 2006 and some level on the electric side since 1990s (new programs beginning 2010)

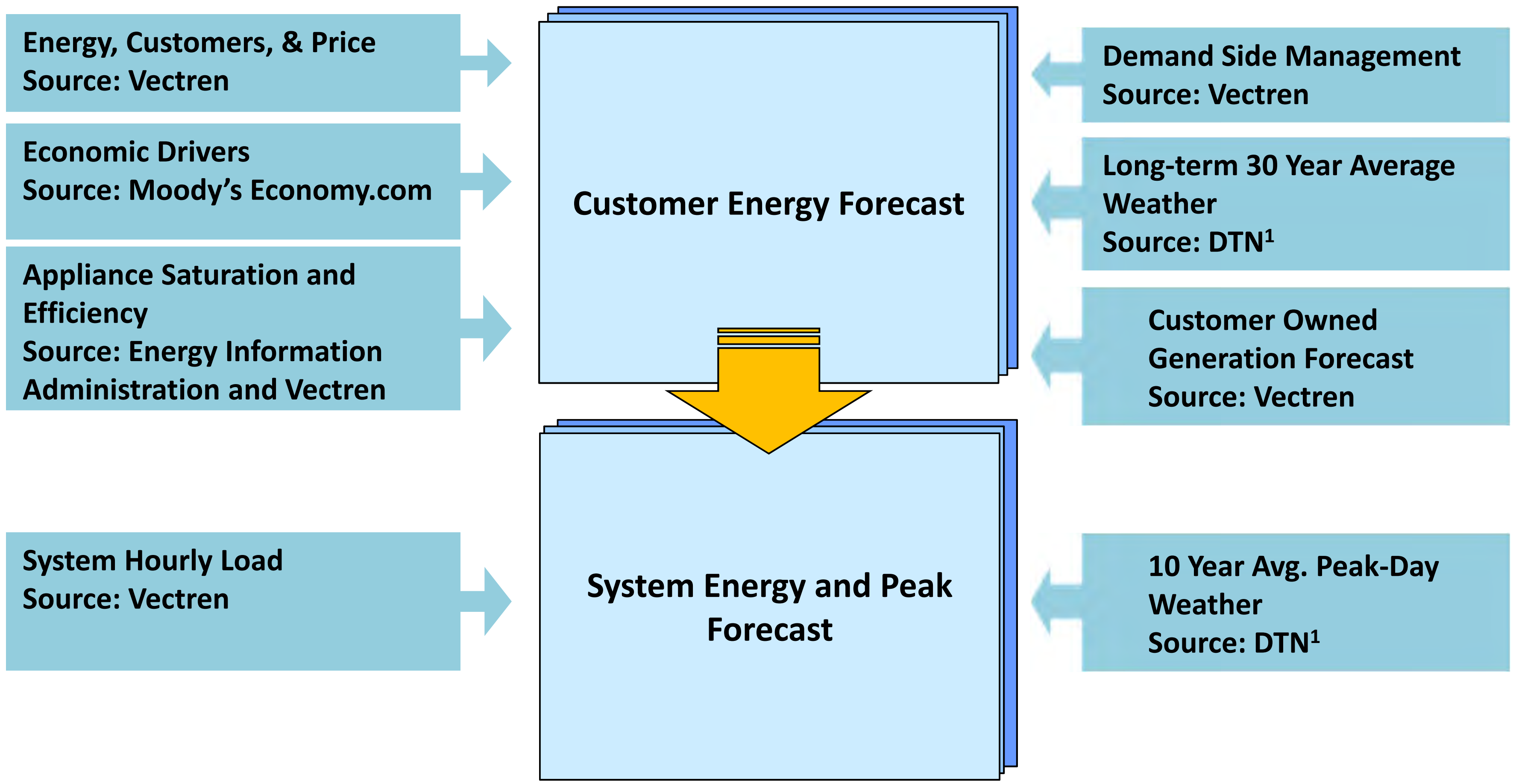
Base Energy Forecast

Includes Demand Side Management goals and customer-owned generation forecast



MWh = Mega Watt Hours

Bottom-Up Forecast Approach

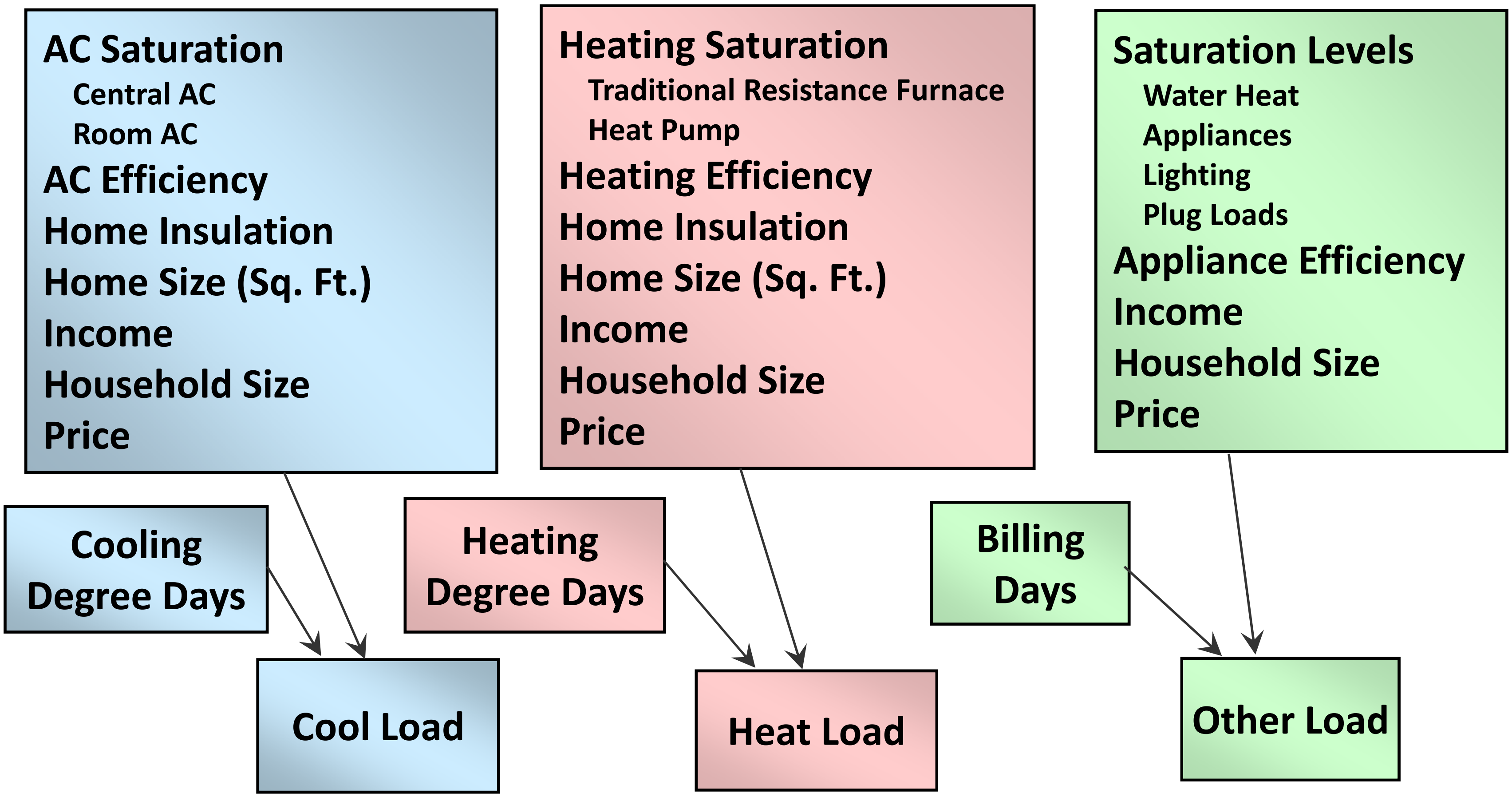


[1] Formerly Data Transmission Network, now known as DTN

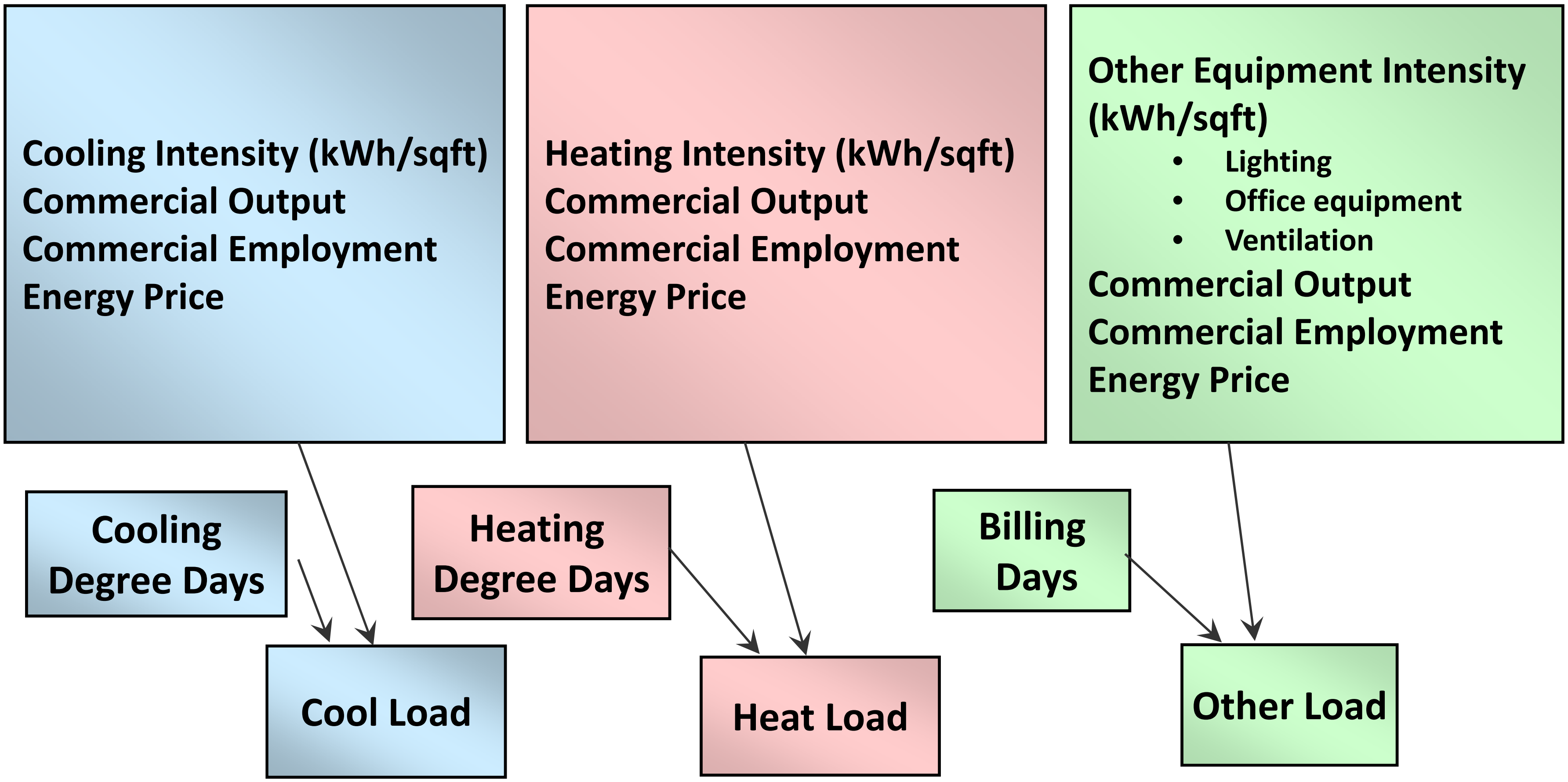
Energy Forecasts Estimated for Four Customer Types

- Residential forecast is the product of two factors
  - Average use
    - Input illustration follows
  - Customer count
    - Based on expected Evansville area long-term population growth
- General service (primarily commercial)
  - Input illustration follows
- Large customer (primarily industrial)
  - Based on manufacturing output and employment projections
- Street lighting
  - Simple seasonal model based on lighting history

Residential Average Use Framework



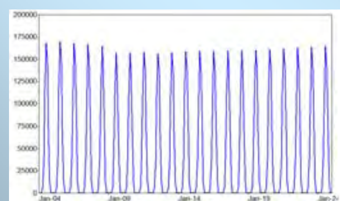
Commercial Energy Framework



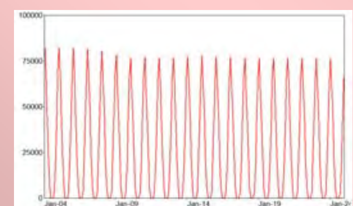
Peak Demand Forecast

- Peak demand is driven by heating, cooling, and base load requirements, which are derived from the customer energy forecast

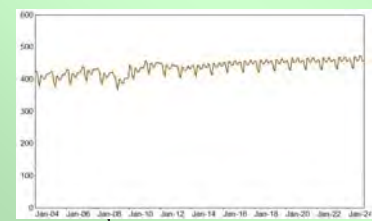
Cooling Load Requirements
- Residential
- General Service
- Large Customer



Heating Load Requirements
- Residential
- General Service



Base Load Requirements
- Residential
- General Service
- Large Customer
- Street Lighting



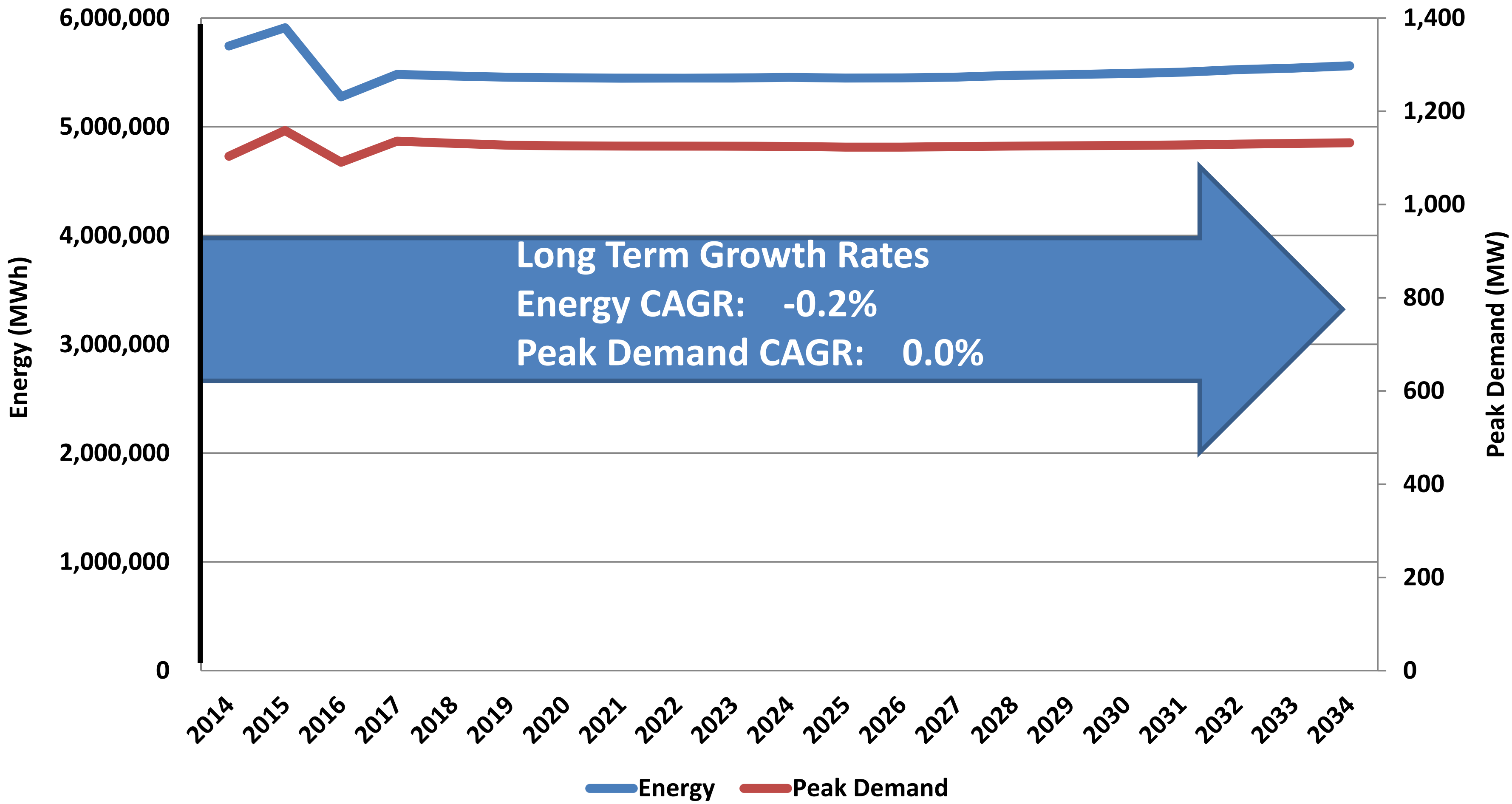
Peak-Day Temperature → **Peak Day Cooling**

Peak-Day Temperature → **Peak Day Heating**

Peak Day Base Load

Energy and Demand Forecast

Includes conservation goals and customer owned generation forecast



CAGR = Compound Annual Growth Rate MWh = Mega Watt Hours MW = Mega Watts

Questions

Demand Side Management: Energy Efficiency and Demand Response

Presented by Robbie Sears , Director of Conservation
2014 Vectren IRP Stakeholder Meeting
March 20, 2014

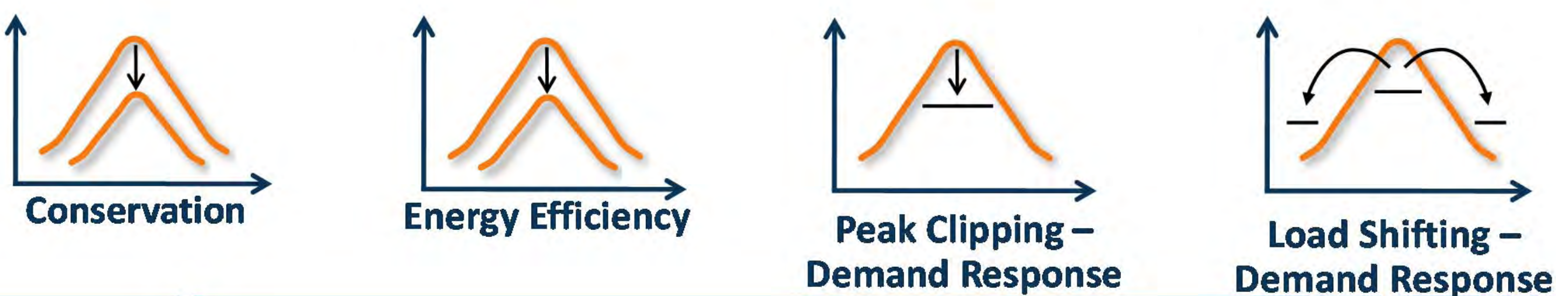
VECTREN Energy Delivery

What is Demand Side Management (DSM)

- The planning and implementation of programs and activities:
  - Designed to influence customers' use of energy in ways that produce desired changes in customer consumption
  - Reflects an intervention in the marketplace to achieve desired changes
  - Includes conservation, energy efficiency and demand response
- Vectren Point of View on DSM
  - Fundamental part of what we do to serve customers and help customers manage their energy bills
  - Vectren considers an ongoing level of DSM as part of our base case load forecast and also a resource for meeting future generation based upon need
  - Offered gas DSM programs since 2006 and began offering electric DSM during the 1990s with demand response components continuing today along with new energy efficiency programs in 2010

What is Demand Side Management (DSM)

- Energy conservation
  - Reducing use of energy
- Energy efficiency
  - Reducing use without impacting level of service
- Demand response
  - Reducing use from normal patterns



DSM Rules and Requirements

- DSM in Integrated Resource Planning:
  - Utility shall consider alternative methods of meeting future demand for electric service
  - Utility must consider demand-side resources as a source of new supply in meeting future electric service requirements
- In December 2009, the Indiana Utility Regulatory Commission (IURC) established DSM targets for all investor owned electric utilities
  - Energy saving targets increase from .3% in 2010 to 2% in 2019
  - Established a set of "Core" DSM programs to be administered by a 3rd party
  - Order allowed utilities to offer self-administered Core Plus programs
- In March 2014, the Indiana General Assembly passed legislation which modified DSM requirements in Indiana
  - Removed requirements for mandatory statewide "Core" DSM programs and savings requirements established in 2009
  - Provided for large customer opt-out of DSM programs (greater than 1 MW)
  - Provided for electric utilities to submit cost-effective energy efficiency plans to the Commission

Current Core and Core Plus Programs

- Vectren's 2014 portfolio of electric efficiency programs
  - Core Programs (Energizing Indiana)
    - Residential Lighting
    - Home Energy Assessment
    - Income Qualified Weatherization
    - School Education & Assessment
    - Commercial & Industrial Prescriptive
  - Core Plus Programs
    - Appliance Recycling
    - Multi-Family Direct Install
    - Residential HVAC
    - Residential New Construction
    - Residential Behavioral Savings
    - Small Business Energy Solutions
    - Commercial & Industrial New Construction
    - Commercial & Industrial Custom

Vectren Electric DSM Program Performance			
Program Year	Percent of Core Goals Achieved		Percent of Core Plus Goals Achieved
2010 (Evaluated)	NA		142%
2011 (Evaluated	NA		183%
2012 (Evaluated)	71%		98%
2013 (Reported)	73%		124%

HVAC = Heating, Ventilating, and Air Conditioning DSMCC = Demand Side Management Coordination Committee

DSM Program Governance

Core Program

- DSMCC provides oversight of the Core Programs with more engagement with the IURC for approval versus Oversight Board model
  - DSMCC members include 5-Investor Owned Utilities, Office of Utility Consumer Counselor, Industrial Group Representative, Citizens Group Representative (Citizens Action Coalition).
  - Responsibilities Include:
    - Develop/Coordinate program designs, selection and management of Statewide Program Administrator and Evaluation Administrator, statewide reporting database.

Core Plus Program

- Oversight Board provides governance/oversight of the Core Plus programs offered by Vectren based upon approved guidelines and funding approved by the IURC.
  - Vectren Electric DSM Oversight board members include Vectren, Office of Utility Consumer Counselor and Citizens Action Coalition.
  - Responsibilities include:
    - Governance/oversight responsibilities including flexibility to manage programs designs and budgets, conduct necessary studies related to Core Plus programs and manage the evaluation, verification and measurement of the programs.

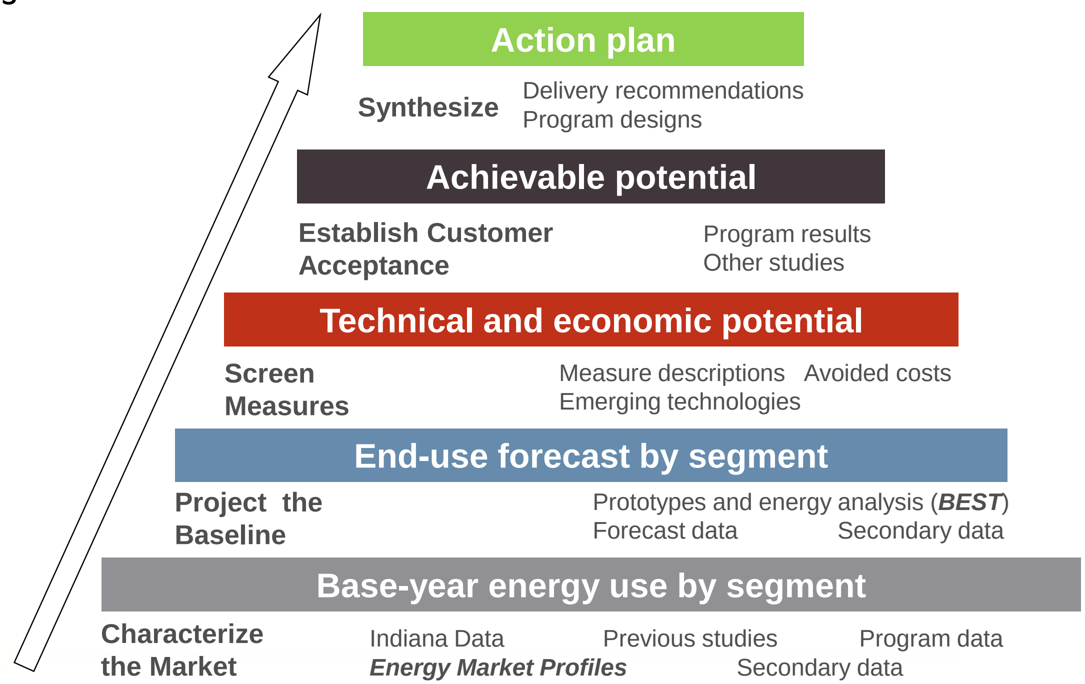
DSM programs savings evaluation and verification

- All programs in Vectren's EE portfolio are subject to cost-effectiveness testing as outlined by the Indiana Utility Regulatory Commission
  - Used to gauge the cost versus benefits of each program
  - Results are compared to other supply-side resources

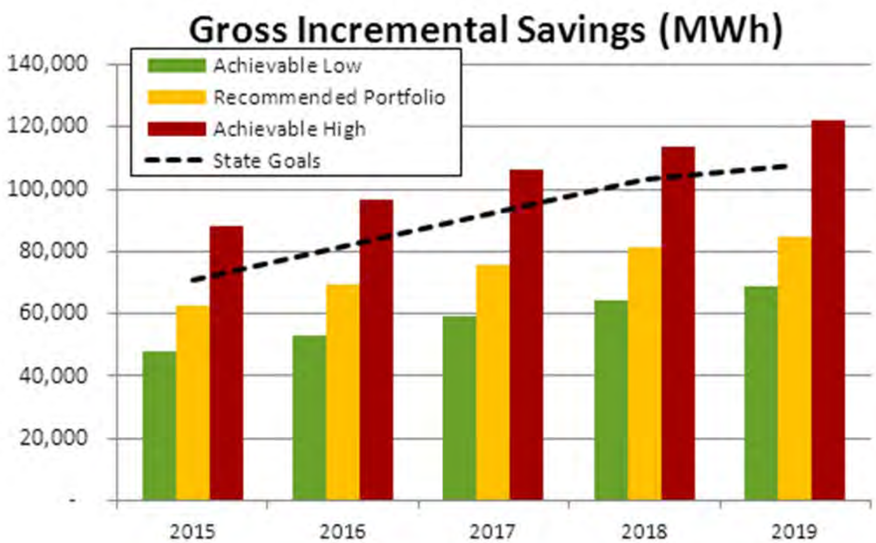
- All Core & Core Plus programs are evaluated annually to verify the energy saving impacts
  - Core programs are evaluated by an independent statewide evaluator
    - Currently Tek Market Works (team includes The Cadmus Group)
  - Core Plus programs are evaluated by an independent evaluator
    - Currently The Cadmus Group

Planning for DSM Programs

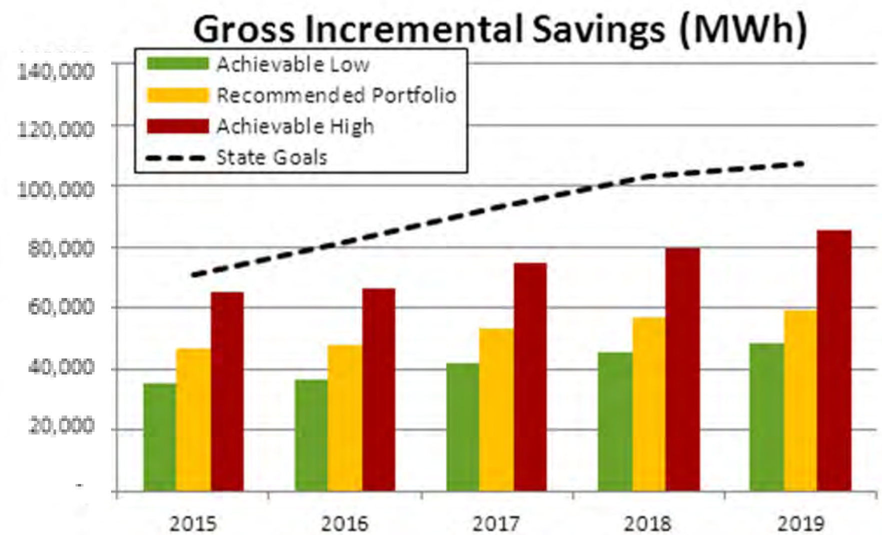
- In cooperation with the Vectren DSM Oversight Board, Vectren completed a DSM Market Potential Study (MPS) in 2013 to identify the potential savings from energy efficiency programs for 2015 – 2019
  - The Oversight Board selected and contracted Enernoc to perform the MPS
  - The Enernoc MPS ultimately provided a Low, High and Recommended Achievable Potential for DSM program savings as well as an action plan with program designs to achieve the savings



DSM market potential estimates for Vectren



2013 Market Potential Study – does not include load changes or large opt-out



2013 Market Potential Study modified to include load changes and 50% large opt-out

- Recommended savings is between the Low and High scenarios guidelines and consider the Indiana state goals, past program experience, industry benchmarks, and feedback from Vectren and Stakeholders
- Achievable High potential establishes a maximum target and involves incentives that represent a substantial portion of the incremental cost, high administrative and marketing costs, customer adoption under ideal market, implementation, information and customer preference conditions
- Achievable Low potential reflects expected program participation given barriers to customer acceptance, non-ideal implementation conditions, and limited program budgets

Current Demand Response Programs

- Vectren's Demand Response programs are primarily focused on reducing electric demand at peak times
- Vectren's Demand Response programs include:
  - Interruptible Contracts – contracts with larger commercial and industrial customers that are willing to reduce electrical consumption at peak times
    - Approximately 26 MW of peak load reduction
  - Residential and commercial air conditioner and water heater cycling/control during peak periods
    - Summer Cycler is voluntary energy management program, with 25,000 participants, that cycles cooling and water heating equipment during periods of peak electricity demand
    - Summer Cycler program participants can earn bill credits up to $20 per cooling system and $8 per electric water heating system over June through September
    - Approximately 17 MW of peak load reduction

Key DSM Assumptions in 2014 IRP

- Vectren will continue to offer cost-effective DSM to assist customers in managing their energy bills and meet future energy requirements
  - Include an ongoing level of energy efficiency in the load forecast
  - Vectren will also consider DSM as a source of new supply in meeting future electric service requirements
- DSM savings levels in the load forecast include:
  - DSM energy efficiency programs available to all customer classes
  - 1% annual savings target for 2015 – 2019 and 0.5% annually thereafter
    - Assumes that 50% of large customer load will opt-out of DSM programs
    - 0.5% of sales after 2019 may be larger if needed and cost effective
    - Estimated $100M DSM spend from 2015 - 2034
- The load forecast also includes an ongoing level of energy efficiency related to codes and standards embedded in the load forecast projections
  - Ongoing energy efficiency includes the impacts of new appliance efficiencies, changes in Federal standards regarding appliance efficiency, new building codes
- Demand Response impacts are considered as part of resource planning

Questions

Distributed Energy Resources

Presented by Josh Pack, Manager of Energy Technologies
2014 Vectren IRP Stakeholder Meeting
March 20, 2014

VECTREN
Energy Delivery

Overview

- Solar
- Combined Heat and Power
- Other Distributed Energy Resources

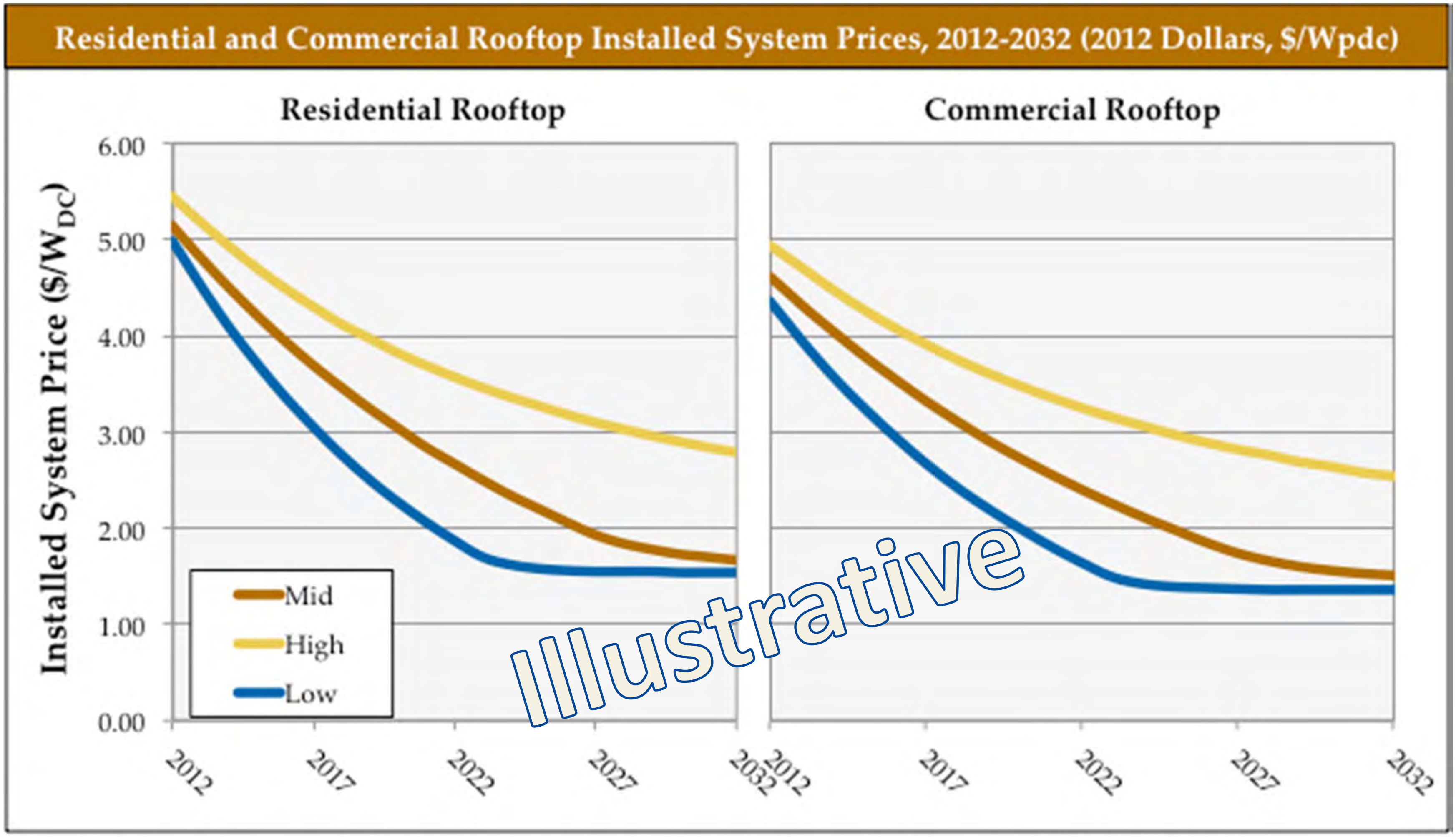
Solar Outlook

- National
  - 3.5 gigawatts of interconnected solar at the end of 2012
    - ~0.3% total installed generating capacity
  - 46% increase over 2011
- Indiana
  - Net metering growth
  - Larger projects

Solar Outlook (continued)

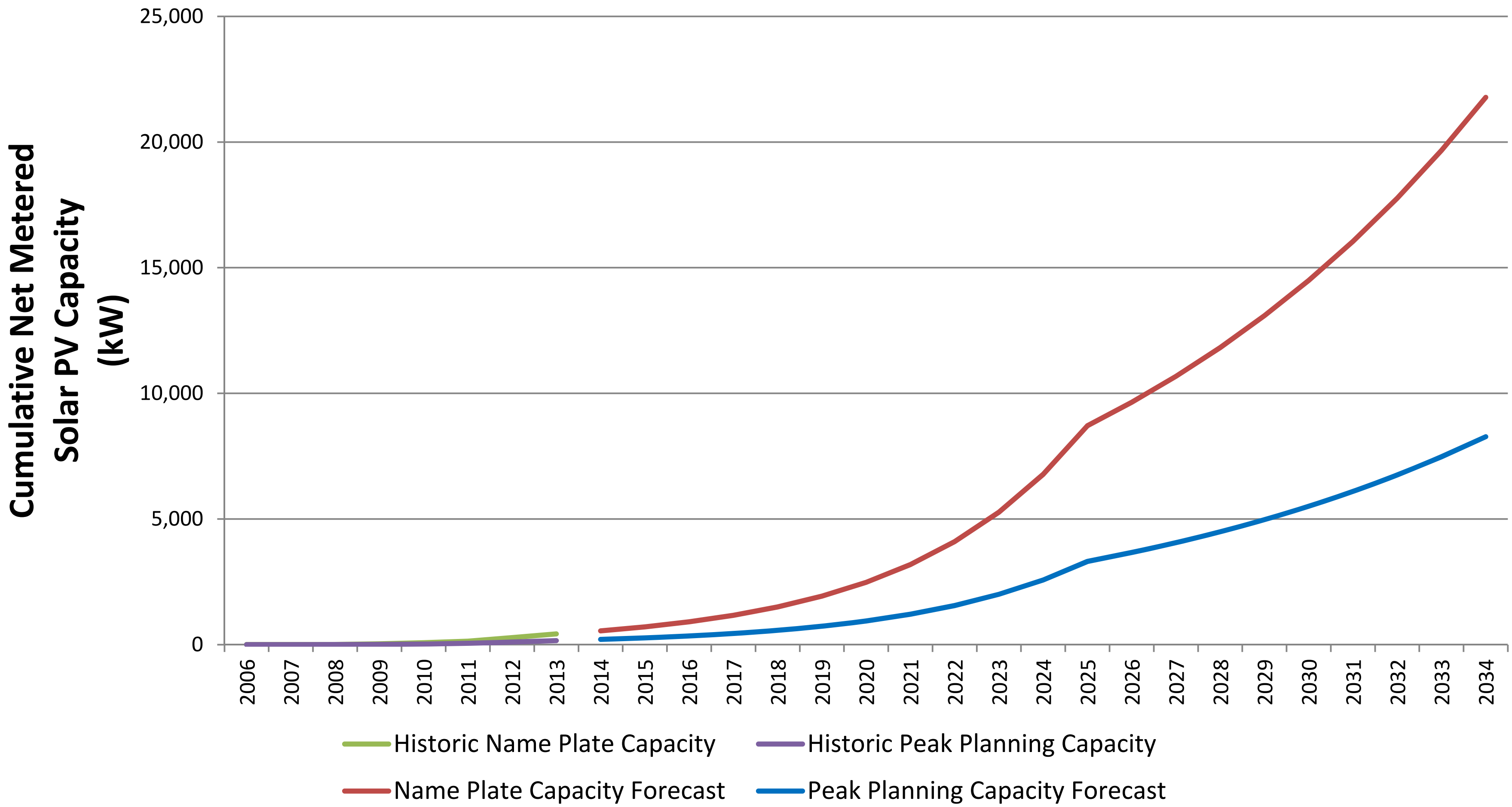
- Vectren
  - Solar resource
  - Customer interest
  - Potential customer benefits
  - Consider other solar options in the best interests of customers

Solar Economic Trends



Sources: Navigant estimate based on industry interviews, market reports, and primary market research 2012; SEPA Pricing Insert 2012; Goodrich et. al., NREL 2012; The SunShot Program, DOE; SRP cost data, various programs

Distributed Solar Capacity Forecast



kW = Kilo Watt
PV = Photo-Voltaic

Source: Navigant Indiana forecast adapted to Vectren early adoption rates.
Peak planning capacity adjustment is 38%.

Combined Heat and Power

- Combined Heat and Power (CHP)
  - Usually customer sited and owned
  - Heat requirements
- Technology options
  - Conventional
    - Natural gas reciprocating engines
    - Natural gas turbines
  - Advanced
    - Fuel cell
    - Microturbine
    - Micro-CHP

Other Distributed Energy Resources

- Vectren recognizes technology innovation is impacting the industry
- "Distributed Energy Resources" go beyond "Distributed Generation"
  - Microgrids
  - Energy storage
  - Building energy management (e.g. Nest)
  - Electric vehicles

VECTREN
Energy Delivery

Summary

- Solar
  - Consider other solar options in the best interests of customers
  - Recognize solar is an important issue
- Combined Heat and Power
  - Very case-specific
  - Technology options
- Actively monitoring trends in Distributed Generation and Distributed Energy Resources

Questions?

Generation Overview

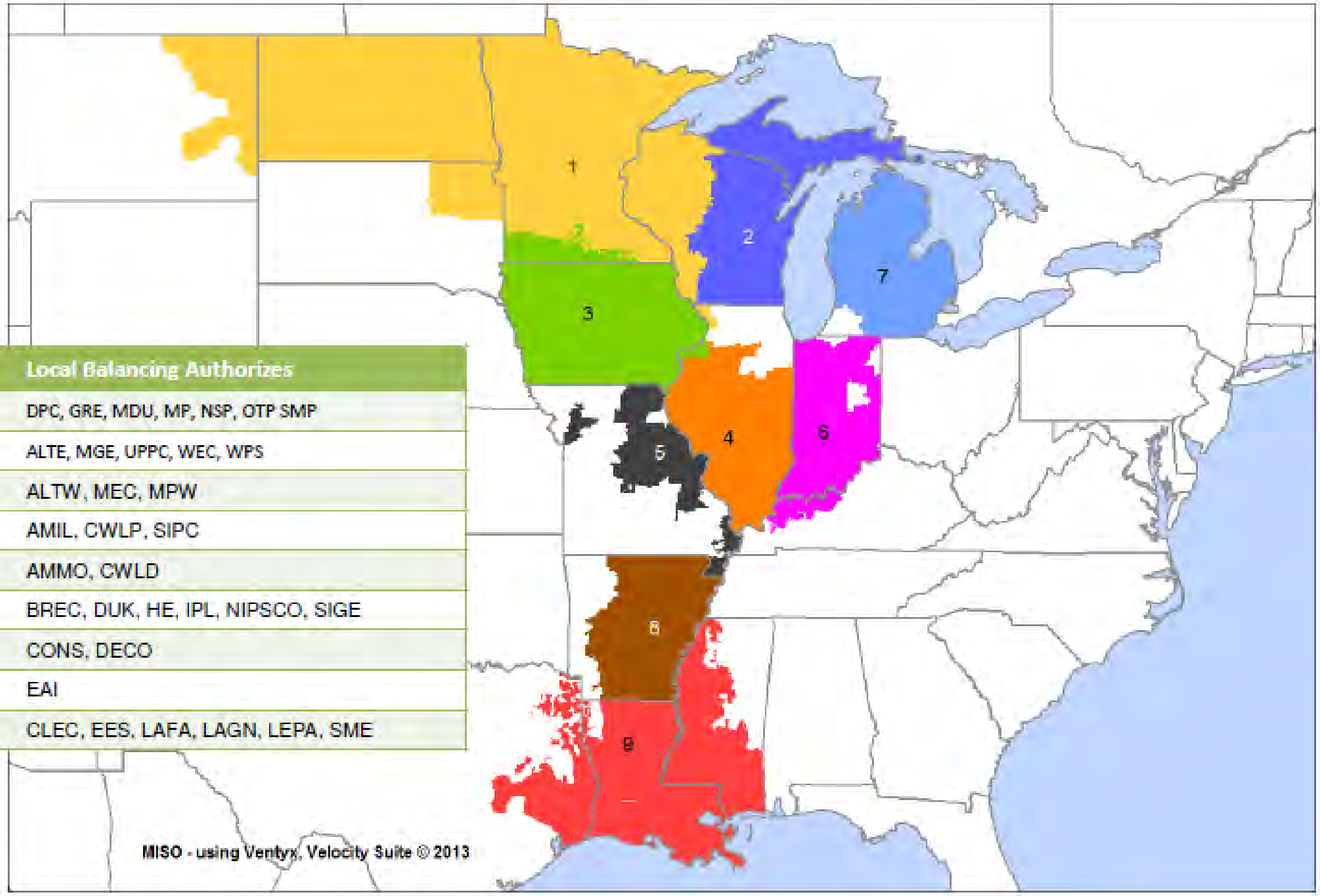
Presented by Wayne Games, Vice President of Power Supply
And Scott Brown, Manager Generation Planning
2014 Vectren IRP Stakeholder Meeting
March 20, 2014

VECTREN
Energy Delivery

Power Generation - Key Concepts

- Energy and Capacity are two separate things
- We deliver Energy to our customers
- We must have the Capacity to produce Energy to deliver to our customers
- Capacity is expressed as Kilowatts (KW) or Megawatts (MW) (1 MW = 1,000 KW)
- Energy is expressed as Kilowatt-Hours (KWH) or Megawatt-Hours (MWH) (1 MWH = 1,000 KWH)
- Planning Reserve Margin – Excess capacity required by MISO to ensure adequate generation will be available on the peak hour of the peak day.

MISO Footprint



LRZ	Local Balancing Authorizes
1	DPC, GRE, MDU, MP, NSP, OTP SMP
2	ALTE, MGE, UPPC, WEC, WPS
3	ALTW, MEC, MPW
4	AMIL, CWLP, SIPC
5	AMMO, CWLD
6	BREC, DUK, HE, IPL, NIPSCO, SIGE
7	CONS, DECO
8	EAI
9	CLEC, EES, LAFA, LAGN, LEPA, SME

MISO

MISO – Midcontinent Independent System Operator, Inc.

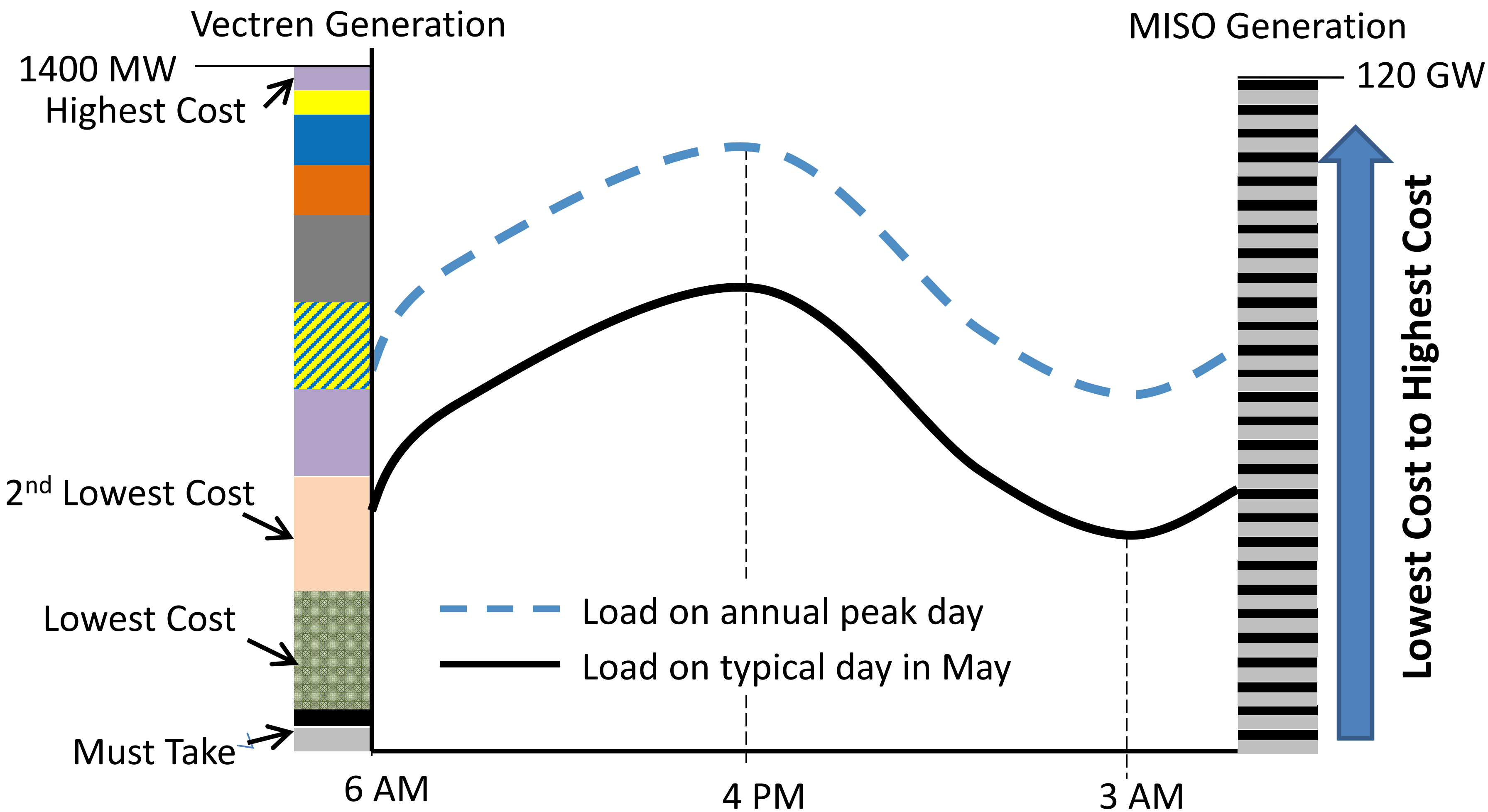
VECTREN
Energy Delivery

MISO's Role
Reliability And Economic Dispatch

- **MISO enhances transmission reliability**
  - A much larger pool of resources - (Both **energy** and **capacity**)
  - Coordinated planning
- **MISO enhances economic dispatch**
- **MISO's practices are reviewed by an independent market monitor, NERC, FERC and state government agencies**

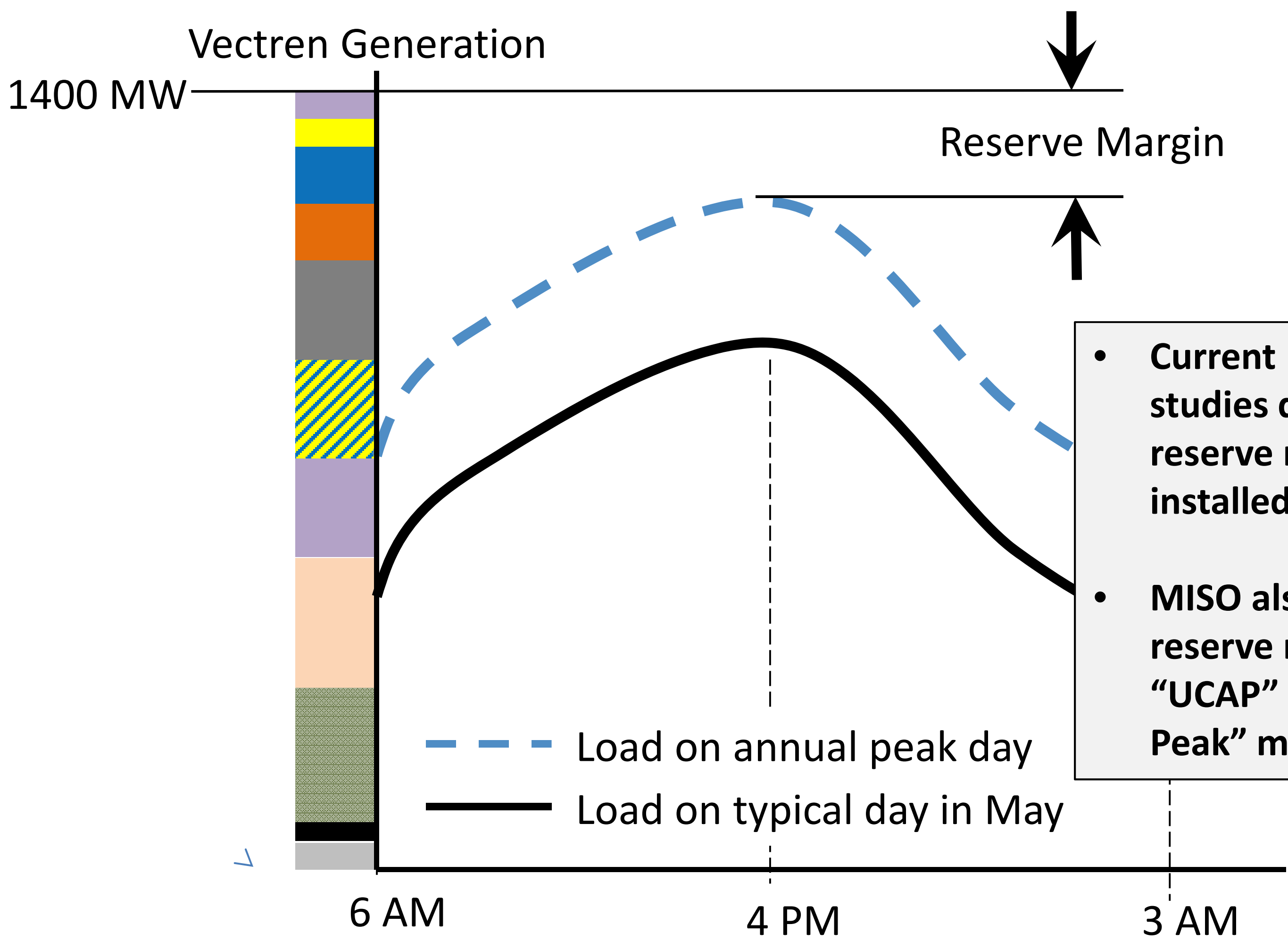
MISO – Midcontinent Independent System Operator, Inc.
NERC – North American Electric Reliability Corporation
FERC – Federal Energy Regulatory Commission

Economic Dispatch



MISO – Midcontinent Independent System Operator, Inc.
GW = Gigawatt = 1,000 MW.

Planning Reserve Margin



- **Current MISO reliability studies determine a 14.8% reserve margin on an installed capacity basis.**
- **MISO also computes a 7.3% reserve margin based on the "UCAP" and "Coincident Peak" method.**

Installed Capacity vs. Unforced Capacity

- The Unforced or "UCAP" capacity is what can be counted at the time of the annual peak load, based on averages over a few years
- Vectren and MISO's peak historically takes place in July or August
- For wind and solar, the averages over a few years of what is actually generated at the time of the system peak are much less than nameplate

Example 1: Based on history, our **80 MW** wind contract can only be counted on for about **7 MW** at the time of the summer peak (About 9% of nameplate)

Example 2: We expect solar to contribute about 38% of nameplate **capacity** at the time of the summer peak (Factors include temperature, cloud cover, angle of sun)

ISO – Independent System Operator

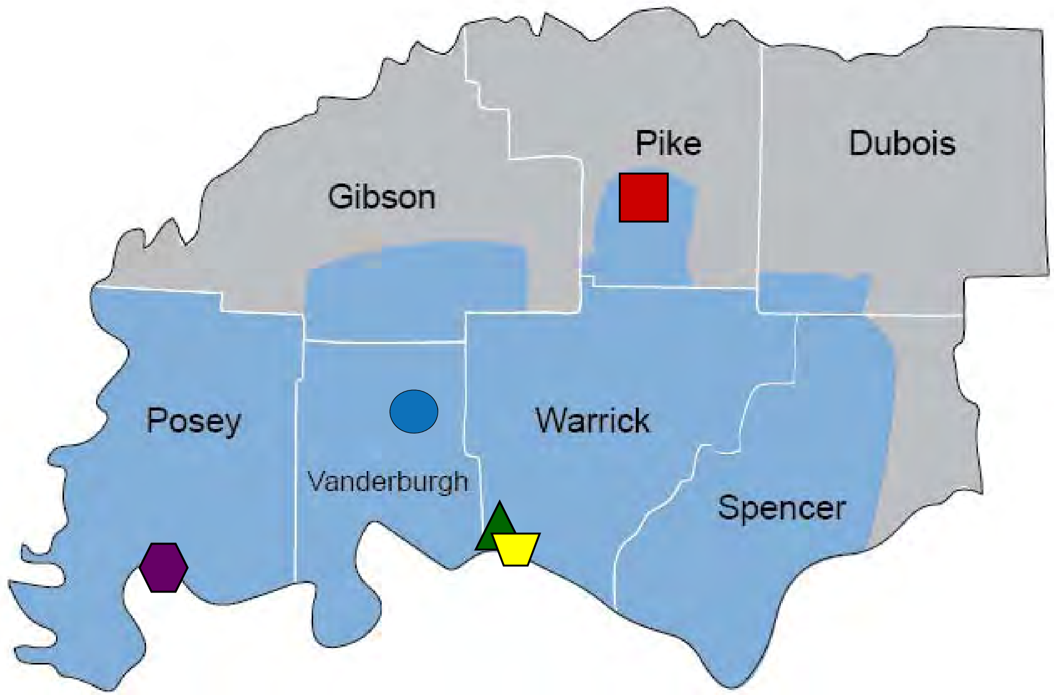
RTO – Regional Transmission Organization

Forced Outage is an unforeseen generation outage.

Vectren's Plant Sites

Vectren Energy Delivery of Indiana – South

Benton County, IN



Power plants

AB Brown

FB Culley

Warrick Unit 4

Blackfoot Clean Energy Plant

Broadway Ave. Peaking Units

Northeast Peaking Units

Fowler Ridge & Benton County Wind Farms

VECTREN Energy Delivery

Vectren Generating Facilities

A.B. Brown Power Plant –

Mt. Vernon, Ind., Posey County

- 2 units (coal) – **490 MW** (Built in 1979 & 1986)
- 2 units (natural gas) – See Peaking Units below

F.B. Culley Power Plant –

Newburgh, Ind., Warrick County

- 2 units (coal) – **360 MW** (Built in 1966 & 1973)

Warrick Unit 4 –

Newburgh, Ind., Warrick County

- 1 unit shared with Alcoa (coal) – **150 MW** of **300 MW** (Built in 1970)

Natural Gas Peaking Units –

Evansville, Ind., Vanderburgh County and Mt. Vernon, Ind., Posey County

- A.B. Brown – **150 MW** (Built in 1991 & 2002)
- Broadway Ave. – **115 MW** (Built in 1971 & 1981)
- Northeast – **20 MW** (Built in 1963 & 1964)

MW = Megawatt = 1,000 KW (Kilowatts)

Renewable Energy

- Wind PPA's (Benton County & Fowler Ridge)
  - Wind **Energy** from these **80 MW** contracts has ranged from **195,734 MWH** to **214,618 MWH** during the last 4 years

- Blackfoot Landfill Gas Project
  - Renewable **Energy** from this **3 MW** facility has ranged from **12,196 MWH** to **17,088 MWH** during the last 4 years

PPA – Purchase Power Agreement

Vectren Capacity

Vectren Installed Capacity

Coal - 1,000 MW

Gas Peaking - 285 MW

Landfill Gas - 3 MW

Vectren Installed - 1,288 MW

Other Capacity

Wind Purchase - 80 MW

OVEC - 32 MW

Total Other - 112 MW

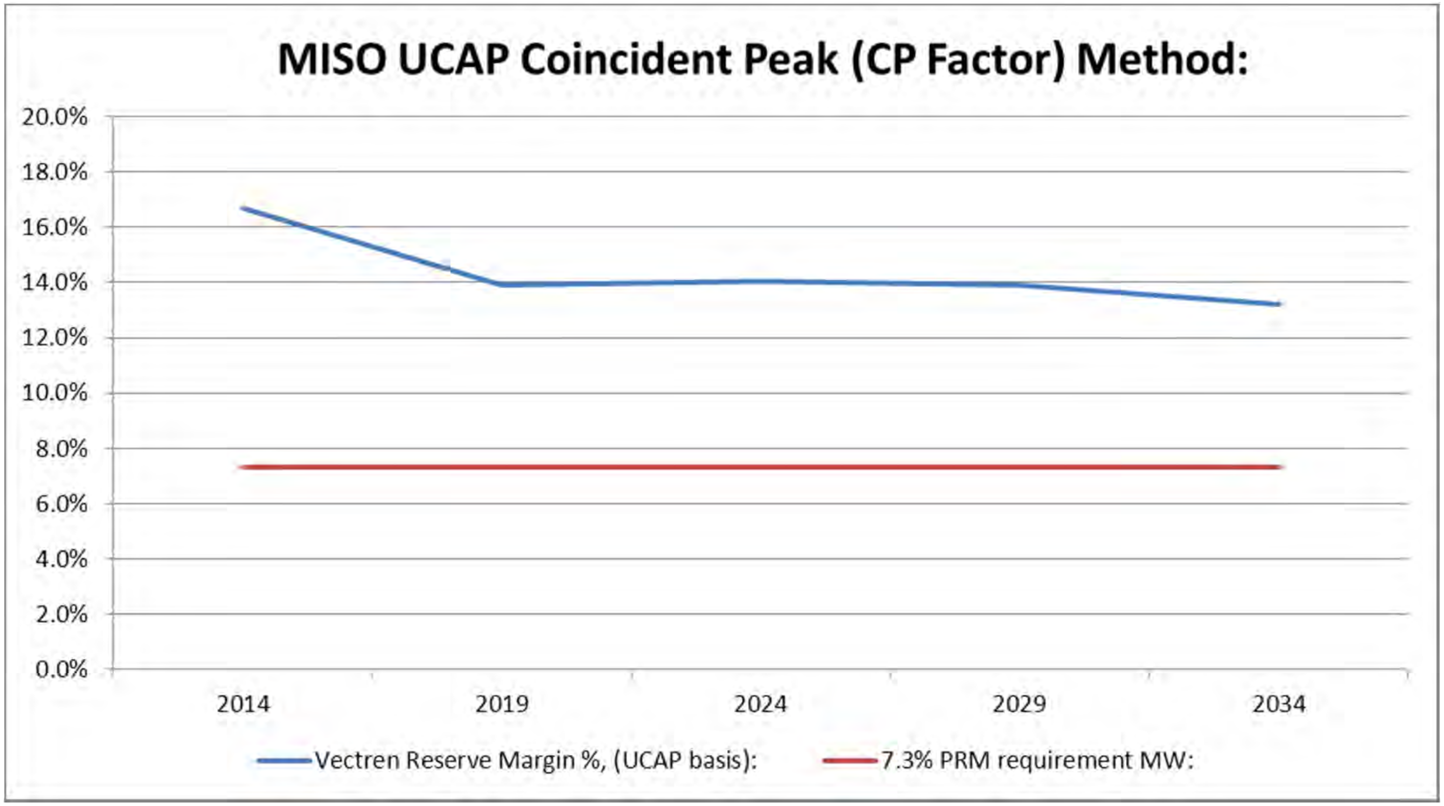
Total Installed Capacity = 1,400 MW

MISO – Midcontinent Independent System Operator, Inc.

PPA – Purchase Power Agreement

OVEC – Ohio Valley Electric Corporation – Vectren's 1.5% ownership share was acquired in 1953

Vectren Planning Reserve Margin (PRM)



MISO – Midcontinent Independent System Operator
PRM – Planning Reserve Margin
UCAP – Unforced Capacity - (Takes into consideration average availability and verification testing)
CP Factor – Coincident Peak Factor (We are typically at about 96% of our Vectren peak load at the time of the MISO system peak.)

MISO - Planning Reserve Margin

- MISO has expressed capacity concerns about unit retirements in the 2016 timeframe
- MISO's 2013 assessment raised the possibility of up to 6 GW of capacity shortfall in 2016
- In 2014 MISO revised the shortfall projection number down to 2 GW
- Vectren currently has adequate Planning Reserve Margin

Questions

Environmental Overview

Presented by Angila Retherford,

Vice President of Environmental Affairs & Corporate Sustainability

2014 Vectren IRP Stakeholder Meeting

March 20, 2014

VECTREN Energy Delivery

Current Environmental Controls

Unit	In Service Date	Generating Capacity	SO_2 Control	NO_x Control	Soot Control
Culley 2	1966	90 MW	Scrubber (1995)	Low NO_x (1995)	ESP (2011)
Culley 3	1973	270 MW	Scrubber (1995)	SCR (2003)	Fabric Filter (2006)
Brown 1	1979	245 MW	Scrubber (1979)	SCR (2005)	Fabric Filter (2004)
Brown 2	1986	245 MW	Scrubber (1986)	SCR (2004)	ESP (2000)
Warrick 4	1970	150 MW	Scrubber (2009)	SCR (2004)	ESP (2008)

SO_2 = Sulfur dioxide
NO_x = Nitrogen oxide
MW = Mega Watts

ESP = Electricstatic Precipitator (used for particulate removal)
SCR = Selective catalytic reduction

VECTREN Energy Delivery

Current Environmental Regulations

- Multiple federal environmental initiatives affecting electric steam generating units
  - Air emissions
    - Clean Air Interstate Rule /Cross State Air Pollution Rule
    - Mercury and Air Toxics Rule
    - Greenhouse Gas Permitting (PSD and major source Title V)
  - Wastewater discharges
    - Increased focus on wastewater from pollution control equipment
    - NPDES water discharge permits
      - First ever mercury discharge limits in recent NPDES renewals
      - Chemical-precipitation treatment system chosen for Culley and Brown plants

PSD = Prevention of Significant Deterioration
NPDES = National Pollution Discharge Elimination System (water permit program)

Future Environmental Regulations

- Coal Combustion Residuals Rule
  - Currently a majority of our fly-ash and scrubber by-product is beneficially reused in encapsulated concrete and synthetic gypsum applications
  - New regulations proposed as a reaction to the TVA dam breach
    - Hazardous vs. solid waste regulations
    - Beneficial Reuse (encapsulated uses) allowed in both Subtitle C and D proposals
      - Recent EPA studies finding encapsulated uses pose no threat to public health and environment.
    - Timing: Recent consent decree deadline December 2014
    - Under either regulatory scenario chosen by the EPA, Vectren will continue to beneficially reuse its fly ash. Timing and costs of existing pond closures will be determined by the EPA in its final rule. Unit retirement considerations are not influenced by pond closure costs, as costs would be applied whether a unit is retired or continues to operate

TVA = Tennessee Valley Authority

Future Environmental Regulations cont.

- Clean Water Act 316(b)
  - Fish Entrainment / Impingement
  - Once through (Culley) versus closed loop (AB Brown) cooling systems
  - Proposal to be finalized in April 2014
- NPDES Water Discharge Permits
  - Increased removal of pollutants from flue gas results in more pollutants in water discharges
  - EPA's proposed Effluent Limitation Guidelines will be incorporated in subsequent NPDES permit renewals. Currently Vectren falls out of some of the 8 listed options due to the size of our units

NPDES = National Pollution Discharge Elimination System (water permit program)
EPA = Environmental Protection Agency

Future Environmental Regulations cont.

- Greenhouse Gas Rulemakings driven by Administration's Climate Action Plan
- New Source Performance Standards for new sources (CAA 111b)
  - EPA set separate emission standards for coal-fired and baseload natural gas combined cycle units and created a less stringent standard for simple cycle peaking units
  - Emission standard for new coal-fired units still so low as to require partial carbon capture and sequestration (CCS)
- New Source Performance Standards for existing sources (CAA 111d)
  - EPA to issue emission guidelines for states to implement through State Implementation Plans
    - Deadlines in Climate Action Plan
      - Proposed June 2014: Finalized June 2015
      - State Implementation Plans due June 2016
  - EPA authority limited to setting efficiency targets for existing units
  - Vectren's generation portfolio have reduced GHG emissions 23% since 2005

CAA = Clean Air Act
EPA = Environmental Protection Agency
GHG = Green House Gas

Upcoming Environmental Projects

- Recent environmental compliance filing pending before IURC. Total estimated $70-90 million for compliance with three new federal environmental initiatives:
  - Mercury and Air Toxics Standards
    - Organo-sulfide scrubber additives
    - HBr injection
  - NPDES mercury limits
  - SO3 mitigation as required by EPA

IURC = Indiana Utility Regulatory Commission
HBr = Hydrogen Bromide
SO3 = Sulfur trioxide
EPA = Environmental Protection Agency

Questions?

Planning Inputs

Presented by Matthew Lind, P.E.

Senior Project Manager, Business & Technology Services

Burns & McDonnell Engineering

2014 Vectren IRP Stakeholder Meeting

March 20, 2014

VECTREN
Energy Delivery

Overview

- Burns & McDonnell has produced a Generation Technology Assessment that looks at a wide range of generation resources to place into the Strategist planning tool
- The planning tool will create feasible generation portfolios over 20 year forecast
- What and when to deploy to achieve lowest total customer costs
  - Capital Costs
  - Fuel Costs
  - O&M Costs
  - Environmental Compliance Costs (including carbon cost estimates)

Strategist is a utility planning software from Ventyx software.

Generation Technology Assessment

Burns & McDonnell's Generation Technology Assessment Report includes the following types of future resources:

- Different classes of Simple Cycle Gas Turbines
- Reciprocating Engine
- Different classes of Combined Cycles
- Battery
- Compressed Air
- Wind
- Solar
- Hydro
- Small Modular Nuclear
- Wood
- Landfill Gas
- Coal
- Integrated Gasification Combined Cycle

Generation Technology Assessment

Examples of likely candidates for gas fired generation for capacity expansion:

	Popular Gas Turbine Types			
Simple Cycle Gas Turbine	LM6000	LMS100	E-Class	F-Class
Initial Unit				
Base Load Net Output (kW)	49,100	106,400	87,500	212,800
Base Load Net Heat Rate (Btu/kWh)	9,570	8,860	11,480	9,940
Percent Efficiency	35.7%	38.5%	29.7%	34.3%
Total Project Costs (2013 $/kW)	$2,015	$1,677	$1,651	$767

Examples of likely candidates for combined cycle generation for capacity expansion:

Combined Cycle	1x1 F-Class
1x1 Plant Configuration	
Base Load Net Output (kW)	317,500
Base Load Net Heat Rate (Btu/kWh)	6,610
Percent Efficiency	51.6%
Total Project Costs (2013 $/kW)	$1,378

kW = Kilowatt kWh = Kilowatt hour

1x1 Combined Cycle Plant is one combustion turbine and one steam turbine utilizing the unused exhaust heat from the combustion turbine.

Generation Technology Assessment

Examples of likely candidates for renewable energy generation capacity expansion:

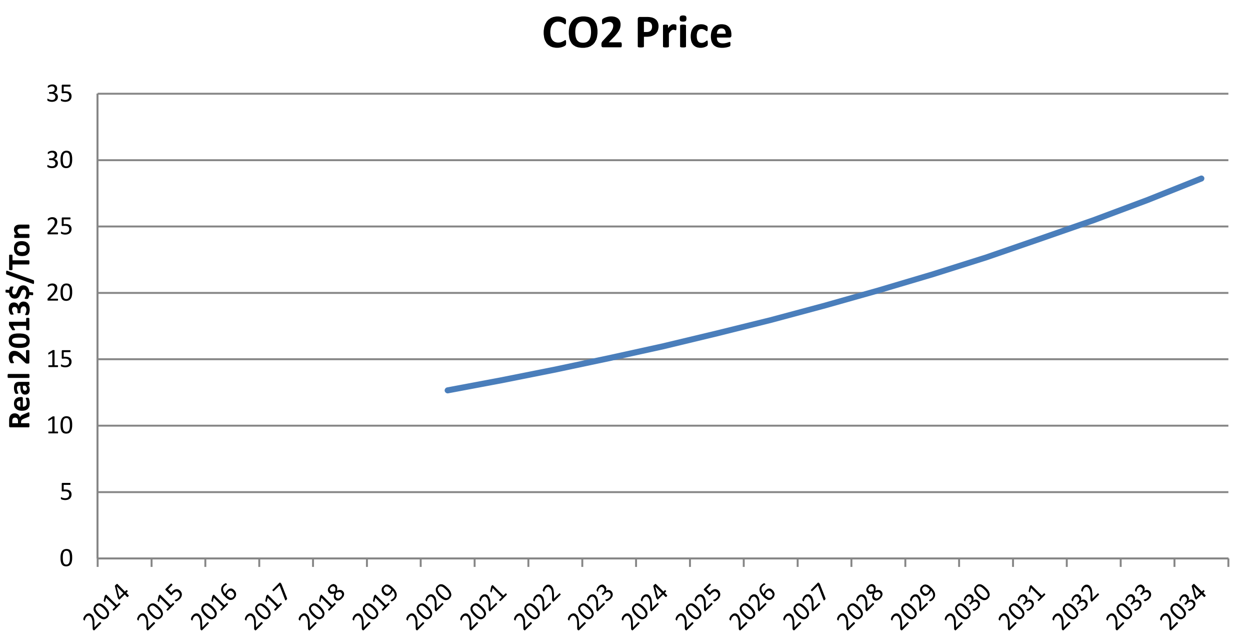
Renewable Generation	Solar Photovoltaic Cells	Hydro	Wind
Initial Unit			
Base Load Net Output (kW)	Scalable	Scalable	Scalable
Capacity Factor (energy annual output)	Intermittent (19%)	44%	Intermittent (27%)
Total Project Costs (2013 $/kW)	$3,070	$4,888	$2,260

- The Technology Assessment numbers were taken as of October 2013. Solar has been showing a decreasing rate to build in the future.

kW = Kilowatt
kWh = Kilowatt hour
PPA = Purchase power agreement

Forecast Inputs

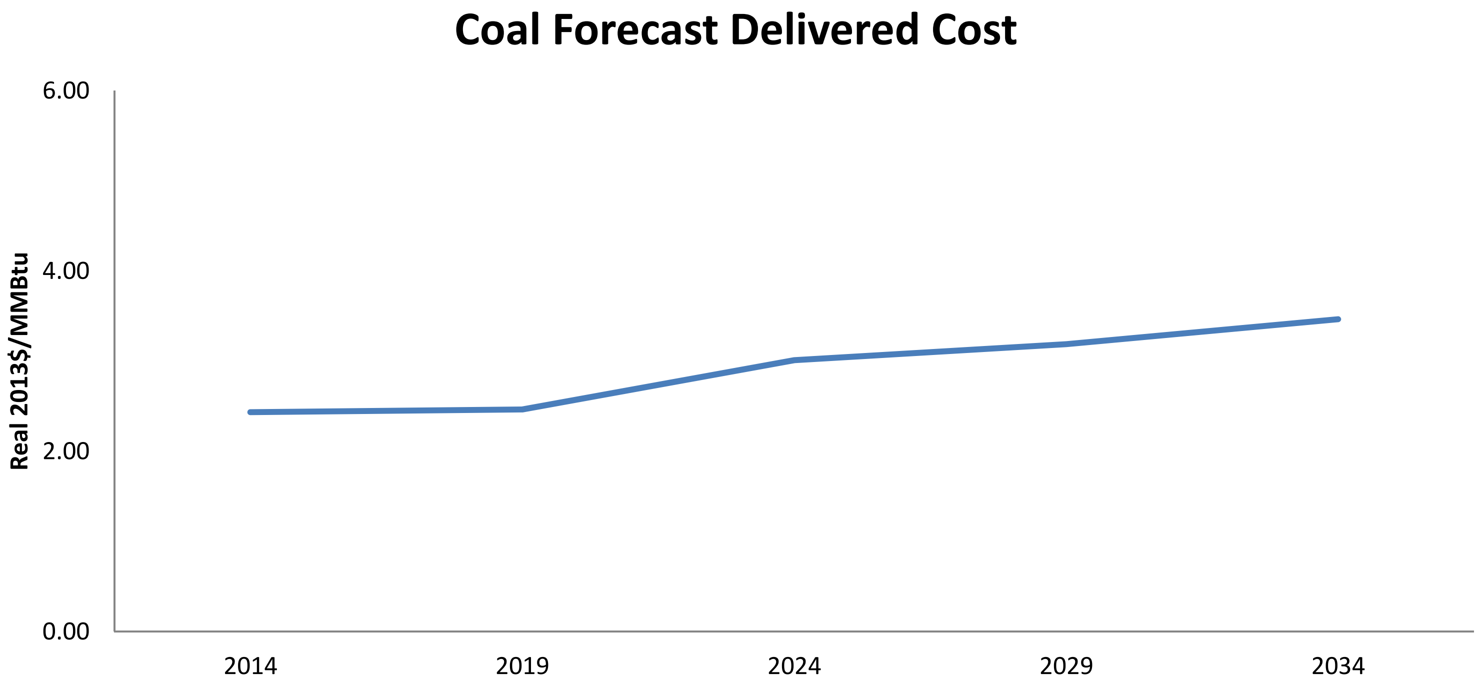
Carbon Pricing Forecast



- Vectren is assuming carbon price of $12.66 in Real 2013 $/Ton starting in year 2020 and increasing at an average annual growth rate of 5.7%. (This was derived from Waxman-Markey Climate bill, American Clean Energy and Security Act of 2009, which passed in the U.S. House of Representatives on June 26, 2009.)

Forecast Inputs

Coal Pricing Forecast



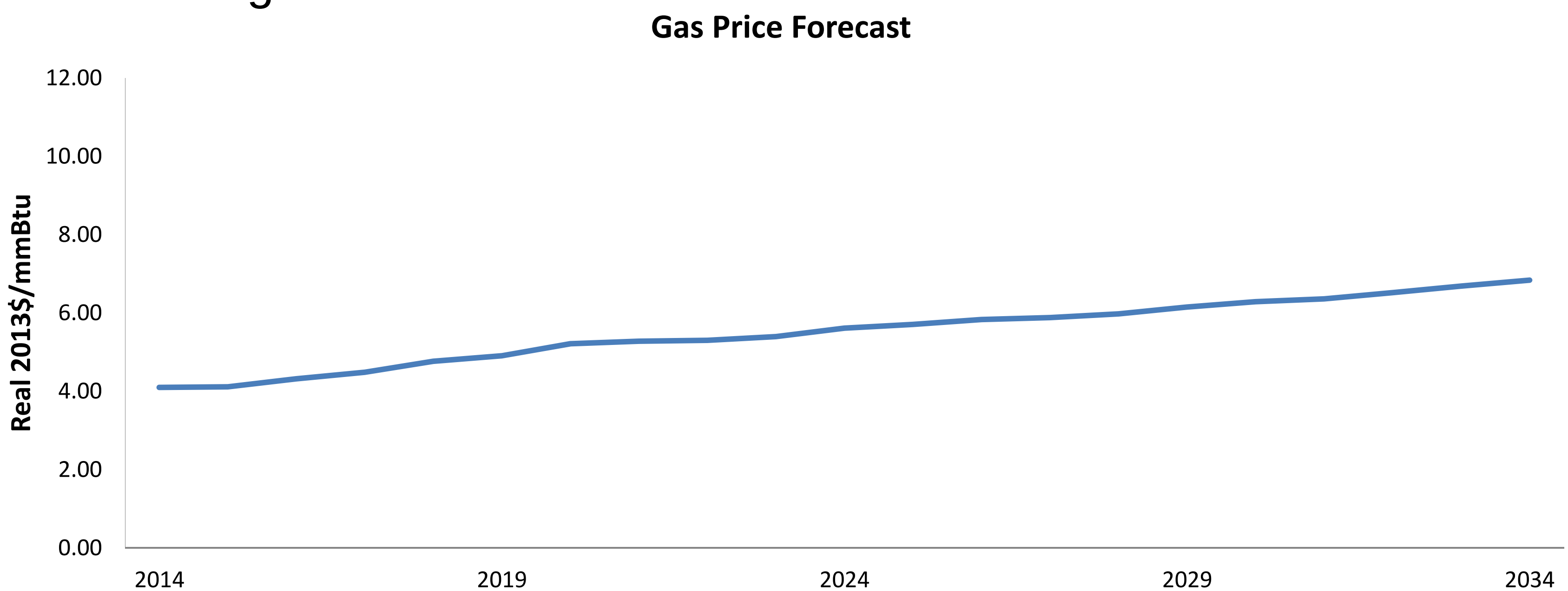
- The coal pricing forecast is a combination of the EIA AEO 2014 coal forecast, Wood Mackenzie's coal forecast, and a 3rd party consultant's coal forecast.

EIA – Energy Information Administration

AEO – Annual Energy Overview

Forecast Inputs

Gas Pricing Forecast



- The gas pricing forecast is a combination of the EIA AEO 2014 gas forecast, Wood Mackenzie's gas forecast, and a 3rd party consultant's gas forecast
- The wholesale electric market prices will be derived from fuel pricing assumptions and the market as part of the study

EIA – Energy Information Administration

AEO – Annual Energy Overview

Questions?

Generation Planning Analysis Road Map

Presented by Matthew Lind, P.E.
Senior Project Manager, Business & Technology Services
Burns & McDonnell Engineering

2014 Vectren IRP Stakeholder Meeting
March 20, 2014

VECTREN
Energy Delivery

IRP Goals

- **Develop a future power supply plan that balances**
  - **Cost**
  - **Reliability**
  - **Environmental Stewardship**

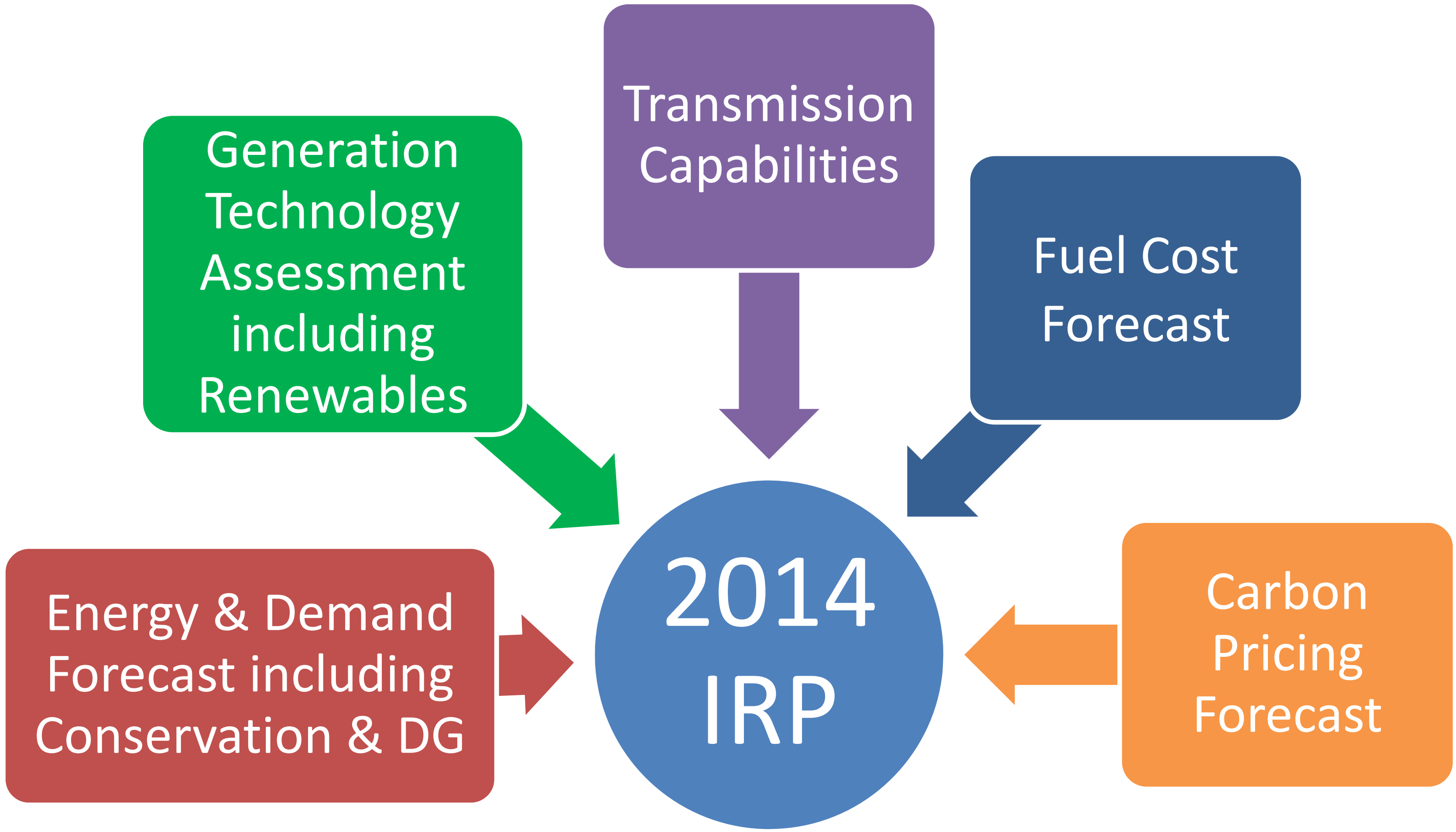
IRP – Integrated Resource Plan

Discussion Purpose

- **Objective**: Create IRP design that is understandable, robust, and in the best interest of Vectren customers
- Provide foundation for understanding IRP analysis approach
- Define planning approach
- Gather participant feedback and input

IRP – Integrated Resource Plan

Analysis Considerations



IRP – Integrated Resource Plan

DG – Distributed Generation (Solar)

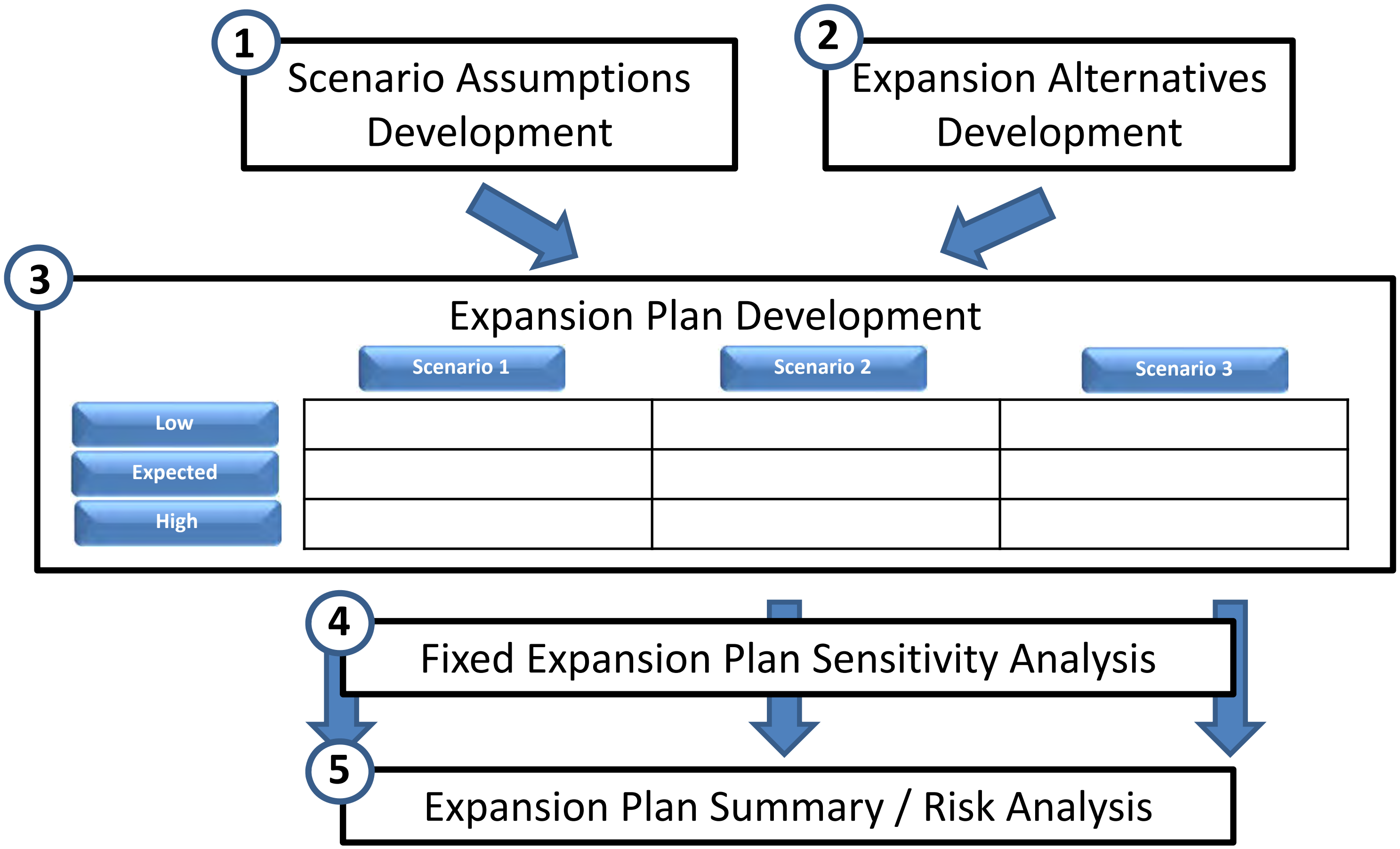
2014 IRP Assumptions Development

- **Objective:** Clearly define analysis assumptions starting point
- **Primary Sources:**
  - Burns & McDonnell's Generation Technology Assessment
  - Energy Information Administration (U.S. DOE)
  - Wood Mackenzie
  - SNL.com (energy data information provider)
  - Sales & Demand Forecast (Vectren & Itron)
  - Other Forecasts (subscriptions, publicly available information and 3rd party consultant information)

IRP – Integrated Resource Plan

DOE – Department of Energy

2014 IRP Analysis Approach

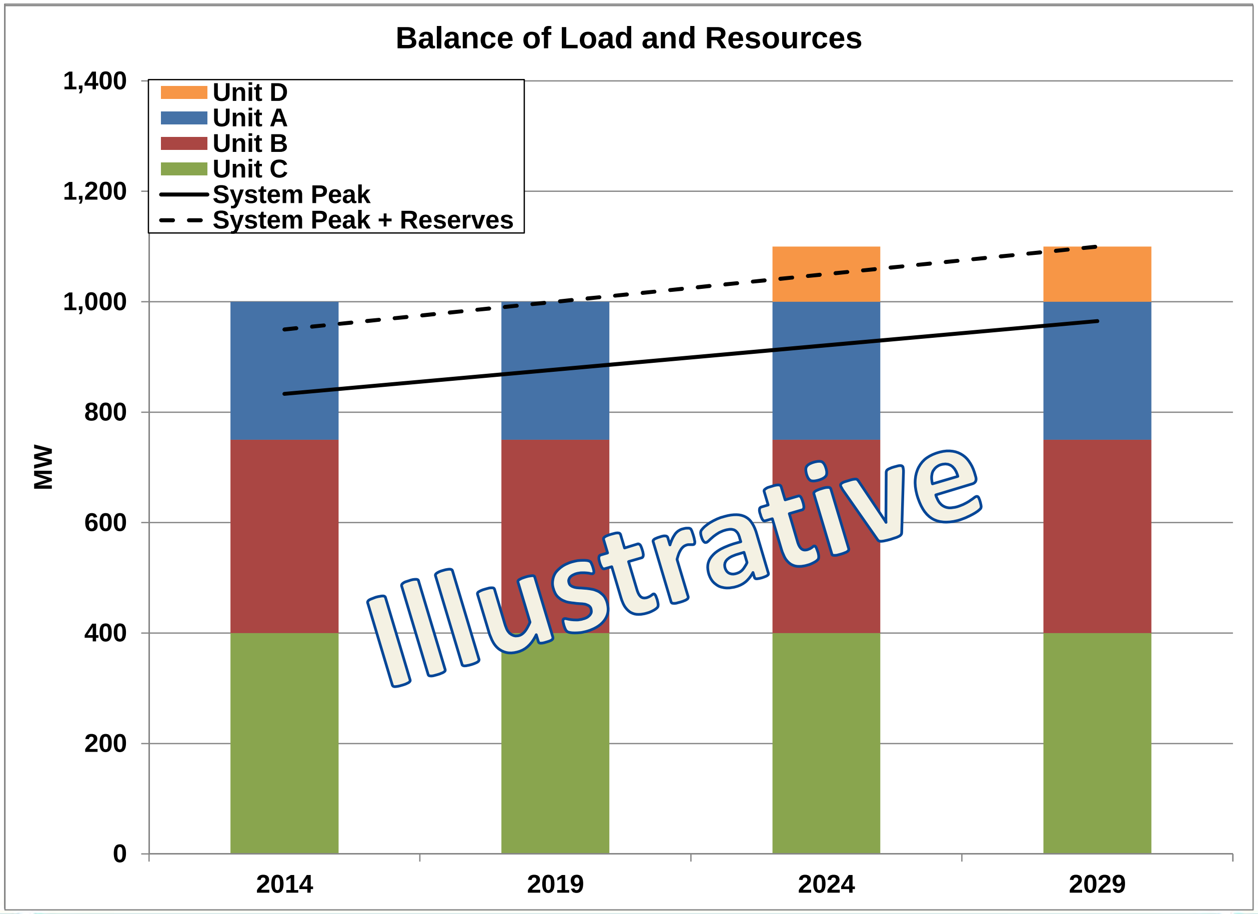


Sensitivity analysis is "What If?" testing

Risk analysis identifies the "Best Option" plan

Planning Tool Background

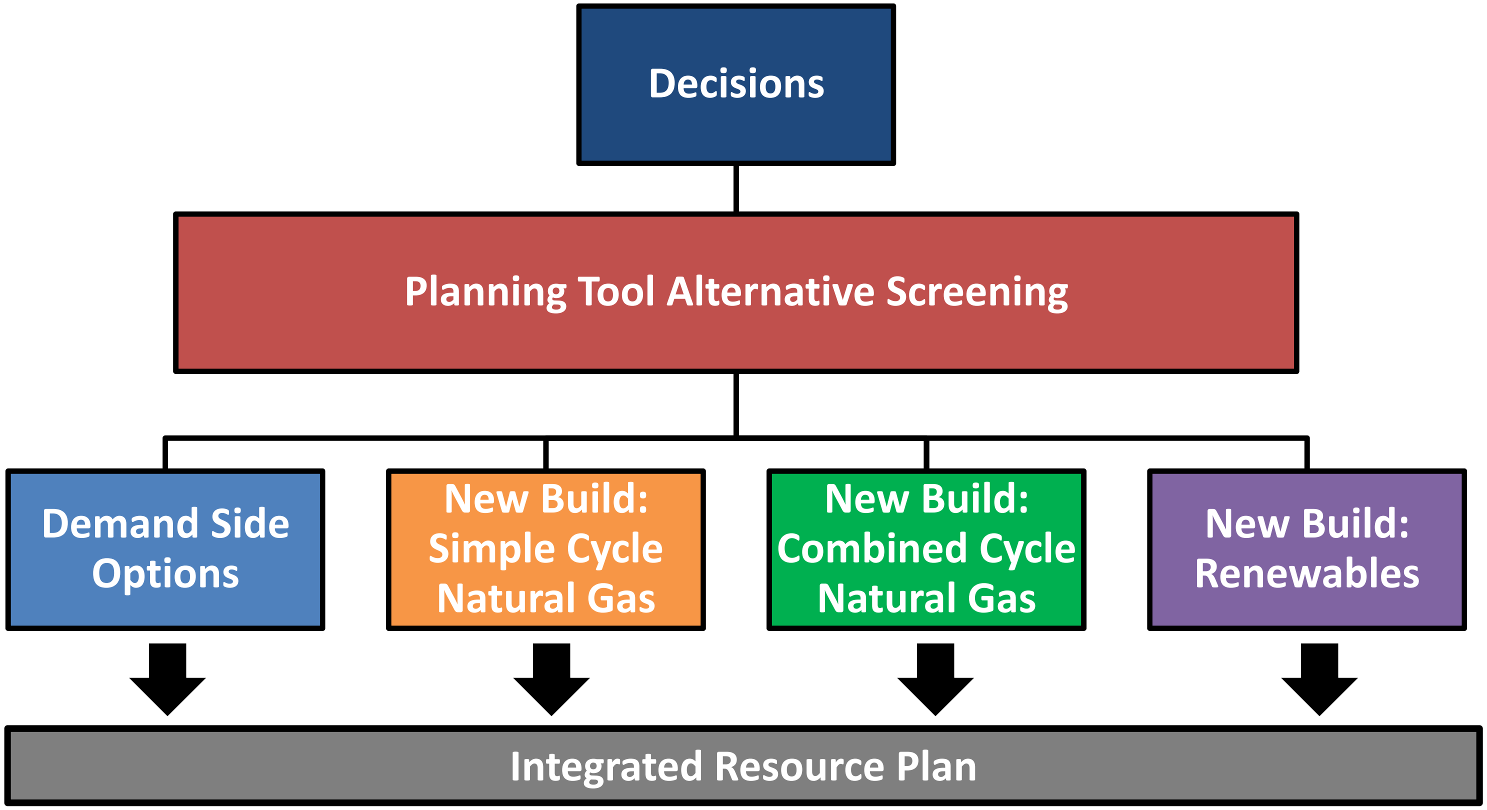
- Demand forecast informs expansion plan need
  (illustrative of a high load forecast)



Planning Tool Background cont.

- Other factors considered in planning tool
  - Renewable energy standard
  - Emission limits
  - Economic
- Define resource options
  - New alternatives
- Define resource option availability
  - Earliest in service date

Expansion Plan Determination



Scenario Expansion Plan Development

	Scenario 1	Scenario 2	Scenario 3
Low Energy Forecast	Expansion Plan	Expansion Plan	Expansion Plan
Base Energy Forecast	Expansion Plan	Expansion Plan	Expansion Plan
High Energy Forecast	Expansion Plan	Expansion Plan	Expansion Plan

Sensitivity Approach

- **Objective**: Identify potential risks
- Fuel (natural gas, coal) pricing
- Wholesale market pricing (MISO)
- CO2 price
- Technology capital costs
- Mandatory renewable portfolio standards
- Load growth

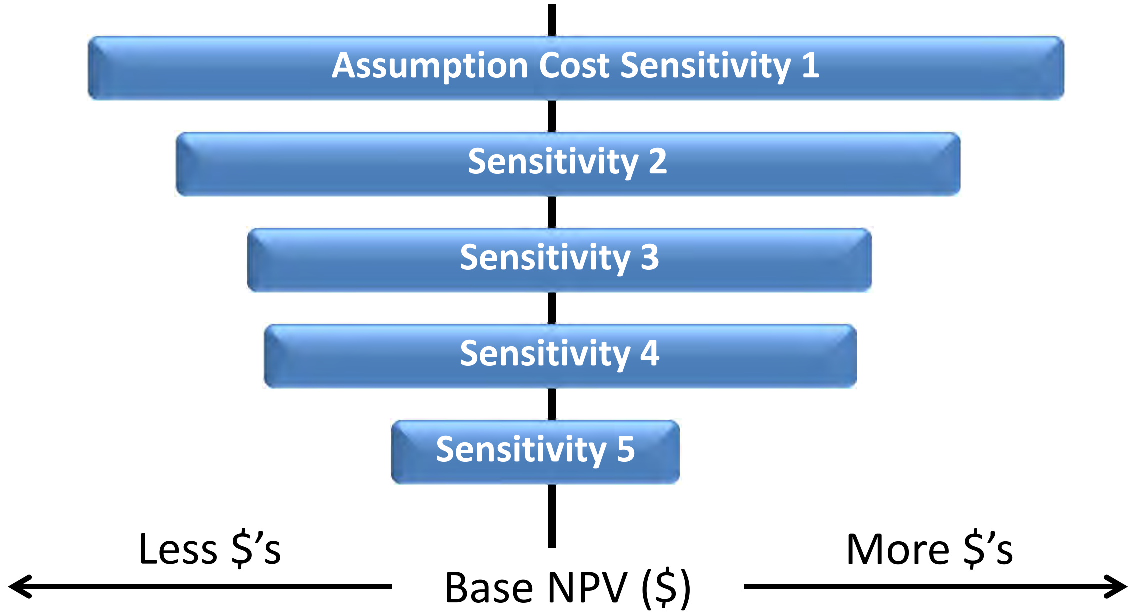
Sensitivity Analysis / Risk Identification

	Scenario 1 Fixed Plan	Scenario 2 Fixed Plan	Scenario 3 Fixed Plan
Base	Plan NPV	Plan NPV	Plan NPV
Low Gas	Plan NPV	Plan NPV	Plan NPV
High Gas	Plan NPV	Plan NPV	Plan NPV
Low Coal	Plan NPV	Plan NPV	Plan NPV
High Coal	Plan NPV	Plan NPV	Plan NPV
Low Market	Plan NPV	Plan NPV	Plan NPV
High Market	Plan NPV	Plan NPV	Plan NPV
Low Carbon Price	Plan NPV	Plan NPV	Plan NPV
High Carbon Price	Plan NPV	Plan NPV	Plan NPV
Low Capital Cost	Plan NPV	Plan NPV	Plan NPV
High Capital Cost	Plan NPV	Plan NPV	Plan NPV

NPV – Net Present Value
Net Present Value is present value of time series of cash flows

Sensitivity Analysis / Risk Identification

- Scenario 1 Assumption Price Sensitivity



- What assumption is greatest cost variation?
- Least cost variation?

Assumption cost sensitivity factors could include changes in fuel price, market price, carbon tax, capital cost, etc

Questions?

VECTREN SOUTH OVERSIGHT BOARD
Governance Provisions
Adopted:

I. Name

The name of the board shall be the Vectren Oversight Board ("VOB").

II. Purpose

VOB is formed for the purpose of (1) promoting the efficient use of electricity and conservation of natural gas throughout Indiana in areas served by Southern Indiana Gas and Electric Company d/b/a Vectren Energy Delivery of Indiana, Inc. ("Vectren South") and Indiana Gas Company, Inc. d/b/a Vectren Energy Delivery of Indiana, Inc. ("Vectren North") (together, "Vectren Energy" or "Company")through the development and oversight of programs that encourage customers to conserve electricity and natural gas and educate customers about the benefits of conservation; (2) overseeing the evaluation, measurement & verification ("EM&V") process, including selecting an EM&V vendor to help evaluate and verify savings of such programs; and (3) reviewing disbursements of the Demand Side Management Adjustment Rider (the "Rider") funds collected by the Company.

III. Duration

The VOB shall serve from January 1, 2015 through December 31, 2015 and may be extended by the mutual agreement of the Parties.

IV. Participants

A. Initial Participants

The Initial Participants of the VOB are the Indiana Office of Utility Consumer Counselor ("OUCC"), and Vectren Energy.

B. *Adding Participants*

The VOB may elect new Participants (voting or non-voting advisory) upon a unanimous vote of the VOB Members. Non-voting Participants may be added in an advisory capacity to provide additional insight. The Citizens Action Coalition joined the VOB in 2013 as a voting Participant.

C. *Terminating Participants*

The Initial Participants of VOB may not be removed. Other Participants may be removed through a unanimous vote of the Initial Participants' VOB Member.

D. *Voting*

Each Participant shall have one vote to be exercised by the VOB Member appointed by each respective Participant.

V. VOB Members

A. Appointment

Each Participant may designate one person to represent it as a VOB Member on behalf of such Participant. Each Participant may freely remove any person designated to serve as its VOB Member.

B. *Vacancies*
Each Participant shall promptly fill vacancies created if its representative ceases to participate in the VOB.

VI. Amendment of Governance Provisions

Amendments to these governance provisions may be proposed by a resolution presented to a quorum of VOB Members. Amendments may be adopted by a unanimous vote of the VOB Members.

VII. General Powers of the VOB

A. General Powers
Subject to any limitations adopted by the Commission, all VOB power and business affairs shall be controlled or exercised by or under the authority of the VOB subject to the following limitations (and any others ordered by the Commission):

(i) The VOB will be responsible for monitoring the progress and effectiveness of electric DSM and natural gas conservation programs and for providing input, guidance and oversight of key decisions with respect to the direction of the Vectren South 2015 Electric DSM Plan ("2015 Plan") and the natural gas 2015 operating plan ("2015 Operating Plan") and use of the funds associated with them. The VOB may vote to exceed the budgets approved by the Commission as defined in the 2015 Plan and 2015 Operating Plan by ten percent (10%) without seeking additional Commission approval.

(ii) The VOB may modify or discontinue specific programs approved in the 2015 Plan and the 2015 Operating Plan, based upon performance. The VOB may add new programs in 2015 as long as those new programs are cost effective and the total approved budget, including the new program, is not exceeded by more than ten percent (10%).

(iii) The VOB may shift funds within a program budget as needed. The VOB may shift funding from one DSM program to another, including transferring funds from the residential sector to the commercial sector and vice versa. Decisions regarding shifting of funds will be made by the VOB on a case by case basis and will consider, among other things, the impact to the affected rate classes.

(iv) The VOB shall ensure that natural gas customers pay for natural gas programs and electric customers pay for electric programs and that one group does not subsidize the DSM and conservation programs of the other.

(v) The VOB will agree upon evaluation methodology and will assess program evaluations.

(vi) The VOB shall meet monthly via conference call, except that at least one meeting during each calendar quarter shall occur in-person. Vectren South, on behalf of the VOB, shall provide meeting minutes and monthly scorecards to VOB members.

B. Notice
Prior to any meeting of the VOB, written notice shall be provided to the VOB Members at least seven (7) days in advance of meeting and subjects to be voted on at the next meeting shall be communicated to all VOB Members, in writing, at least two (2) business days before the meeting. Such notice shall be given either in-person or by e-mail unless a different form of written communication is expressly agreed upon by a unanimous vote of the VOB.

C. *Quorum*
A quorum is required to conduct any meetings of the VOB and to transact or vote upon any business of the VOB. A quorum of the Initial Participants shall be sufficient to conduct business at such meetings.

D. Board Decisions
All VOB Members shall work together in a collaborative fashion, attempting to reach consensus decisions, if possible. However, when consensus cannot be achieved, the issue will be decided by Vectren South, as Vectren South ultimately is tasked with meeting the savings goal set by the Company and approved by the Commission. In the event the VOB cannot reach consensus on a voting issue, then voting members of the Oversight Board could present their positions to the Commission for a decision. Each party will have three (3) business days after the date of the meeting at which a vote is called to record or change its vote. An eligible VOB Member who does not vote at the meeting when the vote is called for or within three (3) business days after the date of the meeting will be presumed to have abstained.

F. Informal Action
Any action that may be taken at a meeting of the VOB may be taken without a meeting if a written vote, setting forth the VOB Member's vote, is signed by an authorized representative of the VOB Member entitled to vote with respect to the subject matter thereof. For purposes of this provision, the term "signed" includes both the person's signature and an electronic transmission sent from the VOB Member's authorized representative's email account.

VIII. Contracts, Loans, Checks and Deposits
A. *Contracts*
VOB is not a legal entity and does not have authority to execute contracts on behalf of the

VOB or Vectren Energy, nor shall the VOB be liable for any expenses or costs related to either the 2015 Plan or 2015 Operating Plan. Vectren Energy shall seek input, guidance and oversight from the VOB with respect to vendor selection to implement both the 2015 Plan and the 2015 Operating Plan; however, Vectren South retains the right to select the vendor it determines, in its sole discretion, is best suited to achieve the savings goals set by the Company and approved by the Commission.

B. *Loans*
No loans shall be contracted on behalf of VOB and no evidences of indebtedness shall be issued in its name.

C. *Disbursement of Funds*
Vectren Energy shall disburse funds collected from the DSMA Rider and shall submit reports of such disbursements to the VOB upon request.

D. Deposits
All funds collected by the Energy Efficiency Funding Component not otherwise employed by VOB shall be kept by either Vectren Energy or another entity designated by the VOB.

E. Record Keeping
The VOB members shall be provided with annual financial reports apprising the members of (1) the amount collected by the Energy Efficiency Funding Component; (2) the amount previously used to cover approved program costs; (3) the amount available for additional expenditures and (4) identification of expenditures in the prior month. Vectren Energy shall be responsible for such reports and shall maintain all records of the VOB, including but not limited to the financial reports sent to the VOB Members, supporting documentation (e.g., invoices, payment records, etc.) and minutes from VOB meetings.

IX. Fiscal Year
The fiscal year of the VOB shall begin on January 1, 2015 and end on December 31, 2015.

Resolution on Joint Statement of the Edison Electric Institute and the Natural Resources Defense Council in Support of the Vital Importance of Pursuing all Cost-Effective Energy Efficiency Opportunities

WHEREAS, On August 2, 2006, the National Association of Regulatory Utility Commissioners (NARUC) adopted a resolution: *Resolution Supporting the National Action Plan on Energy Efficiency* sponsored by the Executive Committee and the Committees on Consumer Affairs, Electricity, Energy Resources and the Environment, and Gas; *and*

WHEREAS, The National Action Plan on Energy Efficiency included the following five recommendations: "(1) Recognize energy efficiency as a high priority energy resource; (2) Make strong, long-term commitments to cost-effective energy efficiency as a resource; (3) Broadly communicate the benefits of and opportunities for energy efficiency; (4) Promote sufficient, timely, and stable program funding to deliver energy efficiency where cost-effective; and (5) Modify policies to align utility incentives with delivery of cost-effective energy efficiency and modify ratemaking practices to promote energy efficiency investments;" *and*

WHEREAS, On November 18, 2008, EEI and NRDC signed a joint statement that highlights their commitment to the National Action Plan on Energy Efficiency and to support the vital importance of pursuing all cost-effective energy efficiency opportunities by engaging in public education and outreach, strengthening the nation's energy efficiency delivery infrastructure, expanding efficiency-related manpower training and technology development, and improving both federal and State building and equipment efficiency standards; *and*

WHEREAS, The EEI and NRDC joint statement also calls for establishing a durable business case for energy efficiency, encourages the integration of energy efficiency into utility resource planning, urges utility regulators to support enhanced utility investment in "smart meters" and a "smart grid" that focus on delivering new energy management tools to customers, and stresses the need for increased research, development and deployment of energy-efficiency technology; *now, therefore, be it*

RESOLVED, That the National Association of Regulatory Utility Commissioners, convened at its 2008 Annual Convention in New Orleans, Louisiana, encourages commissions to consider the recommendations set out in the Joint Statement of the Edison Electric Institute and the Natural Resources Defense Council to work towards a mutual goal of helping energy users pursue all cost-effective energy efficiency opportunities.

Sponsored by the Committees on Energy Resources and the Environment and Electricity
Recommended by the NARUC Board of Directors, November 18, 2008
Adopted by the Committee of the Whole, November 19, 2008

EEI EDISON ELECTRIC INSTITUTE 75 YEARS
Bringing the Electric Industry Together Since 1933

NRDC
THE EARTH'S BEST DEFENSE

November 18, 2008

Dear NARUC Commissioners,

We have represented the Edison Electric Institute and the Natural Resources Defense Council, respectively, for a total of more than five decades. Our constituencies are different, but as many of you know, we have found much common ground on utilities' resource planning and investment role generally and the vital importance of cost-effective energy efficiency in particular. Five years ago, following a lively debate at your Annual Meeting, we presented specific joint recommendations for your consideration on these issues. We return now, on behalf of our institutions, to reaffirm and expand upon those recommendations.

1. **We begin with the increasingly urgent mutual goal of helping energy users exploit all cost-effective energy efficiency opportunities, through an integrated combination of financial incentives to customers and minimum standards governing the performance of buildings and equipment.** We encourage utility regulators and others to join us in a nationwide energy efficiency campaign with the following key elements:

   - Continued cooperation on and participation in all elements of the National Action Plan for Energy Efficiency;

   - A jointly designed public education and outreach campaign;

   - Strengthening the nation's energy efficiency delivery infrastructure dedicated to helping utilities promote energy efficiency in all sectors of the economy, starting with the Edison Foundation's Institute for Electric Efficiency, the Consortium for Energy Efficiency, and regional efficiency alliances such as the Northwest Energy Efficiency Alliance, the Midwest Energy Efficiency Alliance, the Northeast Energy Efficiency Partnerships, and the Southeast Energy Efficiency Alliance

   - Aggressively expanding efficiency-related manpower training and technology development at the nation's colleges, universities and community colleges, building on worthy precedents established recently by the University of California at Davis's Energy Efficiency Center and Stanford University's Precourt Institute for Energy Efficiency (the nation's first two university centers dedicated specifically to energy efficiency).

- Working together at both federal and state levels to secure improved building and equipment efficiency standards and durable tax incentives that reward builders and equipment installers who substantially exceed existing standards.

2. **For most if not all utilities the goal of "all cost-effective energy efficiency" will mean significantly higher investment and savings targets over extended periods, which cannot be sustained without regulatory action to ensure (1) cost recovery for prudent investment, (2) an earnings opportunity tied to verified success in delivering cost-effective saving; and (3) being kept whole for authorized fixed costs as power sales volumes decline (relative to what they otherwise would have been).** In establishing these objectives, we acknowledge the need to allow initially approved fixed-cost revenue requirements to adjust upward between rate cases in ways that reasonably reflect utilities' prudently incurred cost increases, while reaffirming our mutual support for true-up mechanisms that ensure recovery of such appropriately adjusted, PUC-authorized fixed-cost revenue requirements, regardless of retail sales fluctuations. A durable business case for utility involvement in end-use energy efficiency rests on three interrelated elements: cost recovery, a performance-based earnings opportunity tied to verification of results, and being kept whole for authorized fixed costs as power sales volumes decline (relative to what they otherwise would have been) . This package is an urgent item of unfinished business in most states. Mere removal of disincentives is not enough to ensure the level of committed action needed; exemplary performance should be capable of yielding exemplary rewards. Idaho's approach to these issues (per the IPUC's approval of Idaho Power's proposals in March 2007) is an example of a promising approach. These supportive regulatory structures and funding approvals must be sustained for extended periods and cannot be abandoned once utilities have made the necessary staffing changes and investment. These regulatory responsibilities also clearly suggest a need for investments in additional staff training at public utility commissions.

3. **We urge utility regulators to support significantly enhanced utility investment in "smart meters" and a "smart grid" that focuses on delivering new energy management tools to customers, enabling increased energy efficiency, supporting efficient new technology such as plug-in hybrid electric vehicles (PHEVs), and reducing the cost of integrating renewable energy generation with variable output into resource portfolios.** The full value of these investments cannot be realized without changing rate structures to signal the actual cost of electricity to customers. And given the urgent need to encourage utilities to make the significant capital commitments required for grid enhancement, these costs should be recognized and recovered in rates as soon as possible once regulators have approved deployment (as opposed to deferring cost recovery until deployment is finished). As we noted in our 2003 statement, "uncertainty of cost recovery discourages investment in new infrastructure needed for security, reliability and environmentally sustainable service for all customers."

NARUC Commissioners
November 18, 2008
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4. **Research, development and deployment (RD&D) investment is critical to securing the reliable and affordable energy services that will be needed to meet twenty- first century economic and environmental objectives.** We support the National Commission on Energy Policy's call for, within five years, "doubling annual direct federal expenditures on energy-technology research, development and demonstration, corrected for inflation." We will work to ensure significantly increased funding for such initiatives in future federal budgets, tax code reform, and legislation addressing energy and climate policy. In addition, we urge utility regulators to support substantially higher levels of utility investment in joint RD&D initiatives like the Electric Power Research Institute.

We look forward to working together with you on these issues in forums across the nation, as the nation confronts urgent energy and environmental challenges that will require the very best that all of us can give.

Yours sincerely,

David K. Owens
Executive Vice President
Edison Electric Institute

Ralph Cavanagh
Energy Program Co-Director
Natural Resources Defense Council

National Action Plan for Energy Efficiency

A PLAN DEVELOPED BY MORE THAN 50 LEADING ORGANIZATIONS IN PURSUIT OF ENERGY SAVINGS AND ENVIRONMENTAL BENEFITS THROUGH ELECTRIC AND NATURAL GAS ENERGY EFFICIENCY

JULY 2006

The goal is to create a sustainable, aggressive national commitment to energy efficiency through gas and electric utilities, utility regulators, and partner organizations.

Improving energy efficiency in our homes, businesses, schools, governments, and industries—which consume more than 70 percent of the natural gas and electricity used in the country—is one of the most constructive, cost-effective ways to address the challenges of high energy prices, energy security and independence, air pollution, and global climate change.

The U.S. Department of Energy and U.S. Environmental Protection Agency facilitate the work of the Leadership Group and the National Action Plan for Energy Efficiency.

Acknowledgements

The National Action Plan for Energy Efficiency Report discusses policy, planning, and program issues based on a formal work plan developed during the December 2005 and March 2006 Leadership Group meetings. The Leadership Group is led by co-chairs Diane Munns (Member of the Iowa Utilities Board and President of the National Association of Regulatory Utility Commissioners) and Jim Rogers (President and Chief Executive Officer of Duke Energy). A full list of Leadership Group members is provided in both the Executive Summary (Table ES-1) and Chapter 1 (Table 1-2) of this report. Rich Scheer of Energetics Inc. facilitated the Leadership Group discussions during both Leadership Group meetings.

Expert consultants, funded by the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA), drafted many chapters of the Action Plan Report. These consultants included:

- Regulatory Assistance Project: Chapter 2 and Appendix A
- Energy and Environmental Economics, Inc.: Chapters 3 through 5, Energy Efficiency Benefits Calculator, and Appendix B
- KEMA: Chapter 6

In addition, Rich Sedano of the Regulatory Assistance Project and Alison Silverstein of Alison Silverstein Consulting provided their expertise during review and editing of the overall report.

DOE and EPA facilitated the work of the Leadership Group and this report, including Larry Mansueti with DOE's Office of Electricity Delivery and Energy Reliability, Mark Ginsberg with DOE's Office of Energy Efficiency and Renewable Energy, and Kathleen Hogan, Stacy Angel, Maureen McNamara, Katrina Pielli, and Tom Kerr with EPA's Climate Protection Partnership Division.

Eastern Research Group, Inc. provided technical review, copyediting, graphics, and production services.

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List of Acronyms

A

aMW average megawatts

B

Bcf billion cubic feet

BOMA Building Owners & Managers Association

BPA Bonneville Power Administration

C

C/I commercial and industrial

CEC California Energy Commission

CO_2 carbon dioxide

CPP critical peak pricing

CPUC California Public Utility Commission

D

DEER Database for Energy Efficiency Resources

DOE U.S. Department of Energy

DSM demand-side management

E

EE energy efficiency

EEPS energy efficiency portfolio standard

EERS energy efficiency resource standard

EPA U.S. Environmental Protection Agency

EPRI Electric Power Research Institute

ESCO energy services company

ETO Energy Trust of Oregon

F

FERC Federal Energy Regulatory Commission

G

GWh gigawatt-hour (1,000,000 kWh)

H

HERS Home Energy Rating System

HVAC heating, ventilation, and air conditioning

I

IOU investor-owned utility

IPMVP International Performance Measurement and Verification Protocol

IRP integrated resource plan

ISO independent system operator

ISO-NE ISO New England

K

kWh kilowatt-hour (3,412 British thermal units)

L

LIHEAP Low-Income Home Energy Assistance Program

LIPA Long Island Power Authority

List of Acronyms (continued)

M

M&V	measurement and verification
Mcf	one thousand cubic feet
MMBtu	million British thermal units
MW	megawatt (1,000,000 watts)
MWh	megawatt-hour (1,000 kWh)

N

NEEP	Northeast Energy Efficiency Partnerships
NERC	North American Electric Reliability Council
NO_X	nitrogen oxides
NPV	net present value
NSPC	Non-Residential Standard Performance Contract
NWPCC	Northwest Power and Conservation Council
NYSERDA	New York State Energy Research and Development Authority

P

PBL	Power Business Line
PG&E	Pacific Gas & Electric
PIER	Public Interest Energy Research
PSE	Puget Sound Energy
PUCT	Public Utility Commission of Texas
PURPA	Public Utility Regulatory Policies Act

R

R&D	research and development
RARP	Residential Appliance Recycling Program
REAP	Residential Energy Affordability Partnership Program
RFP	request for proposals
RGGI	Regional Greenhouse Gas Initiative
RIM	rate impact measure
ROE	return on equity
RPC	revenue per customer
RTO	regional transmission organization
RTP	real-time pricing

S

SBC	system benefits charge
SCE	Southern California Edison
SMUD	Sacramento Municipal Utility District
SO_2	sulfur dioxide

T

TOU	time of use
TRC	total resource cost

V

VOLL	value of lost load
VOS	value of service

W

WAP	Weatherization Assistance Program

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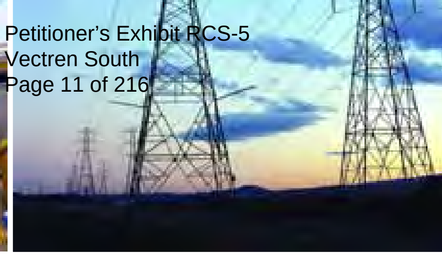

Executive Summary

This National Action Plan for Energy Efficiency (Action Plan) presents policy recommendations for creating a sustainable, aggressive national commitment to energy efficiency through gas and electric utilities, utility regulators, and partner organizations. Such a commitment could save Americans many billions of dollars on energy bills over the next 10 to 15 years, contribute to energy security, and improve our environment. The Action Plan was developed by more than 50 leading organizations representing key stakeholder perspectives. These organizations pledge to take specific actions to make the Action Plan a reality.

A National Action Plan for Energy Efficiency

We currently face a set of serious challenges with regard to the U.S. energy system. Energy demand continues to grow despite historically high energy prices and mounting concerns over energy security and independence as well as air pollution and global climate change. The decisions we make now regarding our energy supply and demand can either help us deal with these challenges more effectively or complicate our ability to secure a more stable, economical energy future.

Improving the energy efficiency[1] of our homes, businesses, schools, governments, and industries—which consume more than 70 percent of the natural gas and electricity used in the country—is one of the most constructive, cost-effective ways to address these challenges.[2] Increased investment in energy efficiency in our homes, buildings, and industries can lower energy bills, reduce demand for fossil fuels, help stabilize energy prices, enhance electric and natural gas system reliability, and help reduce air pollutants and greenhouse gases.

Despite these benefits and the success of energy efficiency programs in some regions of the country, energy efficiency remains critically underutilized in the nation's energy portfolio.[3] Now we simultaneously face the challenges of high prices, the need for large investments in new energy infrastructure, environmental concerns, and security issues. It is time to take advantage of more than two decades of experience with successful energy efficiency programs, broaden and expand these efforts, and capture the savings that energy efficiency offers. Much more can be achieved in concert with ongoing efforts to advance building codes and appliance standards, provide tax incentives for efficient products and buildings, and promote savings opportunities through programs such as ENERGY STAR®. Efficiency of new buildings and those already in place are both important. Many homeowners, businesses, and others in buildings and facilities already standing today—which will represent the vast majority of the nation's buildings and facilities for years to come—can realize significant savings from proven energy efficiency programs.

Bringing more energy efficiency into the nation's energy mix to slow demand growth in a wise, cost-effective manner—one that balances energy efficiency with new generation and supply options—will take concerted efforts by all energy market participants: customers, utilities, regulators, states, consumer advocates, energy service companies (ESCOs), and others. It will require education on the opportunities, review of existing policies, identification of barriers and their solutions, assessment of new technologies, and modification and adoption of policies, as appropriate. Utilities,[4] regulators, and partner organizations need to improve customer access to energy efficiency programs to help them control their own energy costs, provide the funding necessary to deliver these programs, and examine policies governing energy companies to ensure that these policies facilitate—not impede—cost-effective programs for energy efficiency. Historically, the regulatory structure has rewarded utilities for building infrastructure (e.g., power plants, transmission lines, pipelines) and selling energy, while discouraging energy efficiency, even when the energy-saving measures cost less than constructing new infrastructure.[5] And, it has been difficult to establish the funding necessary to capture the potential benefits that cost-effective energy efficiency offers.

This National Action Plan for Energy Efficiency is a call to action to bring diverse stakeholders together at the national, regional, state, or utility level, as appropriate, and foster the discussions, decision-making, and commitments necessary to take investment in energy efficiency to a new level. The overall goal is to create a sustainable, aggressive national commitment to energy efficiency through gas and electric utilities, utility regulators, and partner organizations.

The Action Plan was developed by a Leadership Group composed of more than 50 leading organizations representing diverse stakeholder perspectives. Based upon the policies, practices, and efforts of many organizations across the country, the Leadership Group offers five recommendations as ways to overcome many of the barriers that have limited greater investment in programs to deliver energy efficiency to customers of electric and gas utilities (Figure ES-1). These recommendations may be pursued through a number of different options, depending upon state and utility circumstances.

As part of the Action Plan, leading organizations are committing to aggressively pursue energy efficiency opportunities in their organizations and assist others who want to increase the use of energy efficiency in their regions. Because greater investment in energy efficiency cannot happen based on the work of one individual or organization alone, the Action Plan is a commitment to bring the appropriate stakeholders together—including utilities, state policy-makers, consumers, consumer advocates, businesses, ESCOs, and others—to be part of a collaborative effort to take energy efficiency to a new level. As energy experts, utilities may be in a unique position to play a leading role.

The reasons behind the National Action Plan for Energy Efficiency, the process for developing the Action Plan, and the final recommendations are summarized in greater detail as follows.

Figure ES-1. National Action Plan for Energy Efficiency Recommendations

- **Recognize energy efficiency as a high-priority energy resource.**
- **Make a strong, long-term commitment to implement cost-effective energy efficiency as a resource.**
- **Broadly communicate the benefits of and opportunities for energy efficiency.**
- **Promote sufficient, timely, and stable program funding to deliver energy efficiency where cost-effective**.
- **Modify policies to align utility incentives with the delivery of cost-effective energy efficiency and modify ratemaking practices to promote energy efficiency investments.**

The United States Faces Large and Complex Energy Challenges

Our expanding economy, growing population, and rising standard of living all depend on energy services. Current projections anticipate U.S. energy demands to increase by more than one-third by 2030, with electricity demand alone rising by more than 40 percent (EIA, 2006). At work and at home, we continue to rely on more and more energy-consuming devices. At the same time, the country has entered a period of higher energy costs and limited supplies of natural gas, heating oil, and other fuels. These issues present many challenges:

Growing energy demand stresses current systems, drives up energy costs, and requires new investments. Events such as the Northeast electricity blackout of August 2003 and Hurricanes Katrina and Rita in 2005 increased focus on energy reliability and its economic and human impacts. Transmission and pipeline systems are becoming overburdened in places. Overburdened systems limit the availability of low-cost electricity and fossil fuels, raise energy prices in or near congested areas, and potentially compromise energy system reliability. High fuel prices also contribute to higher electricity prices. In addition, our demand for natural gas to heat our homes, for industrial and business use, and for power generation is straining the available gas supply in North America and putting upward pressure on natural gas prices. Addressing these issues will require billions of dollars in investments in energy efficiency, new power plants, gas rigs, transmission lines, pipelines, and other infrastructure, notwithstanding the difficulty of building new energy infrastructure in dense urban and suburban areas. In the absence of investments in new or expanded capacity, existing facilities are being stretched to the point where system reliability is steadily eroding, and the ability to import lower cost energy into high-growth load areas is inhibited, potentially limiting economic expansion.

High fuel prices increase financial burdens on households and businesses and slow our economy. Many household budgets are being strained by higher energy costs, leaving less money available for other household purchases and needs. This burden is particularly harmful for low-income households. Higher energy bills for industry can reduce the nation's economic competitiveness and place U.S. jobs at risk.

Growing energy demand challenges attainment of clean air and other public health and environmental goals. Energy demand continues to grow at the same time that national and state regulations are being implemented to limit the emission of air pollutants, such as sulfur dioxide (SO_2), nitrogen oxides (NO_x), and mercury, to protect public health and the environment. In addition, emissions of greenhouse gases continue to increase.

Uncertainties in future prices and regulations raise questions about new investments. New infrastructure is being planned in the face of uncertainties about future energy prices. For example, high natural gas prices and uncertainty about greenhouse gas and other environmental regulations, impede investment decisions on new energy supply options.

Our energy system is vulnerable to disruptions in energy supply and delivery. Natural disasters such as the hurricanes of 2005 exposed the vulnerability of the U.S. energy system to major disruptions, which have significant impacts on energy prices and service reliability. In response, national security concerns suggest that we should use fossil fuel energy more efficiently, increase supply diversity, and decrease the vulnerability of domestic infrastructure to natural disasters.

Energy Efficiency Can Be a Beneficial Resource in Our Energy Systems

Greater investment in energy efficiency can help us tackle these challenges. Energy efficiency is already a key component in the nation's energy resource mix in many parts of the country. Utilities, states, and others across the United States have decades of experience in delivering energy efficiency to their customers. These programs can provide valuable models, upon which more states,

Benefits of Energy Efficiency

Lower energy bills, greater customer control, and greater customer satisfaction. Well-designed energy efficiency programs can provide opportunities for customers of all types to adopt energy savings measures that can improve their comfort and level of service, while reducing their energy bills.[6] These programs can help customers make sound energy use decisions, increase control over their energy bills, and empower them to manage their energy usage. Customers are experiencing savings of 5, 10, 20, or 30 percent, depending upon the customer, program, and average bill. Offering these programs can also lead to greater customer satisfaction with the service provider.

Lower cost than supplying new generation only from new power plants. In some states, well-designed energy efficiency programs are saving energy at an average cost of about one-half of the typical cost of new power sources and about one-third of the cost of natural gas supply (EIA, 2006).[7] When integrated into a long-term energy resource plan, energy efficiency programs could help defer investments in new plants and lower the total cost of delivering electricity.

Modular and quick to deploy. Energy efficiency programs can be ramped up over a period of one to three years to deliver sizable savings. These programs can also be targeted to congested areas with high prices to bring relief where it might be difficult to deliver new supply in the near term.

Significant energy savings. Well-designed energy efficiency programs are delivering annual energy savings on the order of 1 percent of electricity and natural gas sales.[8] These programs are helping to offset 20 to 50 percent of expected growth in energy demand in some areas without compromising the end users' activities and economic well-being (Nadel et al., 2004; EIA, 2006).

Environmental benefits. While reducing customers' energy bills, cost-effective energy efficiency offers environmental benefits related to reduced demand such as lower air pollution, reduced greenhouse gas emissions, lower water use, and less environmental damage from fossil fuel extraction. Energy efficiency can be an attractive option for utilities in advance of requirements to reduce greenhouse gas emissions.

Economic development. Greater investment in energy efficiency helps build jobs and improve state economies. Energy efficiency users often redirect their bill savings toward other activities that increase local and national employment, with a higher employment impact than if the money had been spent to purchase energy (Kushler et al., 2005; NYSERDA, 2004). Many energy efficiency programs create construction and installation jobs, with multiplier impacts on employment and local economies. Local investments in energy efficiency can offset imports from out-of-state, improving the state balance of trade. Lastly, energy efficiency investments usually create long-lasting infrastructure changes to building, equipment and appliance stocks, creating long-term property improvements that deliver long-term economic value (Innovest, 2002).

Energy security. Energy efficiency reduces the level of U.S. per capita energy consumption, thus decreasing the vulnerability of the economy and individual consumers to energy price disruptions from natural disasters and attacks on domestic and international energy supplies and infrastructure. In addition, energy efficiency can be used to reduce the overall system peak demand or the peak demand in targeted load areas with limited generating or transport capability. Reducing peak demand improves system reliability and reduces the potential for unplanned brownouts or black-outs, which can have large adverse economic consequences.

utilities, and other organizations can build. Experience shows that energy efficiency programs can lower customer energy bills; cost less than, and help defer, new energy infrastructure; provide energy savings to consumers; improve the environment; and spur local economic development (see box on Benefits of Energy Efficiency). Significant opportunities for energy efficiency are likely to continue to be available at low costs in the future. State and regional studies have found that adoption of economically attractive, but as yet untapped, energy efficiency could yield more than 20 percent savings in total electricity demand nationwide by 2025. Depending on the underlying load growth, these savings could help cut load growth by half or more compared to current forecasts (Nadel et al., 2004; SWEEP, 2002; NEEP, 2005; NWPCC, 2005; WGA, 2006). Similarly, savings from direct use of natural gas could provide a 50 percent or greater reduction in natural gas demand growth (Nadel et al., 2004).

Capturing this energy efficiency resource would offer substantial economic and environmental benefits across the country. Widespread application of energy efficiency programs that already exist in some regions could deliver a large part of these potential savings.[9] Extrapolating the results from existing programs to the entire country would yield annual energy bill savings of nearly $20 billion, with net societal benefits of more than $250 billion over the next 10 to 15 years. This scenario could defer the need for 20,000 megawatts (MW), or 40 new 500-MW power plants, as well as reduce U.S. emissions from energy production and use by more than 200 million tons of carbon dioxide (CO_2), 50,000 tons of SO_2, and 40,000 tons of NO_x annually.[10] These significant economic and environmental benefits can be achieved relatively quickly because energy efficiency programs can be developed and implemented within several years.

Additional policies and programs are required to help capture these potential benefits and address our substantial underinvestment in energy efficiency as a nation. An important indicator of this underinvestment is that the level of funding across the country for organized efficiency programs is currently less than $2 billion per year while it would require about 4 times today's funding levels to achieve the economic and environment benefits presented above.[11, 12]

The current underinvestment in energy efficiency is due to a number of well-recognized barriers, including some of the regulatory policies that govern electric and natural gas utilities. These barriers include:

- *Market barriers,* such as the well-known "split-incentive" barrier, which limits home builders' and commercial developers' motivation to invest in energy efficiency for new buildings because they do not pay the energy bill; and the transaction cost barrier, which chronically affects individual consumer and small business decision-making.

- *Customer barriers,* such as lack of information on energy saving opportunities, lack of awareness of how energy efficiency programs make investments easier, and lack of funding to invest in energy efficiency.

- *Public policy barriers,* which can present prohibitive disincentives for utility support and investment in energy efficiency in many cases.

- *Utility, state, and regional planning barriers,* which do not allow energy efficiency to compete with supply-side resources in energy planning.

- *Energy efficiency program barriers,* which limit investment due to lack of knowledge about the most effective and cost-effective energy efficiency program portfolios, programs for overcoming common marketplace barriers to energy efficiency, or available technologies.

While a number of energy efficiency policies and programs contribute to addressing these barriers, such as building codes, appliance standards, and state government leadership programs, organized energy efficiency programs provide an important opportunity to deliver greater energy efficiency in the homes, buildings, and facilities that already exist today and that will consume the majority of the energy used in these sectors for years to come.

The Leadership Group and National Action Plan for Energy Efficiency

Recognizing that energy efficiency remains a critically underutilized resource in the nation's energy portfolio, more than 50 leading electric and gas utilities, state utility commissioners, state air and energy agencies, energy service providers, energy consumers, and energy efficiency and consumer advocates have formed a Leadership Group, together with the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA), to address the issue. The goal of this group is to create a sustainable, aggressive national commitment to energy efficiency through gas and electric utilities, utility regulators, and partner organizations. The Leadership Group recognizes that utilities and regulators play critical roles in bringing energy efficiency programs to their communities and that success requires the joint efforts of customers, utilities, regulators, states, and other partner organizations.

Under co-chairs Diane Munns (Member of the Iowa Utilities Board and President of the National Association of Regulatory Utility Commissioners) and Jim Rogers (President and Chief Executive Officer of Duke Energy), the Leadership Group members (see Table ES-1) have developed the National Action Plan for Energy Efficiency Report, which:

- Identifies key barriers limiting greater investment in energy efficiency.
- Reviews sound business practices for removing these barriers and improving the acceptance and use of energy efficiency relative to energy supply options.
- Outlines recommendations and options for overcoming these barriers.

The members of the Leadership Group have agreed to pursue these recommendations and consider these options through their own actions, where appropriate, and to support energy efficiency initiatives by other industry members and stakeholders.

Recommendations

The National Action Plan for Energy Efficiency is a call to action to utilities, state utility regulators, consumer advocates, consumers, businesses, other state officials, and other stakeholders to create an aggressive, sustainable national commitment to energy efficiency.[1] The Action Plan offers the following recommendations as ways to overcome barriers that have limited greater investment in energy efficiency for customers of electric and gas utilities in many parts of the country. The following recommendations are based on the policies, practices, and efforts of leading organizations across the country. For each recommendation, a number of options are available to be pursued based on regional, state, and utility circumstances (see also Figure ES-2).

Recognize energy efficiency as a high-priority energy resource. Energy efficiency has not been consistently viewed as a meaningful or dependable resource compared to new supply options, regardless of its demonstrated contributions to meeting load growth.[13] Recognizing energy efficiency as a high-priority energy resource is an important step in efforts to capture the benefits it offers and lower the overall cost of energy services to customers. Based on jurisdictional objectives, energy efficiency can be incorporated into resource plans to account for the long-term benefits from energy savings, capacity savings, potential reductions of air pollutants and greenhouse gases, as well as other benefits. The explicit integration of energy efficiency resources into the formalized resource planning processes that exist at regional, state, and utility levels can help establish the rationale for energy efficiency funding levels and for properly valuing and balancing the benefits. In some jurisdictions, these existing planning processes might need to be adapted or even created to meaningfully incorporate energy efficiency resources into resource planning. Some states have recognized energy efficiency as the resource of first priority due to its broad benefits.

Make a strong, long-term commitment to implement cost-effective energy efficiency as a resource. Energy efficiency programs are most successful and provide the greatest benefits to stakeholders when appropriate policies are established and maintained over the long-term. Confidence in long-term stability of the program will help maintain energy efficiency as a dependable resource compared to supply-side resources, deferring or even avoiding the need for other infrastructure investments, and maintain customer awareness and support. Some steps might include assessing the long-term potential for cost-effective energy efficiency within a region (i.e., the energy efficiency that can be delivered cost-effectively through proven programs for each customer class within a planning horizon); examining the role for cutting-edge initiatives and technologies; establishing the cost of supply-side options versus energy efficiency; establishing robust measurement and verification (M&V) procedures; and providing for routine updates to information on energy efficiency potential and key costs.

Broadly communicate the benefits of and opportunities for energy efficiency. Experience shows that energy efficiency programs help customers save money and contribute to lower cost energy systems. But these benefits are not fully documented nor recognized by customers, utilities, regulators, or policy-makers. More effort is needed to establish the business case for energy efficiency for all decision-makers and to show how a well-designed approach to energy efficiency can benefit customers, utilities, and society by (1) reducing customers' bills over time, (2) fostering financially healthy utilities (e.g., return on equity, earnings per share, and debt coverage ratios unaffected), and (3) contributing to positive societal net benefits overall. Effort is also necessary to educate key stakeholders that although energy efficiency can be an important low-cost resource to integrate into the energy mix, it does require funding just as a new power plant requires funding. Further, education is necessary on the impact that energy efficiency programs can have in concert with other energy efficiency policies such as building codes, appliance standards, and tax incentives.

Promote sufficient, timely, and stable program funding to deliver energy efficiency where cost-effective. Energy efficiency programs require consistent and long-term funding to effectively compete with energy supply options. Efforts are necessary to establish this consistent long-term funding. A variety of mechanisms have been, and can be, used based on state, utility, and other stakeholder interests. It is important to ensure that the efficiency programs' providers have sufficient long-term funding to recover program costs and implement the energy efficiency measures that have been demonstrated to be available and cost effective. A number of states are now linking program funding to the achievement of energy savings.

Modify policies to align utility incentives with the delivery of cost-effective energy efficiency and modify ratemaking practices to promote energy efficiency investments. Successful energy efficiency programs would be promoted by aligning utility incentives in a manner that encourages the delivery of energy efficiency as part of a balanced portfolio of supply, demand, and transmission investments. Historically, regulatory policies governing utilities have more commonly compensated utilities for building infrastructure (e.g., power plants, transmission lines, pipelines) and selling energy, while discouraging energy efficiency, even when the energy-saving measures might cost less. Within the existing regulatory processes, utilities, regulators, and stakeholders have a number of opportunities to create the incentives for energy efficiency investments by utilities and customers. A variety of mechanisms have already been used. For example, parties can decide to provide incentives for energy efficiency similar to utility incentives for new infrastructure investments, provide rewards for prudent management of energy efficiency programs, and incorporate energy efficiency as an important area of consideration within rate design. Rate design offers

Figure ES-2. National Action Plan for Energy Efficiency Recommendations & Options

Recognize energy efficiency as a high priority energy resource.

Options to consider:

- Establishing policies to establish energy efficiency as a priority resource.
- Integrating energy efficiency into utility, state, and regional resource planning activities.
- Quantifying and establishing the value of energy efficiency, considering energy savings, capacity savings, and environmental benefits, as appropriate.

Make a strong, long-term commitment to implement cost-effective energy efficiency as a resource.

Options to consider:

- Establishing appropriate cost-effectiveness tests for a portfolio of programs to reflect the long-term benefits of energy efficiency.
- Establishing the potential for long-term, cost-effective energy efficiency savings by customer class through proven programs, innovative initiatives, and cutting-edge technologies.
- Establishing funding requirements for delivering long-term, cost-effective energy efficiency.
- Developing long-term energy saving goals as part of energy planning processes.
- Developing robust measurement and verification (M&V) procedures.
- Designating which organization(s) is responsible for administering the energy efficiency programs.
- Providing for frequent updates to energy resource plans to accommodate new information and technology.

Broadly communicate the benefits of and opportunities for energy efficiency.

Options to consider:

- Establishing and educating stakeholders on the business case for energy efficiency at the state, utility, and other appropriate level addressing relevant customer, utility, and societal perspectives.
- Communicating the role of energy efficiency in lowering customer energy bills and system costs and risks over time.
- Communicating the role of building codes, appliance standards, and tax and other incentives.

Provide sufficient, timely, and stable program funding to deliver energy efficiency where cost-effective.

Options to consider:

- Deciding on and committing to a consistent way for program administrators to recover energy efficiency costs in a timely manner.
- Establishing funding mechanisms for energy efficiency from among the available options such as revenue requirement or resource procurement funding, system benefits charges, rate-basing, shared-savings, incentive mechanisms, etc.
- Establishing funding for multi-year periods.

Modify policies to align utility incentives with the delivery of cost-effective energy efficiency and modify ratemaking practices to promote energy efficiency investments.

Options to consider:

- Addressing the typical utility throughput incentive and removing other regulatory and management disincentives to energy efficiency.
- Providing utility incentives for the successful management of energy efficiency programs.
- Including the impact on adoption of energy efficiency as one of the goals of retail rate design, recognizing that it must be balanced with other objectives.
- Eliminating rate designs that discourage energy efficiency by not increasing costs as customers consume more electricity or natural gas.
- Adopting rate designs that encourage energy efficiency by considering the unique characteristics of each customer class and including partnering tariffs with other mechanisms that encourage energy efficiency, such as benefit sharing programs and on-bill financing.

opportunities to encourage customers to invest in efficiency where they find it to be cost effective and participate in new programs that provide innovative technologies (e.g., smart meters) to help customers control their energy costs.

National Action Plan for Energy Efficiency: Next Steps

In summer 2006, members of the Leadership Group of the National Action Plan on Energy Efficiency are announcing a number of specific activities and initiatives to formalize and reinforce their commitments to energy efficiency as a resource. To assist the Leadership Group and others in making and fulfilling their commitments, a number of tools and resources have been developed:

National Action Plan for Energy Efficiency Report. This report details the key barriers to energy efficiency in resource planning, utility incentive mechanisms, rate design, and the design and implementation of energy efficiency programs. It also reviews and presents a variety of policy and program solutions that have been used to overcome these barriers as well as the pros and cons for many of these approaches.

Energy Efficiency Benefits Calculator. This calculator can be used to help educate stakeholders on the broad benefits of energy efficiency. It provides a simplified framework to demonstrate the business case for energy efficiency from the perspective of the consumer, the utility, and society. It has been used to explore the benefits of energy efficiency program investments under a range of utility structures, policy mechanisms, and energy growth scenarios. The calculator can be adapted and applied to other scenarios.

Experts and Resource Materials on Energy Efficiency. A number of educational presentations on the potential for energy efficiency and various policies available for pursuing the recommendations of the Action Plan will be developed. In addition, lists of policy and program experts in energy efficiency and the various policies available for pursuing the recommendations of the Action Plan will be developed. These lists will be drawn from utilities, state utility regulators, state energy offices, third-party energy efficiency program administrators, consumer advocacy organizations, ESCOs, and others. These resources will be available in fall 2006.

DOE and EPA are continuing to facilitate the work of the Leadership Group and the National Action Plan for Energy Efficiency. During winter 2006–2007, the Leadership Group plans to report on its progress and identify next steps for the Action Plan.

Table ES-1. Members of the National Action Plan for Energy Efficiency

Co-Chairs

Diane Munns	Member President	Iowa Utilities Board National Association of Regulatory Utility Commissioners
Jim Rogers	President and Chief Executive Officer	Duke Energy

Leadership Group

Barry Abramson	Senior Vice President	Servidyne Systems, LLC
Angela S. Beehler	Director of Energy Regulation	Wal-Mart Stores, Inc.
Bruce Braine	Vice President, Strategic Policy Analysis	American Electric Power
Jeff Burks	Director of Environmental Sustainability	PNM Resources
Kateri Callahan	President	Alliance to Save Energy
Glenn Cannon	General Manager	Waverly Light and Power
Jorge Carrasco	Superintendent	Seattle City Light
Lonnie Carter	President and Chief Executive Officer	Santee Cooper
Mark Case	Vice President for Business Performance	Baltimore Gas and Electric
Gary Connett	Manager of Resource Planning and Member Services	Great River Energy
Larry Downes	Chairman and Chief Executive Officer	New Jersey Natural Gas (New Jersey Resources Corporation)
Roger Duncan	Deputy General Manager, Distributed Energy Services	Austin Energy
Angelo Esposito	Senior Vice President, Energy Services and Technology	New York Power Authority
William Flynn	Chairman	New York State Public Service Commission
Jeanne Fox	President	New Jersey Board of Public Utilities
Anne George	Commissioner	Connecticut Department of Public Utility Control
Dian Grueneich	Commissioner	California Public Utilities Commission
Blair Hamilton	Policy Director	Vermont Energy Investment Corporation
Leonard Haynes	Executive Vice President, Supply Technologies, Renewables, and Demand Side Planning	Southern Company
Mary Healey	Consumer Counsel for the State of Connecticut	Connecticut Consumer Counsel
Helen Howes	Vice President, Environment, Health and Safety	Exelon
Chris James	Air Director	Connecticut Department of Environmental Protection
Ruth Kinzey	Director of Corporate Communications	Food Lion
Peter Lendrum	Vice President, Sales and Marketing	Entergy Corporation
Rick Leuthauser	Manager of Energy Efficiency	MidAmerican Energy Company
Mark McGahey	Manager	Tristate Generation and Transmission Association, Inc.
Janine Migden-Ostrander	Consumers' Counsel	Office of the Ohio Consumers' Counsel
Richard Morgan	Commissioner	District of Columbia Public Service Commission
Brock Nicholson	Deputy Director, Division of Air Quality	North Carolina Air Office
Pat Oshie	Commissioner	Washington Utilities and Transportation Commission
Douglas Petitt	Vice President, Government Affairs	Vectren Corporation

Bill Prindle	Deputy Director	American Council for an Energy-Efficient Economy
Phyllis Reha	Commissioner	Minnesota Public Utilities Commission
Roland Risser	Director, Customer Energy Efficiency	Pacific Gas and Electric
Gene Rodrigues	Director, Energy Efficiency	Southern California Edison
Art Rosenfeld	Commissioner	California Energy Commission
Jan Schori	General Manager	Sacramento Municipal Utility District
Larry Shirley	Division Director	North Carolina Energy Office
Michael Shore	Senior Air Policy Analyst	Environmental Defense
Gordon Slack	Energy Business Director	The Dow Chemical Company
Deb Sundin	Director, Business Product Marketing	Xcel Energy
Dub Taylor	Director	Texas State Energy Conservation Office
Paul von Paumgartten	Director, Energy and Environmental Affairs	Johnson Controls
Brenna Walraven	Executive Director, National Property Management	USAA Realty Company
Devra Wang	Director, California Energy Program	Natural Resources Defense Council
Steve Ward	Public Advocate	State of Maine
Mike Weedall	Vice President, Energy Efficiency	Bonneville Power Administration
Tom Welch	Vice President, External Affairs	PJM Interconnection
Jim West	Manager of *energy right* & Green Power Switch	Tennessee Valley Authority
Henry Yoshimura	Manager, Demand Response	ISO New England Inc.

Observers

James W. (Jay) Brew	Counsel	Steel Manufacturers Association
Roger Cooper	Executive Vice President, Policy and Planning	American Gas Association
Dan Delurey	Executive Director	Demand Response Coordinating Committee
Roger Fragua	Deputy Director	Council of Energy Resource Tribes
Jeff Genzer	General Counsel	National Association of State Energy Officials
Donald Gilligan	President	National Association of Energy Service Companies
Chuck Gray	Executive Director	National Association of Regulatory Utility Commissioners
John Holt	Senior Manager of Generation and Fuel	National Rural Electric Cooperative Association
Joseph Mattingly	Vice President, Secretary and General Counsel	Gas Appliance Manufacturers Association
Kenneth Mentzer	President and Chief Executive Officer	North American Insulation Manufacturers Association
Christina Mudd	Executive Director	National Council on Electricity Policy
Ellen Petrill	Director, Public/Private Partnerships	Electric Power Research Institute
Alan Richardson	President and Chief Executive Officer	American Public Power Association
Steve Rosenstock	Manager, Energy Solutions	Edison Electric Institute
Diane Shea	Executive Director	National Association of State Energy Officials
Rick Tempchin	Director, Retail Distribution Policy	Edison Electric Institute
Mark Wolfe	Executive Director	Energy Programs Consortium

Notes

1 Energy efficiency refers to using less energy to provide the same or improved level of service to the energy consumer in an economically efficient way. The term energy efficiency as used here includes using less energy at any time, including at times of peak demand through demand response and peak shaving efforts.

2 Addressing transportation-related energy use is also an important challenge as energy demand in this sector continues to increase and oil prices hit historical highs. However, transportation issues are outside the scope of this effort, which is focused only on electricity and natural gas systems.

3 This effort is focused on energy efficiency for regulated energy forms. Energy efficiency for unregulated energy forms, such as fuel oil for example, is closely related in terms of actions in buildings, but is quite different in terms of how policy can promote investments.

4 A utility is broadly defined as an organization that delivers electric and gas utility services to end users, including, but not limited to, investor-owned, publicly-owned, cooperatively-owned, and third-party energy efficiency utilities.

5 Many energy efficiency programs have an average life cycle cost of $0.03/kilowatt-hour (kWh) saved, which is 50 to 75 percent of the typical cost of new power sources (ACEEE, 2004; EIA, 2006). The cost of energy efficiency programs varies by program and can include higher cost programs and options with lower costs to a utility such as modifying rate designs.

6 See Chapter 6: Energy Efficiency Program Best Practices for more information on leading programs.

7 Data refer to EIA 2006 new power costs and gas prices in 2015 compared to electric and gas program costs based on leading energy efficiency programs, many of which are discussed in Chapter 6: Energy Efficiency Program Best Practices.

8 Based on leading energy efficiency programs, many of which are discussed in Chapter 6: Energy Efficiency Program Best Practices.

9 These estimates are based on assumptions of average program spending levels by utilities or other program administrators, with conservatively high numbers for the cost of energy efficiency programs. See highlights of some of these programs in Chapter 6: Energy Efficiency Program Best Practices, Tables 6-1 and 6-2.

10 These economic and environmental savings estimates are extrapolations of the results from regional program to a national scope. Actual savings at the regional level vary based on a number of factors. For these estimates, avoided capacity value is based on peak load reductions de-rated for reductions that do not result in savings of capital investments. Emissions savings are based on a marginal on-peak generation fuel of natural gas and marginal off-peak fuel of coal; with the on-peak period capacity requirement double that of the annual average. These assumptions vary by region based upon situation-specific variables. Reductions in capped emissions might reduce the cost of compliance.

11 This estimate of the funding required assumes 2 percent of revenues across electric utilities and 0.5 percent across gas utilities. The estimate also assumes that energy efficiency is delivered at a total cost (utility and participant) of $0.04 per kWh and $3 per million British thermal units (MMBtu), which are higher than the costs of many of today's programs.

12 This estimate is provided as an indicator of underinvestment and is not intended to establish a national funding target. Appropriate funding levels for programs should be established at the regional, state, or utility level. In addition, energy efficiency investments by customers, businesses, industry, and government also contribute to the larger economic and environment benefits of energy efficiency.

13 One example of energy efficiency's ability to meet load growth is the Northwest Power Planning Council's Fifth Power Plan which uses energy conservation and efficiency to meet a targeted 700 MW of forecasted capacity between 2005 and 2009 (NWPCC, 2005).

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1: Introduction and Background

Overview

We currently face a number of challenges in securing affordable, reliable, secure, and clean energy to meet our nation's growing energy demand. Demand is outpacing supply, costs are rising, and concerns for the environment are growing.

Improving the energy efficiency[1] of our homes, businesses, schools, governments, and industries – which consume more than 70 percent of the energy used in the country—is one of the most constructive, cost-effective ways to address these challenges. Greater investment in energy efficiency programs across the country could help meet our growing electricity and natural gas demand, save customers billions of dollars on their energy bills, reduce emissions of air pollutants and greenhouse gases, and contribute to a more secure, reliable, and low-cost energy system. Despite this opportunity, energy efficiency remains an under-utilized resource in the nation's energy portfolio.

There are many ways to increase investment in cost-effective energy efficiency including developing building codes and appliance standards, implementing government leadership efforts, and educating the public through programs such as ENERGY STAR®.[2] Another important area is greater investment in organized energy efficiency programs that are managed by electric and natural gas providers, states, or third-party administrators. Energy efficiency programs already contribute to the energy mix in many parts of the country and have delivered significant savings and other benefits. Despite the benefits, these programs face hurdles in many areas of the country. Identifying and removing these barriers is a focus of this effort.

October 2005
Excerpt from Letter From Co-Chairs to the National Action Plan for Energy Efficiency Leadership Group

Energy efficiency is a critically under-utilized resource in the nation's energy portfolio. Those states and utilities that have made significant investments in energy efficiency have lowered the growth for energy demand and moderated their energy costs. However, many hurdles remain that block broader investments in cost-effective energy efficiency.

That is why we have agreed to chair the Energy Efficiency Action Plan. It is our hope that with the help of leading organizations like yours, we will identify and overcome these hurdles.

Through this Action Plan, we intend to identify the major barriers currently limiting greater investment by utilities in energy efficiency. We will develop a series of business cases that will demonstrate the value and contributions of energy efficiency and explain how to remove these barriers (including regulatory and market challenges). These business cases, along with descriptions of leading energy efficiency programs, will build upon practices already in place across the country.

Diane Munns
President, NARUC
Member, Iowa Utilities Board

Jim Rogers
President and CEO
Duke Energy

To drive a sustainable, aggressive national commitment to energy efficiency through gas and electric utilities, utility regulators, and partner organizations, more than 50 leading organizations joined together to develop this National Action Plan for Energy Efficiency. The Action Plan is co-chaired by Diane Munns, Member of the Iowa

[1] Energy efficiency refers to using less energy to provide the same or improved level of service to the energy consumer in an economically efficient way. The term energy efficiency as used here includes using less energy at any time, including at times of peak demand through demand response and peak shaving efforts.

[2] See EPA 2006 for a description of a broad set of policies being used at the state level to advance energy efficiency.

Utilities Board and President of the National Association of Regulatory Utility Commissioners, and Jim Rogers, President and Chief Executive Officer of Duke Energy. The Leadership Group includes representatives from a broad set of stakeholders, including electric and gas utilities, state utility commissioners, state air and energy agencies, energy service providers, energy consumers, and energy efficiency and consumer advocates. This effort is facilitated by the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA). The National Action Plan for Energy Efficiency:

- Identifies key barriers limiting greater investment in energy efficiency,
- Reviews sound business practices for removing these barriers and improving the acceptance and use of energy efficiency relative to energy supply options, and
- Outlines recommendations and options for overcoming these barriers.

In addition, members of the Leadership Group are committing to act within their own organizations and spheres of influence to increase attention and investment in energy efficiency. Greater investment in energy efficiency cannot happen based on the work of one individual or organization alone. The Leadership Group recognizes that the joint efforts of the customer, utility, regulator, and partner organizations are needed to reinvigorate and increase the use of energy efficiency in America. As energy experts, utilities may be in a unique position to play a leadership role.

The rest of this introduction chapter establishes why now is the time to increase our investment in energy efficiency, outlines the approach taken in the National Action Plan for Energy Efficiency, and explains the structure of this report.

Why Focus on Energy Efficiency?

Energy Challenges

We currently face multiple challenges in providing affordable, clean, and reliable energy in today's complex energy markets:

- *Electricity demand* continues to rise. Given current energy consumption and demographic trends, DOE projects that U.S. energy consumption will increase by more than one-third by the year 2025. Electric power consumption is expected to increase by almost 40 percent, and total fossil fuel use is projected to increase similarly (EIA, 2005). At work and at home, we continue to rely on more energy-consuming devices. This growth in demand stresses current systems and requires substantial new investments in system expansions.
- *High energy prices.* Our demand for natural gas to heat our homes, for industrial and business uses, and for power plants is straining the available gas supply in North America and putting upward pressure on natural gas prices. Many household budgets are being strained by higher energy costs, leaving less money available for other household purchases and needs; this situation is particularly harmful for low-income households. Consumers are looking for ways to manage their energy bills. Higher energy bills for industry are reducing the nation's economic competitiveness and placing U.S. jobs at risk. Higher energy prices also raise the financial risk associated with the development of new natural gas-fired power plants, which had been expected to make up more than 60 percent of capacity additions over the next 20 years (EIA, 2005). Coal prices are also increasing and contributing to higher electricity costs.
- *Energy system reliability.* Events such as the Northeast electricity blackout of August 2003 and Hurricanes Katrina and Rita in 2005 highlighted the vulnerability of our energy system to disruptions. This led to an

increased focus on energy reliability and its economic and human impacts, as well as national security concerns using fossil fuel more efficiently and increasing energy supply diversity.

- *Transmission systems* are overburdened in some places, limiting the flow of economical generation and, in some cases, shrinking reserve margins of the electricity grid to inappropriately small levels. This situation can cause reliability problems and high electricity prices in or near congested areas.

- *Environmental concerns.* Energy demand continues to grow as national and state regulations are being implemented to significantly limit the emissions of air pollutants, such as sulfur dioxide (SO_2), nitrogen oxides (NO_X), and mercury, to protect public health and the environment. Many existing base load generation plants are aging and significant retrofits are needed to ensure old generating units meet these emissions regulations. In addition, emissions of greenhouse gases continue to increase.

Addressing these issues will require billions of dollars in investments in new power plants, gas rigs, transmission lines, pipelines, and other infrastructure, notwithstanding the difficulty of building new energy infrastructure in dense urban and suburban locations even with current energy efficiency investment. The decisions we make now regarding our energy supply and demand can either help us deal with these challenges more effectively or complicate our ability to secure a more stable, economical energy future.

Benefits of Energy Efficiency

Greater investment in energy efficiency can help us tackle these challenges. Energy efficiency is already a key component in the nation's energy resource mix in many parts of the country, and experience shows that energy efficiency programs can lower customer energy bills; cost less than, and help defer, new energy production; provide environmental benefits; and spur local economic development. Some of the major benefits of energy efficiency include:

- *Lower energy bills, greater customer control, and greater customer satisfaction.* Well-designed programs can provide opportunities for all customer classes to adopt energy savings measures and reduce their energy bills.[3] These programs can help customers make sound energy use decisions, increase control over their energy bills with savings of 5 to 30 percent, and empower them to manage their energy usage. Customers often express greater satisfaction with electricity and natural gas providers where energy efficiency is offered.

- *Lower cost than supplying new generation only from new power plants.* Well-designed energy efficiency programs are saving energy at an average cost of one-half of the typical cost of new power sources and about one-third of the cost of providing natural gas.[4] When integrated into a long-term energy resource plan, energy efficiency could help defer investments in new plants and lower the total energy system cost.

- *Modular and quick to deploy.* Energy efficiency programs can be ramped up over a period of one to three years to deliver sizable savings. These programs can also be targeted to congested areas with high prices to bring relief where it might be difficult to deliver new supply in the near term.

- *Significant energy savings.* Well-designed energy efficiency programs are delivering energy savings each year on the order of 1 percent of total electric and natural gas sales.[5] These programs are helping to offset 20 to 50 percent of expected growth in energy

[3] See Chapter 6: Energy Efficiency Program Best Practices for more information on leading programs.

[4] Based on new power costs and gas prices in 2015 (EIA, 2006) compared to electric and gas program costs based on leading energy programs, many of which are discussed in Chapter 6: Energy Efficiency Program Best Practices.

[5] Based on leading energy efficiency programs, many of which are discussed in Chapter 6: Energy Efficiency Program Best Practices.

demand in some areas without compromising the end users' activities and economic well-being (Nadel, et al., 2004; EIA, 2006).

- *Environmental benefits.* Cost-effective energy efficiency offers environmental benefits related to reduced demand, such as reduced air pollution and greenhouse gas emissions, lower water use, and less environmental damage from fossil fuel extraction. Energy efficiency is an attractive option for generation owners in advance of requirements to reduce greenhouse gas emissions.

- *Economic development.* Greater investment in energy efficiency helps build jobs and improve state economies. Energy efficiency users often redirect their bill savings toward other activities that increase local and national employment, with a higher employment impact than if the money had been spent to purchase energy (York and Kushler, 2005; NYSERDA, 2004). Many energy efficiency programs create construction and installation jobs, with multiplier impacts on other employment and local economies (Sedano et al., 2005). Local investments in energy efficiency can offset energy imports from out-of-state, improving the state balance of trade. Lastly, energy efficiency investments usually create long-lasting infrastructure changes to building, equipment and appliance stocks, creating long-term property improvements that deliver long-term economic value (Innovest, 2002).

- *Energy security.* Energy efficiency reduces the level of U.S. per capita energy consumption, thus decreasing the vulnerability of the economy and individual consumers to energy price disruptions from natural disasters and attacks upon domestic and international energy supplies and infrastructure.

Decades of Experience With Energy Efficiency

Utilities and their regulators began recognizing the potential benefits of improving efficiency and reducing demand in the 1970s and 1980s. These "demand-side management" (DSM) approaches meet increased demands for electricity or natural gas by managing the demand on the customer's side of the meter rather than increasing or acquiring more supplies. Planning processes, such as "least-cost planning" or "integrated resource planning," have been used to evaluate DSM programs on par with supply options and allow investment in DSM programs when they cost less than new supply options.

DSM program spending exceeded $2 billion a year (in 2005 dollars) in 1993 and 1994 (York and Kushler, 2005). In the late 1990s, funding for utility-sponsored energy efficiency was reduced in about half of the states due to changed regulatory structures and increased political and regulatory pressures to hold down electricity prices. This funding has partially recovered with new

Long Island Power Authority's (LIPA) Clean Energy Program Drives Economic Development, Customer Savings, and Environmental Quality Enhancements

LIPA started its Clean Energy Initiative in 1999 and has invested $229 million over the past 6 years. LIPA's portfolio of energy efficiency programs from 1999 to 2005 produced significant energy savings, emissions reductions and stimulated economic growth on Long Island:

- 296 megawatts (MW) peak demand savings
- 1,348 gigawatt-hours (GWh) cumulative savings
- Emissions reductions of:
    - Greater than 937,402 tons of carbon dioxide (CO_2)
    - Greater than 1,334 tons of NO_X
    - Greater than 4,298 tons of SO_2
- $275 million in customer bill savings and rebates
- $234 million increase in net economic output on Long Island
- 4,500 secondary jobs created

Source: LIPA, 2006

policies and funding mechanisms (see Figure 1-1) implemented to ensure that some level of cost-effective energy efficiency was pursued.

Notwithstanding the policy and regulatory changes that have affected energy efficiency program funding, wide scale, organized energy efficiency programs have now been operating for decades in certain parts of the country. These efforts have demonstrated the following:

- *Energy efficiency programs deliver significant savings.* In the mid-1990s, based on the high program funding levels of the early 1990s, electric utilities estimated program savings of 30 gigawatts (the output of about 100 medium-sized power plants) and more than 60 million megawatt-hours (MWh).

- *Energy efficiency programs can be used to meet a significant portion of expected load growth.* For example:

  — The Pacific Northwest region has met 40 percent of its growth over the past two decades through energy efficiency programs (see Figure 1-2).

  — California's energy efficiency goals, adopted in 2004 by the Public Utilities Commission, are to

Puget Sound Energy's (PSE) Resource Plan Includes Accelerated Conservation to Minimize Risks and Costs

PSE's 2002 and 2005 Integrated Resource Plans (IRPs) found that the accelerated development of energy efficiency minimizes both costs and risks. As a result, PSE significantly expanded its energy efficiency efforts. PSE is now on track to save 279 average MW (aMW) between 2006 and 2015, more than the company had saved between 1980 and 2004. The 279 aMW of energy efficiency represents nearly 10 percent of its forecasted 2015 sales.

Source: Puget Sound Energy, 2005

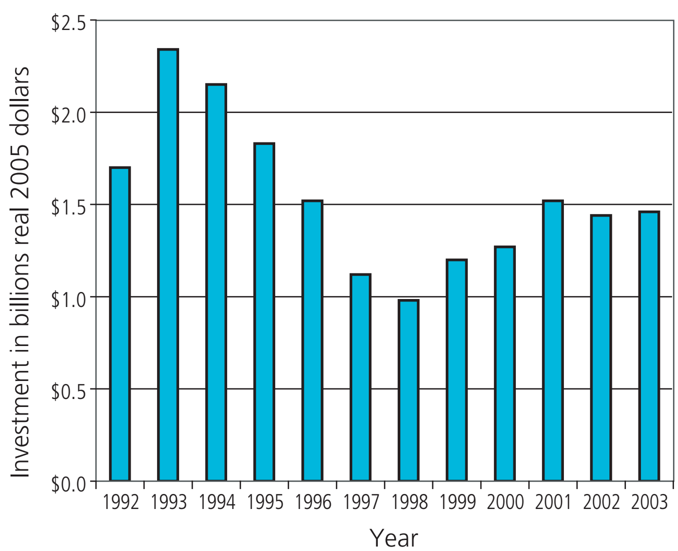
Connecticut's Energy Efficiency Programs Generate Savings of $550 Million in 2005

In 2005, the Connecticut Energy Efficiency Fund, managed by the Energy Conservation Management Board, invested $80 million in energy efficiency. This investment is expected to produce $550 million of bill savings to Connecticut electricity consumers. In addition, the 2005 programs, administered by Northeast Utilities and United Illuminating, resulted in:

- 126 MW peak demand reduction
- 4,398 GWh lifetime savings
- Emissions reductions of:
  — Greater than 2.7 million tons of CO_2
  — Greater than 1,702 tons of NO_X
  — Greater than 4,616 tons of SO_2
- 1,000 non-utility jobs in the energy efficiency industry

Source: CECMB, 2006

Figure 1-1: Energy Efficiency Spending Has Declined



Source: Data derived from ACEEE 2005 Scorecard (York and Kushler, 2005) adjusted for inflation using U.S. Department of Labor Bureau of Labor Statistics Inflation Calculator use energy efficiency to displace more than half of future electricity load growth and avoid the need to build three large (500 MW) power plants.

- *Energy efficiency is being delivered cost-competitively with new supply.* Programs across the country are demonstrating that energy efficiency can be delivered at a cost of 2 to 4 cents per kilowatt-hour (kWh) and a cost of $1.30 to $2.00 per lifetime million British thermal units (MMBtu) saved.

- *Energy efficiency can be targeted to reduce peak demand.* A variety of programs address the peak demand of different customer classes, lowering the strain on existing supply assets (e.g., pipeline capacity, transmission and distribution capacity, and power plant capability), allowing energy delivery companies to better utilize existing assets and deferring new capital investments.

- *Proven, cost-effective program models are available to build upon.* These program models are available for almost every customer class, both gas and electric.

Southern California Edison's (SCE) Energy Efficiency Investments Provide Economic and Environmental Savings

SCE's comprehensive portfolio of energy efficiency programs for 2006 through 2008 will produce:

- 3 percent average bill reduction by 2010
- 3.5 billion kWh of energy savings
- 888 MW of demand savings
- 20.5 million tons of CO_2 emission reductions
- 5.5 million tons of NO_X emission reductions
- Energy saved at a cost of less than 4.1 cents/kWh

Source: *Southern California Edison,* 2006

New York State's Aggressive Energy Efficiency Programs Help Power the Economy As Well As Reduce Energy Costs

New York State Energy Research and Development Authority's (NYSERDA's) portfolio of energy efficiency programs for the period from 1999 to 2005 produced significant energy savings, as well as stimulated economic growth and jobs, and reduced energy prices in the state:

- 19 billion kWh/year of energy savings
- 4,166 added jobs/year (created/retained) from 1999 to 2017
- $244 million/year in added total economic growth from 1999 to 2017
- $94.5 million in energy price savings over three years

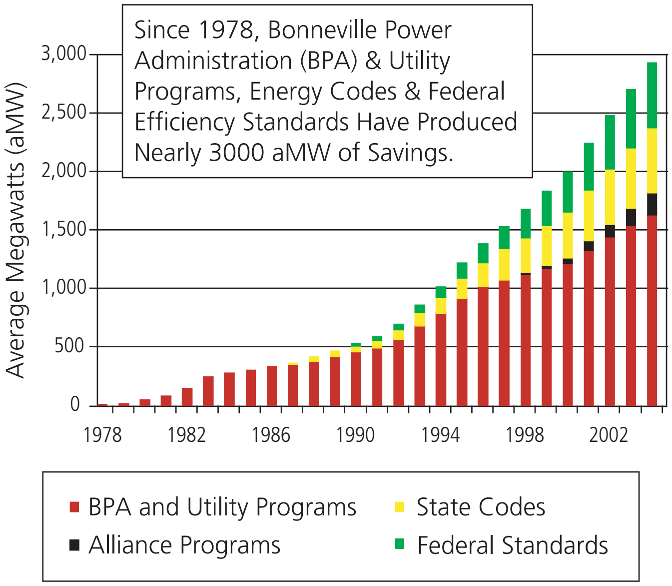
Source: NYSERDA, 2006

National Case for Energy Efficiency

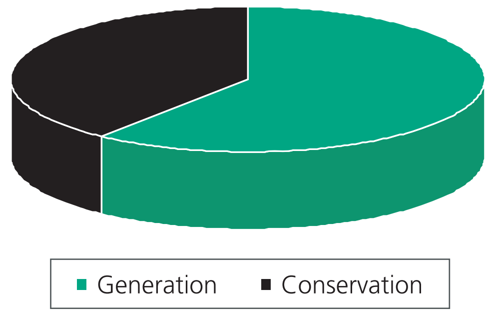
Improving the energy efficiency of homes, businesses, schools, governments, and industries—which consume more than 70 percent of the energy used in the country — is one of the most constructive, cost-effective ways to address the nation's energy challenges. Many of these buildings and facilities are decades old and will consume the majority of the energy to be used in these sectors for years to come. State and regional studies have found that adoption of economically attractive, but as yet untapped, energy efficiency could yield more than 20 percent savings in total electricity demand nationwide by 2025. Depending on the underlying load growth, these savings could help cut load growth by half or more compared to current forecasts (Nadel et al., 2004; SWEEP, 2002; NEEP, 2005; NWPCC, 2005; WGA, 2006). Similarly, energy efficiency targeted at direct natural gas use could lower natural gas demand growth by 50 percent (Nadel et al., 2004). Furthermore, studies also show that significant reductions in energy consumption can be achieved quickly (Callahan, 2006) and at low costs for many years to come.

Figure 1-2: Energy Efficiency Has Been a Resource in the Pacific Northwest for the Past Two Decades

Pacific Northwest Energy Efficiency Achievements 1978 - 2004



Energy Efficiency Met Nearly 40 Percent of Pacific Northwest Regional Firm Sales Growth Between 1980 to 2003



Source: Eckman, 2005

Capturing this energy efficiency resource would offer substantial economic and environmental benefits across the country. Widespread application of energy efficiency programs that already exist in some regions[6] could deliver a large part of these potential savings. Extrapolating the results from existing programs to the entire country would yield over the next 10 to 15 years[7]:

- Energy bill savings of nearly $20 billion annually.
- Net societal benefits of more than $250 billion.[8]
- Avoided need for 20,000 MW (40 new 500 MW-power plants).
- Avoided annual air emissions of more than 200 million tons of CO_2, 50,000 tons of SO_2, and 40,000 tons of NO_X.

These benefits illustrate the magnitude of the benefits cost-effective energy efficiency offers. They are estimated based on (1) assumptions of average program spending levels by utilities or other program administrators that currently sponsor energy efficiency programs and (2) conservatively high estimates for the cost of the energy efficiency programs themselves (see Table 1-1).[9] They are not meant as a prescription; there are differences in opportunities and costs for energy efficiency that need to be addressed at the regional, state, and utility level to design and operate effective programs.

6 See highlights of some of these programs in Chapter 6: Energy Efficiency Program Best Practices, Tables 6-1 and 6-2.

7 These economic and environmental savings estimates extrapolate the results from regional programs to a national scope. Actual savings at the regional level vary based on a number of factors. For these estimates, avoided capacity value is based on peak load reductions de-rated for reductions that do not result in savings of capital investments. Emission savings are based on a marginal on-peak generation fuel of natural gas and marginal off-peak fuel of coal; with the on-peak period capacity requirement double that of the annual average. These assumptions vary by region based upon situation-specific variables. Reductions in capped emissions might reduce the cost of compliance.

8 Net present value (NPV) assuming 5 percent discount rate.

9 This estimate of the funding required assumes 2 percent of revenues across electric utilities and 0.5 percent across gas utilities. The estimate also assumes that energy efficiency is delivered at a total cost (utility and participant) of $0.04 per kWh and $3 per MMBtu, which are higher than the costs of many of today's programs.

Table 1-1. Summary of Benefits for National Energy Efficiency Efforts

Program Cost	Electric	Natural Gas	Total
Utility Program Spending (% of utility revenue)	2.0%	0.5%	
Total Cost of Efficiency (customer & utility)	$35/MWh	$3/MMBtu	
Cost of Efficiency (customer)	$15/MWh	$2/MMBtu	
Average Annual Cost of Efficiency ($MM)	$6,800	$1,200	
Total Cost of Efficiency (NPV, $MM)	$140,000	$25,000	$165,000
Efficiency Spending - Customer (NPV, $MM)	$60,000	$13,000	$73,000
Efficiency Program Spending - Utility (NPV, $MM)	$80,000	$13,000	$93,000
Resulting Savings	**Electric**	**Natural Gas**	**Total**
Net Customer Savings (NPV, $MM)	$277,000	$76,500	$353,500
Annual Customer Savings $MM	*$18,000*	*$5,000*	*$23,000*
Net Societal Savings (NPV, $MM)	$270,000	$74,000	$344,000
Annual Net Societal Savings ($MM)	*$17,500*	*$5,000*	*$22,500*
Decrease in Revenue Requirement (NPV, $MM)	$336,000	$89,000	$425,000
Annual Decrease in Revenue Requirement ($MM)	*$22,000*	*$6,000*	*$28,000*
Energy Savings	**Electric**	**Natural Gas**	**Total**
Percent of Growth Saved, Year 15	61%	52%	
Percent of Consumption Saved, Year 15	12%	5%	
Peak Load Reduction, Year 15 (De-rated)[1]	34,000 MW		
Energy Saved, Year 15	588,000 GWh	1,200 BcF	
Energy Saved (cumulative)	9,400,000 GWh	19,000 BcF	
Emission Reductions	**Electric**	**Natural Gas**	**Total**
CO2 Emission Reduction (1,000 Tons), Year 15	338,000	72,000	410,000
NOx Emission Reduction (Tons), Year 15	67,000	61,000	128,000
Other Assumptions	**Electric**	**Natural Gas**	
Load Growth (%)	2%	1%	
Utility NPV Discount Rate	5%	5%	
Customer NPV Discount Rate	5%	5%	
EE Project Life Term (years)	15	15	

Source: Energy Efficiency Benefits Calculator developed for the National Action Plan for Energy Efficiency, 2006.

NPV = net present value; $MM = million dollars

[1] De-rated peak load reduction based on the coincident peak load reduced multiplied by the percent of growth-related capital expenditures that are saved. Peak load reductions in unconstrained areas are not counted.

As a nation we are passing up these savings by substantially underinvesting in energy efficiency. One indicator of this underinvestment is the level of energy efficiency program funding across the country. Based on the effectiveness of current energy efficiency programs operated in certain parts of the country, the funding necessary to yield the economic and environmental benefits presented above is approximately four times the funding levels for organized efficiency programs today (less than $2 billion per year). Again, this is one indicator of underinvestment and not meant to be a national funding target. Appropriate funding levels need to be established at the regional, state, or utility level based on the cost-effective potential for energy efficiency as well as other factors.

The current underinvestment in energy efficiency is due to a number of well-recognized barriers. Some key barriers arise from choices concerning regulation of electric and natural gas utilities. These barriers include:

- *Market barriers*, such as the well-known "split-incentive" barrier, which limits home builders' and commercial developers' motivation to invest in new building energy efficiency because they do not pay the energy bill, and the transaction cost barrier, which chronically affects individual consumer and small business decision-making.

- *Customer barriers*, such as lack of information on energy saving opportunities, lack of awareness of how energy efficiency programs make investments easier through low-interest loans, rebates, etc., lack of time and attention to implementing efficiency measures, and lack of availability of necessary funding to invest in energy efficiency.

- *Public policy barriers*, which often discourage efficiency investments by electric and natural gas utilities, transmission and distribution companies, power producers and retail electric providers. Historically these organizations have been rewarded more for building infrastructure (e.g., power plants, transmission lines, pipelines) and increasing energy sales than for helping their customers use energy wisely even when the energy-saving measures might cost less.[10]

- *Utility, state, and region planning barriers*, which do not allow energy efficiency to compete with supply-side resources in energy planning.

- *Energy efficiency program barriers*, which limit investment due to lack of knowledge about the most effective and cost-effective energy efficiency program portfolios, programs for overcoming common market barriers to energy efficiency, or available technologies.

While a number of energy efficiency policies and programs contribute to addressing these barriers such as building codes, appliance standards, and state government leadership programs, energy efficiency programs organized through electricity and gas providers also encourage greater energy efficiency in the homes, buildings, and facilities that exist today that will consume the majority of the energy used in these sectors for years to come.

[10] Many energy efficiency programs have an average lifecycle cost of $0.03/kWh saved, which is 50-75% of the typical cost of new power sources (ACEEE, 2004; EIA, 2006).

The National Action Plan for Energy Efficiency

To drive a sustainable, aggressive national commitment to energy efficiency through gas and electric utilities, utility regulators, and partner organizations, more than 50 leading organizations joined together to develop this National Action Plan for Energy Efficiency. The Leadership Group members (Table 1-2) have developed this National Action Plan for Energy Efficiency Report, which:

- Reviews the barriers limiting greater investment in energy efficiency by gas and electric utilities and partner organizations.
- Presents sound business strategies that are available to overcome these barriers.
- Documents a set of business cases showing the impacts on key stakeholders as utilities under different circumstances increase energy efficiency programs.
- Presents best practices for energy efficiency program design and operation.
- Presents policy recommendations and options for spurring greater investment in energy efficiency by utilities and energy consumers.

The report chapters address four main policy and program areas (see Figure 1-3):

- *Utility Ratemaking and Revenue Requirements.* Lost sales from the expanded use of energy efficiency have a negative effect on the financial performance of electric and natural gas utilities, particularly those that are investor-owned under conventional regulation. Cost-recovery strategies have been designed and implemented to successfully "decouple" utility financial health from electricity sales volumes to remove financial disincentives to energy efficiency, and incentives have been developed and implemented to make energy efficiency investments as financially rewarding as capital investments.

The goal of the National Action Plan for Energy Efficiency is to create a sustainable, aggressive national commitment to energy efficiency through gas and electric utilities, utility regulators, and partner organizations.

The Leadership Group:

- Recognizes that utilities and regulators have critical roles in creating and delivering energy efficiency programs to their communities.
- Recognizes that success requires the joint efforts of the customer, utility, regulator, and partner organizations.
- Will work across their spheres of influence to remove barriers to energy efficiency.
- Commits to take action within their own organization to increase attention and investment in energy efficiency.

Leadership Group Recommendations:

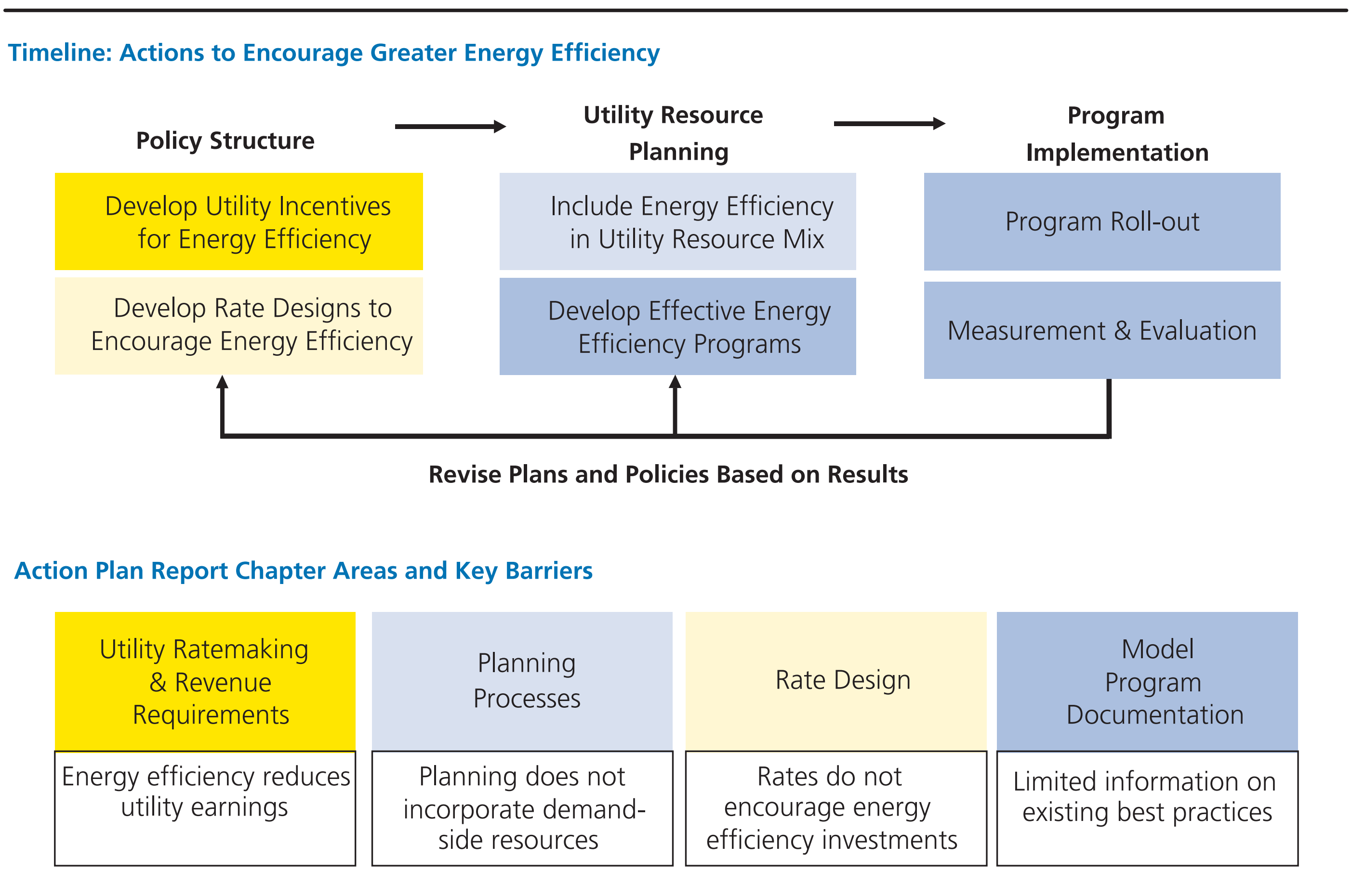
- Recognize energy efficiency as a high-priority energy resource.
- Make a strong, long-term commitment to implement cost-effective energy efficiency as a resource.
- Broadly communicate the benefits of and opportunities for energy efficiency.
- Promote sufficient, timely, and stable program funding to deliver energy efficiency where cost-effective.
- Modify policies to align utility incentives with the delivery of cost-effective energy efficiency and modify ratemaking practices to promote energy efficiency investments.

- *Planning Processes.* Energy efficiency, along with other customer-side resources, are not fully integrated into state and utility planning processes that identify the need to acquire new electricity and natural gas resources.

- *Rate Design.* Some regions are successfully using rate designs such as time-of-use (TOU) or seasonal rates to more accurately reflect the cost of providing electricity and to encourage customers to consume less energy.

- *Energy Efficiency Program Best Practices Documentation.* One reason given for slow adoption of energy efficiency is a lack of knowledge about the most effective and cost-effective energy efficiency program options. However, many states and electricity and gas providers are successfully operating energy efficiency programs across end-use sectors and customer classes, including residential, commercial, industrial, low-income, and small business. These programs employ a variety of approaches, including providing public information and training, offering financing and financial incentives, allowing energy savings bidding, and offering performance contracting.

Figure 1-3: National Action Plan for Energy Efficiency Report Addresses Actions to Encourage Greater Energy Efficiency

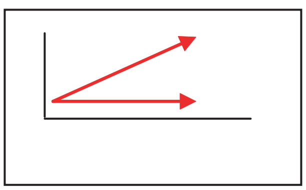


Business Cases for Energy Efficiency

A key element of the National Action Plan for Energy Efficiency is exploring the benefits of energy efficiency and the mechanisms and policies that might need to be modified so that each of the key stakeholders can benefit from energy efficiency investments. A key issue is that adoption of energy efficiency saves resources and utility costs, but also reduces utility sales. Therefore, the effect on utility financial health must be carefully evaluated. To that end, the Leadership Group offers an Energy Efficiency Benefits Calculator (Calculator) that evaluates the financial impact of energy efficiency on its major stakeholders—utilities, customers, and society. The Calculator allows stakeholders to examine different efficiency and utility cases with transparent input assumptions.

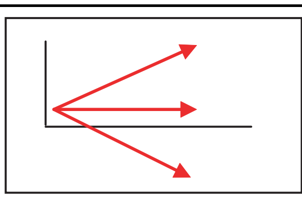
The business cases presented in Chapter 4 of this report show the impact of energy efficiency investments upon sample utility's financial health and earnings, upon customer energy bills, and upon social resources such as net efficiency costs and pollutant emissions. In general, the impacts of offering energy efficiency programs versus not offering efficiency follow the trends and findings illustrated below from the customer, utility and society perspectives.

Utility Perspective. Energy efficiency affects utility revenues, shareholder earnings, and costs associated with capital investments. The utility can be financially neutral to investments in energy efficiency, at a minimum, or encourage greater investment through the implementation of a variety of decoupling, ratemaking, and incentives policies. These policies can ensure that shareholder returns and earnings could be the same or increased. Utility investment in infrastructure and contractual obligations for energy procurement could be reduced, providing a favorable balance sheet impact.



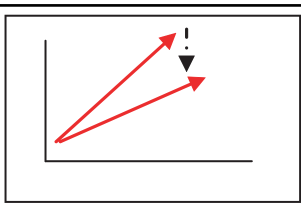
Utility Returns – No Change or Increase

Utility earnings remain stable or increase if decoupling or the use of shareholder incentives accompanies an energy efficiency program. Without incentives, earnings might be lower because effective energy efficiency will reduce the utility's sales volume and reduce the utility's rate base, and thus the scope of its earnings.



Change in Utility Earnings – Results Vary

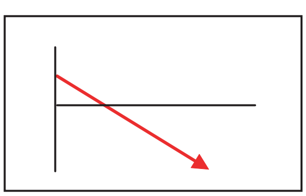
Depending on the inclusion of decoupling and/or shareholder incentives, utility earnings vary. Utility earnings increase if decoupling or shareholder incentives are included. If no incentives, earnings might be lower due to reduced utility investment.



Peak Load Growth and Associated Capital Investment – Decreases

Capital investments in new resources and energy delivery infrastructure are reduced because peak capacity savings are captured due to energy efficiency measures.

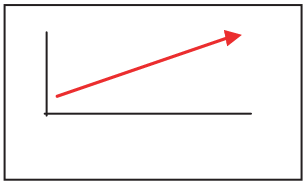
Customer Perspective. Customers' overall bills will decrease with energy efficiency because lower energy usage offsets potential rate increases to cover the cost of offering the efficiency program.



Customer Bills – Decrease

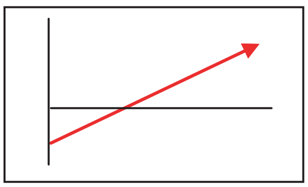
Total customer bills decline over time as a result of investment in cost-effective energy efficiency programs as customers save due to lower energy consumption. This decline follows an initial rise in customer bills reflecting the cost of energy efficiency programs, which will then reduce costs over many years.

Customer Perspective (continued)

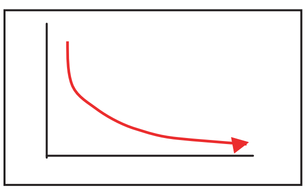


Customer Rates – Mild Increase[12]
Rates might increase slightly to cover the cost of the energy efficiency program.

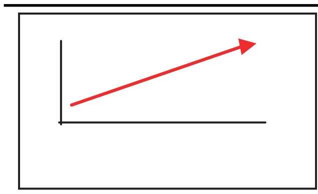
Community or Society Perspective. From a broad community/society perspective, energy efficiency produces real savings over time. While initially, energy efficiency can raise energy costs slightly to finance the new energy efficiency investment, the reduced bills (as well as price moderation effects) provide a rapid payback on these investments, especially compared to the ongoing costs to cover the investments in new energy production and delivery infrastructure costs. Moreover, the environmental benefits of energy efficiency continue to grow. The Calculator evaluates the net societal savings, utility savings, emissions reductions, and the avoided growth in energy demand associated with energy efficiency.



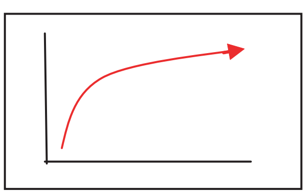
Net Resources Savings – Increases
Over time, as energy efficiency programs ramp up, cumulative energy efficiency savings lead to cost savings that exceed the energy efficiency program cost.



Total Resource Cost (TRC) per Unit - Declines
Total cost of providing each unit of energy (MWh, MMBtu gas) declines over time because of the impacts of energy savings, decreased peak load requirements, and decreased costs during peak periods. Well-designed energy efficiency programs can deliver energy at an average cost less than that of new power sources.



Emissions and Cost Savings – Increases
Efficiency prevents or avoids producing many annual tons of emissions and emission control costs.



Growth Offset by EE – Increases
As energy efficiency programs ramp up, the percent of growth that is offset by energy efficiency climbs and then levels as cumulative savings as a percent of demand growth stabilizes.

12 The changes shown in the business cases indicate a change from what would have otherwise occurred. This change does not include a one-time infrastructure investment in the assumptions, but it does include smooth capital expenditures. Energy efficiency will moderate prices of fossil fuels. The fuel price reductions from an aggressive energy efficiency program upon fuel prices have not been included and could result in an overall rate reduction.

About This Report

The National Action Plan for Energy Efficiency is structured as follows:

Chapter 2: *Utility Ratemaking & Revenue Requirements*

- Reviews mechanisms for removing disincentives for utilities to consider energy efficiency.
- Reviews the pros and cons for different strategies to reward utility energy efficiency performance, including the use of energy efficiency targets, shared savings approaches, and shareholder/company performance incentives.
- Reviews various funding options for energy efficiency programs.
- Presents recommendations and options for modifying policies to align utility incentives with the delivery of cost-effective energy efficiency and providing for sufficient and stable program funding to deliver energy efficiency where cost effective.

Chapter 3: *Energy Resource Planning Processes*

- Reviews state and regional planning approaches, including Portfolio Management and Integrated Resource Planning, which are being used to evaluate a broad array of supply and demand options on a level playing field in terms of their ability to meet projected energy demand.
- Reviews methods to quantify and simplify the value streams that arise from energy efficiency investments—including reliability enhancement/congestion relief, peak demand reductions, and greenhouse gas emissions reductions—for direct comparison to supply-side options.
- Presents recommendations and options for making a strong, long-term commitment to cost-effective energy efficiency as a resource.

Chapter 4: *Business Case for Energy Efficiency*

- Outlines the business case approach used to examine the financial implications of enhanced energy efficiency investment on utilities, consumers, and society.
- Presents case studies for eight different electric and natural gas utility situations, including different ownership structures, gas and electric utilities, and different demand growth rates.

Chapter 5: *Rate Design*

- Reviews a variety of rate design structures and their effect in promoting greater investment in energy efficiency by the end-user.
- Presents recommended strategies that encourage greater use of energy efficiency through rate design.

Chapter 6: *Energy Efficiency Program Best Practices*

- Reviews and presents best practices for operating successful energy efficiency programs at a portfolio level, addressing issues such as assessing energy efficiency potential, screening energy efficiency programs for cost-effectiveness, and developing a portfolio of approaches.
- Provides best practices for successful energy efficiency programs across end-use sectors, customer classes, and a broad set of approaches.
- Documents the political and administrative factors that lead to program success.

Chapter 7: *Report Summary*

- Summarizes the policy and program recommendations and options.

For More Information

Visit the National Action Plan for Energy Efficiency Web site: *www.epa.gov/cleanenergy/eeactionplan.htm* or contact:

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Table 1-2. Members of the National Action Plan for Energy Efficiency

Co-Chairs

Diane Munns	Member President	Iowa Utilities Board National Association of Regulatory Utility Commissioners
Jim Rogers	President and Chief Executive Officer	Duke Energy

Leadership Group

Barry Abramson	Senior Vice President	Servidyne Systems, LLC
Angela S. Beehler	Director of Energy Regulation	Wal-Mart Stores, Inc.
Bruce Braine	Vice President, Strategic Policy Analysis	American Electric Power
Jeff Burks	Director of Environmental Sustainability	PNM Resources
Kateri Callahan	President	Alliance to Save Energy
Glenn Cannon	General Manager	Waverly Light and Power
Jorge Carrasco	Superintendent	Seattle City Light
Lonnie Carter	President and Chief Executive Officer	Santee Cooper
Mark Case	Vice President for Business Performance	Baltimore Gas and Electric
Gary Connett	Manager of Resource Planning and Member Services	Great River Energy
Larry Downes	Chairman and Chief Executive Officer	New Jersey Natural Gas (New Jersey Resources Corporation)
Roger Duncan	Deputy General Manager, Distributed Energy Services	Austin Energy
Angelo Esposito	Senior Vice President, Energy Services and Technology	New York Power Authority
William Flynn	Chairman	New York State Public Service Commission
Jeanne Fox	President	New Jersey Board of Public Utilities
Anne George	Commissioner	Connecticut Department of Public Utility Control
Dian Grueneich	Commissioner	California Public Utilities Commission
Blair Hamilton	Policy Director	Vermont Energy Investment Corporation
Leonard Haynes	Executive Vice President, Supply Technologies, Renewables, and Demand Side Planning	Southern Company
Mary Healey	Consumer Counsel for the State of Connecticut	Connecticut Consumer Counsel
Helen Howes	Vice President, Environment, Health and Safety	Exelon
Chris James	Air Director	Connecticut Department of Environmental Protection
Ruth Kinzey	Director of Corporate Communications	Food Lion
Peter Lendrum	Vice President, Sales and Marketing	Entergy Corporation
Rick Leuthauser	Manager of Energy Efficiency	MidAmerican Energy Company
Mark McGahey	Manager	Tristate Generation and Transmission Association, Inc.
Janine Migden-Ostrander	Consumers' Counsel	Office of the Ohio Consumers' Counsel
Richard Morgan	Commissioner	District of Columbia Public Service Commission
Brock Nicholson	Deputy Director, Division of Air Quality	North Carolina Air Office
Pat Oshie	Commissioner	Washington Utilities and Transportation Commission
Douglas Petitt	Vice President, Government Affairs	Vectren Corporation

Bill Prindle	Deputy Director	American Council for an Energy-Efficient Economy
Phyllis Reha	Commissioner	Minnesota Public Utilities Commission
Roland Risser	Director, Customer Energy Efficiency	Pacific Gas and Electric
Gene Rodrigues	Director, Energy Efficiency	Southern California Edison
Art Rosenfeld	Commissioner	California Energy Commission
Jan Schori	General Manager	Sacramento Municipal Utility District
Larry Shirley	Division Director	North Carolina Energy Office
Michael Shore	Senior Air Policy Analyst	Environmental Defense
Gordon Slack	Energy Business Director	The Dow Chemical Company
Deb Sundin	Director, Business Product Marketing	Xcel Energy
Dub Taylor	Director	Texas State Energy Conservation Office
Paul von Paumgartten	Director, Energy and Environmental Affairs	Johnson Controls
Brenna Walraven	Executive Director, National Property Management	USAA Realty Company
Devra Wang	Director, California Energy Program	Natural Resources Defense Council
Steve Ward	Public Advocate	State of Maine
Mike Weedall	Vice President, Energy Efficiency	Bonneville Power Administration
Tom Welch	Vice President, External Affairs	PJM Interconnection
Jim West	Manager of *energy right* & Green Power Switch	Tennessee Valley Authority
Henry Yoshimura	Manager, Demand Response	ISO New England Inc.

Observers

James W. (Jay) Brew	Counsel	Steel Manufacturers Association
Roger Cooper	Executive Vice President, Policy and Planning	American Gas Association
Dan Delurey	Executive Director	Demand Response Coordinating Committee
Roger Fragua	Deputy Director	Council of Energy Resource Tribes
Jeff Genzer	General Counsel	National Association of State Energy Officials
Donald Gilligan	President	National Association of Energy Service Companies
Chuck Gray	Executive Director	National Association of Regulatory Utility Commissioners
John Holt	Senior Manager of Generation and Fuel	National Rural Electric Cooperative Association
Joseph Mattingly	Vice President, Secretary and General Counsel	Gas Appliance Manufacturers Association
Kenneth Mentzer	President and Chief Executive Officer	North American Insulation Manufacturers Association
Christina Mudd	Executive Director	National Council on Electricity Policy
Ellen Petrill	Director, Public/Private Partnerships	Electric Power Research Institute
Alan Richardson	President and Chief Executive Officer	American Public Power Association
Steve Rosenstock	Manager, Energy Solutions	Edison Electric Institute
Diane Shea	Executive Director	National Association of State Energy Officials
Rick Tempchin	Director, Retail Distribution Policy	Edison Electric Institute
Mark Wolfe	Executive Director	Energy Programs Consortium

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2: Utility Ratemaking & Revenue Requirements

While some utilities manage aggressive energy efficiency programs as a strategy to diversify their portfolio, lower costs, and meet customer demand, many still face important financial disincentives to implementing such programs. Regulators working with utilities and other stakeholders, as well as boards working with publicly owned utilities, can establish or reinforce several policies to help address these disincentives, including overcoming the throughput incentive, ensuring program cost recovery, and defining shareholder performance incentives.

Overview

The practice of utility regulation is, in part, a choice about how utilities make money and manage risk. These regulatory choices can guide utilities toward or away from investing in energy efficiency, demand response, and distributed generation (DG). Traditional ratemaking approaches have strongly linked a utility's financial health to the volume of electricity or gas sold via the ratemaking structure, creating a disincentive to investment in cost-effective demand-side resources that reduce sales. The ratemaking structure and process establishes the rates that generate the revenues that gas and electric utilities, both public and private, can recover based on the just and reasonable costs they incur to operate the system and to procure and deliver energy resources to serve their customers.

Alternate financial incentive structures can be designed to encourage utilities to actively promote implementation of energy efficiency when it is cost effective to do so. Aligning utility and public interest aims by disconnecting profits and fixed cost recovery from sales volumes, ensuring program cost recovery, and rewarding shareholders can "level the playing field" to allow for a fair, economically based comparison between supply- and demand-side resource alternatives and can yield a lower cost, cleaner, and reliable energy system.

This chapter explores the utility regulatory approaches that limit greater deployment of energy efficiency as a resource in U.S. electricity and natural gas systems. Generally, it is within the power of utility commissions and utilities to remove these barriers.[1] Eliminating the throughput incentive is one way to remove a disincentive to invest in efficiency. Offering shareholder incentives will further encourage utility investment. Other disincen-

Leadership Group Recommendations Applicable to Utility Ratemaking and Revenue Requirements

- Modify policies to align utility incentives with the delivery of cost-effective energy efficiency and modify ratemaking practices to promote energy efficiency investments.
- Make a strong, long-term commitment to implement cost-effective energy efficiency as a resource.
- Broadly communicate the benefits of and opportunities for energy efficiency.
- Provide sufficient, timely, and stable program funding to deliver energy efficiency where cost-effective.

A more detailed list of options specific to the objective of promoting energy efficiency in ratemaking and revenue requirements is provided at the end of this chapter.

[1] In some cases, state law limits the latitude of a commission to grant ratemaking or earnings flexibility. Removing barriers to energy efficiency in these states faces the added challenge of amending statutes.

tives for energy efficiency include a short-term resource acquisition horizon and wholesale market rules that do not capture the system value of energy efficiency. After an introduction to these barriers and solutions, this chapter will report on successful efforts in states to implement these solutions. The chapter closes with a set of recommendations for pursuing the removal of these barriers.

This chapter refers to utilities as integrated energy companies selling electricity as well as delivering it. Many of these concepts, however, also apply to states that removed retail electricity sales responsibilities from utilities—turning the utility into an electric transmission and distribution company without a retail sales function.

Barriers and Solutions to Effective Energy Efficiency Deployment

Common disincentives for utilities to invest more in cost-effective energy efficiency programs include the "throughput incentive," the lack of a mechanism for utilities to recover the costs of and provide funding for energy efficiency programs, and a lack of shareholder and other performance incentives to compete with those for investments in new generation.

Traditional Regulation Motivates Utilities to Sell More: The Throughput Incentive

Rates change with each major "rate case," the traditional and dominant form of state-level utility ratemaking.[2] Between rate cases, utilities have a financial incentive to increase retail sales of electricity (relative to forecast or historic levels, which set "base" rates) and to maximize the "throughput" of electricity across their wires. This incentive exists because there is often a significant incremental profit margin on incremental sales. When rates are reset, the throughput incentive resumes with the new base. In jurisdictions where prices are capped for an extended time, the utility might be particularly anxious to grow sales to add revenue to cover cost increases that might occur during the freeze.

With traditional ratemaking, there are few mechanisms to prevent "over-recovery" of costs, which occurs if sales are higher than projected, and no way to prevent "under-recovery," which can happen if forecast sales are too optimistic (such as when weather or regional economic conditions deviate from forecasted or "normal" conditions).[3]

This dynamic creates an automatic disincentive for utilities to promote energy efficiency, because those actions will reduce the utility's net income—even if energy efficiency is clearly established and agreed-upon as a less expensive means to meet customer needs as a least-cost resource and is valuable to the utility for risk management, congestion reduction, and other reasons (EPA, 2006). The effect of this disincentive is exacerbated in the case of distribution-only utilities, because the revenue impact of electricity sales reduction is disproportionately larger for utilities without generation resources. While some states have ordered utilities to implement energy efficiency, others have questioned the practicality of asking a utility to implement cost-effective energy efficiency when their financial self-interest is to have greater sales.

Several options exist to help remove this financial barrier to greater investment in energy efficiency:

Decouple Sales from Profits and Fixed Cost Recovery

Utilities can be regulated or managed in a manner that allows them to receive their revenue requirement with less linkage to sales volume. The point is to regulate utilities such that reductions in sales from consumer-funded energy

[2] Public power utilities and cooperative utilities have their own processes to adjust rates that do not require state involvement.

[3] Over-recovery means that more money is collected from consumers in rates than is needed to pay for allowed costs, including return on investment. This happens because average rates tend to collect more for sales in excess of projected demand than the marginal cost to produce and deliver the electricity for those increased sales. Likewise, under-recovery happens if sales are less than the amount used to set rates (Moskovitz, 2000).

Utility and Industry Structure and Energy Efficiency

Publicly and Cooperatively Owned Utilities Compared With Investor-Owned Utilities

The throughput incentive affects municipal and cooperative utilities in a distinctive way. Public power and co-ops and their lenders are concerned with ensuring that income covers debt costs, while they are not concerned about "profits." Available low-cost financing for co-ops sometimes comes with restrictions that limit its use to power lines and generation, further diminishing interest in energy efficiency investments.

Natural Gas vs. Electric Utilities

Natural gas and electric utilities both experience the throughput incentive under traditional ratemaking. Natural gas utilities operate in a more competitive environment than do electric utilities because of the non-regulated alternative fuels, but this situation can cut either way for energy efficiency. For some gas utilities, energy efficiency is an important customer service tool, while in other cases, it is just seen as an imposed cost that competitors do not have. Natural gas companies in the United States also generally see a decline in sales due to state-of-the-art efficiencies in gas end uses, a phenomenon not seen by electric companies. Yet cost-effective efficiency opportunities for local gas distribution companies remain available.

Restructured vs. Traditional Markets

The transition to retail electric competition threw open for reconsideration all assumptions about utility structure. The effects on energy efficiency have been strongly positive and negative. The throughput incentive is stronger for distribution-only companies with no generation and transmission rate base. Price caps, which typically are imposed in a transition to retail competition, diminish utility incentive to reduce sales because added revenue helps cope with new costs. Price caps also discourage utilities from adding near-term costs that can produce a long-term benefit, such as energy efficiency. As a result, energy efficiency is often disconnected from utility planning. On the other hand, several states have provided stable funding for energy efficiency as part of the restructuring process.

High-Cost vs. Low-Cost States

Energy efficiency has been more popular in high-cost states. Low-cost states tend to see energy efficiency as more expensive than their supplies from hydroelectric and coal sources, though there are exceptions where efficiency is seen as a low-cost incremental resource and a way to meet environmental goals. Looking forward, all states face similar, higher cost options for new generation, suggesting that the current resource mix will be less important than future resource options in considering the value of new energy efficiency investments.

efficiency, building codes, appliance standards, and distributed generation are welcomed, and not discouraged.

For example, if utility revenues were connected to the number of customers, instead of sales, the utility would experience different incentives and might behave quite differently. Under this approach, at the conclusion of a conventional revenue requirement proceeding, a utility's revenues per customer could be fixed. An automatic adjustment to the revenue requirement would occur to account for new or departing customers (a more reliable driver of costs than sales). An alternative to the revenue per customer approach is to use a simple escalation formula to forecast the fixed cost revenue requirement over time.

Under this type of rate structure, a utility that is more efficient and reduces its costs over time through energy efficiency will be able to increase profits. Furthermore, if sales are reduced by any means (e.g., efficiency, weather, or economic swings) revenues and profits will not be affected.

This approach eliminates the throughput disincentive and does not require a commission resolution of the amount of lost revenues associated with energy efficiency (see Table 2-1). A critical element of revenue decoupling is a true-up of actual results to forecasted results. Rates would vary up or down reflecting a balancing account for total authorized revenue requirements and actual revenues from electricity or gas consumed by customers. The true-up is fundamental to accomplish decoupling profits and fixed cost revenues from sales volumes. Annual adjustments have been typical and can be modeled in the Energy Efficiency Benefits Calculator (see Chapter 4: Business Case for Energy Efficiency), but a quarterly or monthly adjustment might be preferred. The plan may also include a deadband, meaning that modest deviations from the forecast would produce no change in rates, while larger deviations will result in a rate change. The plan might also share some of the deviations between customers and the utility. The magnitude of rate changes at any one time can be capped if the utility and regulators agree to defer the balance of exceptional changes to be resolved later. Prudence reviews should be unaffected by a decoupling plan. A decoupling plan would typically last a few years and could be changed to reflect new circumstances and lessons learned. Decoupling has the potential to lower the risk of the utility, and this feature should lead to consumer benefits through an overall lower cost of capital to the utility.[4]

Decoupling through a revenue per customer cap is presently more prevalent in natural gas companies, but can be a sound tool for electric companies also. Rate design need not be affected by decoupling (see Chapter 5: Rate Design for rate design initiatives that promote energy efficiency), and a shift of revenues from the variable portion of rates to the fixed portion does not address the throughput incentive. The initial revenue requirement would be determined in a routine rate case, the revenue per customer calculation would flow from the same billing determinants used to set rates. Service performance measures can be added to assure that cost reductions result from efficiency rather than service reductions. Some state laws limit the use of balancing accounts and true-ups, so legislative action would be necessary to enable decoupling in those states.

A decoupling system can be simple or complex, depending on the needs of regulators, the utility, or other parties and the value of a broad stakeholder process leading up to a decoupling system (Kantor, 2006). As the text box addressing lessons learned suggests, it is important to establish the priorities that the system is being created to address so it can be as simple as possible while avoiding unintended consequences. Additionally, it is important to evaluate any decoupling system to ensure it is performing as expected.[5]

Shifting More Utility Fixed Costs Into Fixed Customer Charges

Traditionally, rates recover a portion of the utility's fixed costs through volumetric rates, which helps service remain affordable. To better assure recovery of capital asset costs with reduced dependence on sales, state utility commissions could reduce variable rates and increase the fixed rate component, often referred to as the fixed charge or customer charge. This option might be particularly relevant in retail competition states because wires-only electric utilities have relatively high proportions of fixed costs. This shift is attractive to some natural gas systems experiencing sales volume attrition due to improved furnace efficiency and other trends. This shift reduces the throughput incentive for distribution companies and is an alternative to decoupling. There are some limiting concerns, including the effect a reduction in the variable charge might have on consumption and consumers' motivation to practice energy efficiency, and the potential for high using consumers to benefit from the change while low-using customers pay more.

[4] The lowering of a gas utility's cost of capital because of the reduced risk introduced by a revenue decoupling mechanism was recently affirmed by Barone (2006).

[5] Two recent papers discuss decoupling in some detail: Costello, 2006 and NERA, 2006.

The First Wave of Decoupling and Lessons Learned

In the early 1990s, several state commissions and utilities responded to the throughput incentive by creating decoupling systems. In all cases, decoupling was discontinued by the end of the decade. The reasons for discontinuation provide guidance to those considering decoupling today and indicate that the initial idea was good, but that the execution left important issues unaddressed.

In the case of California, decoupling was functioning well, using forecasted revenues and true-ups to actuals, but the move to retail competition precipitated its end in 1996 (CPUC, 1996). Following the energy crisis of 2000-2001, California recognized the importance of long-term energy efficiency investments and reinstated mechanisms to eliminate the throughput incentive.

Puget Sound Energy in Washington adopted a decoupling plan in 1990. There were several problems. The split between variable power costs (recovered via a true-up based on actual experience) and fixed costs (recovered based on a revenue-per-customer calculation) was wrong. While customer numbers (and revenue) were increasing, new investments in transmission were not needed so the fixed cost part of the plan over-recovered. Meanwhile, new generation from independent generators was too expensive, and this added power cost (minus a prudence disallowance, which further complicated the scene) was passed to ratepayers. Unlike the current California decoupling method, there was no reasonable forecast over time for power costs. Risk of power cost increases was insufficiently shared. The results were a big rate increase and anger among customers. In retrospect, risk allocation and the split of fixed and variable costs were incompatible to the events that followed and offer a useful lesson to future attempts. The true-up process and the weather normalization process worked well. The power costs that ignited the controversy over the decoupling plan would have been recoverable in rates under the traditional system. A recent effort to restore decoupling with Puget foundered over a dispute about whether the allowed return on equity during a prior rate case should be changed if decoupling was reinstated (Jim Lazar, personal communication, October 21, 2005).

Central Maine Power also adopted a decoupling plan at the beginning of the 1990s. The plan was ill-equipped, however, to account for an ensuing steep economic downturn that reduced sales by several percentage points. Unfortunately, this effect far outweighed any benefits from energy efficiency. The true-ups called for in the plan were onerous due to the dip in sales, and authorities decided to delay them in hopes that the economy would turn around. When that did not happen, the rate change was quite large and was attributed to the decoupling plan, even though most of the rate increase was due to reduced sales and would have occurred anyway. A lesson from this experience is to not let the period between true-ups go on too long and to consider more carefully what happens if market prices, the economy, the weather, or other significant drivers are well outside expected ranges.

In both the Puget and Central Maine cases, responsibility for large rate increases was misassigned to the decoupling plan, when high power costs from independent power producers (Puget) or general economic conditions (Central Maine) were primarily responsible. That said, serious but correctable flaws in the decoupling plans left consumers exposed to more risk than was necessary.

Provide Utilities the Profit Lost Through Efficiency

Another way to address the throughput incentive is to calculate the profits foregone to successful energy efficiency. Lost Revenue Adjustment Mechanisms (LRAM) allow a utility to directly recoup the "lost" profits and contributions to fixed costs associated with not selling additional units of energy because of the success of energy efficiency programs in reducing electricity consumption. The amount of lost profit can be estimated by multiplying the fixed portion of the utility's prices by the energy savings from energy efficiency programs or the energy generated from DG, based on projected savings or ex post impact evaluation studies. The amount of lost estimated profits is then directly returned to the utility's shareholders. Some states have adopted these mechanisms either through rate cases or add-ons to the fuel adjustment clause calculations.

Experience has shown that LRAM can allow utilities to recover more profits than the energy efficiency program

Table 2-1. Options to Mitigate the Throughput Incentive: Pros and Cons

Policy	Pros	Cons
Traditional cost of service plus return regulation	• Familiar system for regulators and utilities. • Rate changes follow rate cases (except for fuel/purchased gas adjustment clause states).	• Reduced sales reduce net income and contributions to fixed costs. • Sales forecasts can be contentious. • Harder to connect good utility performance to a financial consequence. Risks outside control of utility might be assigned to the utility.
Decoupling (use of a forecast of revenue or revenue per customer, with true-ups to actual results during a defined timeframe)	• Removes sales incentive and distributed resource disincentives. • Authorized fixed costs covered by revenue. • All beneficial actions and policies that reduce sales (distributed generation, energy efficiency programs, codes and standards, voluntary actions by customers, demand response) can be promoted by the utility without adversely affecting net income or coverage of fixed costs. Opportunity to easily reward or penalize utilities based on performance. • True-ups from balancing accounts or revenue per customer are simple. • Easy to add productivity factors, inflation adjustments, and performance indicators with rewards and penalties that can be folded into the true-up process. • Reduces volatility of utility revenue resulting from many causes. Risks from abnormal weather, economic performance, or energy markets can be allocated explicitly between customers and the utility.	• Lack of experience. Viewed by some as a more complex process. • Quality of forecasts is very important. • Some consumer advocates are uncomfortable with rate adjustments outside rate case or familiar fuel adjustment clause. • Frequent rate adjustments from true-ups are objectionable to those favoring rate stability who worry about accountability for rate increases. • Process of risk allocation can cause decoupling plan to break down. Connection between reconstituted risks and cost of capital can cause impasse. • Many issues to factor into the decoupling agreement. Past experience with decoupling indicates that it can be hard to "get it right," though these experiences suggest solutions.
Lost revenue adjustment	• Restores revenue to utility that would have gone to earnings and coverage of fixed costs but is lost by energy efficiency. • Diminishes the throughput disincentive for specific qualifying programs.	• Any sales reductions from efficiency initiatives outside qualifying programs are not addressed, leaving the throughput incentive in place. • Historically contentious, complex process to decide on lost revenue adjustment. Potentially rewards under-performing energy efficiency programs.
Independent energy efficiency administration	• Administration of energy efficiency is assigned to an entity without the conflict of the throughput incentive.	• Utility can still promote load building. Programs that would reduce sales outside the activities of the independent administrator might still be discouraged due to the throughput incentive.

actually saved because the lost profit is based on projected, rather than actual, energy savings. Resolving LRAM in rate cases has been contentious in some states. Furthermore, because utilities still earn increased profits on additional sales, this approach still discourages utilities from implementing additional energy efficiency or supporting independent energy efficiency activities. A comparison of decoupling and the LRAM approach is provided in Table 2-1.

A variation is to roughly estimate the amount of lost profits and make a specified portion (50 to 100 percent) available to the utility to collect based on its performance at achieving certain program goals. This approach is simpler and more constructive than a commission docket to calculate lost revenue. It provides a visible way for the utility to earn back lost profits with program performance and achievements consistent with the public interest. This system translates well into employee merit pay systems, and the goals can fit nicely into management objectives reported to shareholders, a utility's board of directors, or Governors. Public interest groups appreciate the connection to performance.

Non-Utility Administration

Several states, such as Oregon, Vermont and New York, have elected to relieve utilities from the task of managing energy efficiency programs. In some cases, state government has taken on this responsibility, and in others, a third party was created or hired for this purpose. The utility still has the throughput incentive, so while efficiency administration might be without conflict, the utility may still engage in load-building efforts contrary to the messages from the efficiency programs. Addressing the throughput incentive remains desirable even where non-utility administration is in place. Non-utility energy efficiency administration can apply to either electricity or natural gas. Where non-utility energy efficiency administration is in place, cooperation with the utility remains important to ensure that the customer receives good service (Harrington, 2003).

Wholesale Power Markets and the Throughput Incentive

In recent years, wholesale electric power prices have increased, driven by increases in commodity fuel costs. In many parts of the country, these increases have created a situation in which utilities with generation or firm power contracts that cost less than clearing prices might make a profit if they can sell excess energy into the wholesale market. Some have questioned whether or not the situation of utilities seeing wholesale profits from reduced retail sales diminishes or removes the throughput incentive.

Empirically, these conditions do not appear to have moved utilities to accelerate energy efficiency program deployment. In states in which generation is divested from the local utility, the companies serving retail customers see no change to the throughput incentive. There is little to suggest how these market conditions will persist or change. In the absence of a more definitive course change, evidence suggests that the recent trend should not dissuade policymakers and market participants from addressing the throughput incentive.

Recovering Costs / Providing Funding for Energy Efficiency Programs

Removing the throughput incentive is a necessary step in addressing the barriers many utilities face to investing more in energy efficiency. It is unlikely to be sufficient by itself in promoting greater investment, however, because under traditional ratemaking, utilities might be unable to cover the costs of running energy efficiency programs.[6] To ensure funds are available for energy efficiency, policymakers can utilize and establish the following mechanisms with cooperation from stakeholders:

Revenue Requirement or Procurement Funding

Policy-makers and regulators can set clear expectations that utilities should consider energy efficiency as a resource in their resource planning processes, and it should spend money to procure that resource as it would

[6] See Chapter 3: Energy Resource Planning Processes for discussion of utility resource planning budgets being used to fund energy efficiency.

for other resources. This spending would be part of the utility revenue requirement and would likely appear as part of the resource procurement spending for all resources needed to meet consumer demand in all hours. In retail competition states, the default service provider, the distribution company, or a third party can handle the responsibility of acquiring efficiency resources.

Spending Budgets

To reduce regulatory disputes and create an atmosphere of stability among utility managers, trade allies, and customers, the legislature or regulator can determine a budget level for energy efficiency spending—generally a percentage of utility revenue. This budget level would be set to achieve some amount of the potentially available, cost-effective, program opportunities. The spending budget allows administrator staff, trade allies, and consumers to count on a baseline level of effort and reduces the likelihood of spending disruptions that erode customer expectations and destroy hard-to-replace market infrastructure needed to deliver energy efficiency. Unfortunately, spending budgets are sometimes treated as a maximum spending level even if more cost-effective efficiency can be gained. Alternatively, a spending budget can be treated as a minimum if policymakers also declare efficiency to be a resource. In that event, additional cost-effective investments would be recovered as part of the utility revenue requirement.

Savings Target

An alternative to minimum spending levels is a minimum energy savings target. This alternative could be policy-driven (designed for consistency to obtain a certain percentage of existing sales or forecasted growth, or as an Energy Efficiency Portfolio Standard [EEPS]) or resource-driven (changing as system needs dictate). Efficiency budgets can be devised annually to achieve the targets. The use of savings targets does not address how money is collected from customers, or how program administration is organized. For more information on how investments are selected, see Chapter 3: Energy Resource Planning Processes.

Clear, Reliable, and Timely Energy Efficiency Cost Recovery System

Utilities value a clear and timely path to cost recovery, and a well-functioning regulatory process should provide that. Such a process contributes to a stable regulatory atmosphere that supports energy efficiency programs. Cost recovery can be linked to program performance (as discussed in the next section) so that utilities would be responsible for prudent spending of efficiency funds.

The energy efficiency program cost recovery issue is eliminated from the utility perspective if a non-utility administrative structure is used; however, this approach does not eliminate the throughput incentive. Furthermore, funding still needs to be established for the non-utility administrator.

Tariff Rider for Energy Efficiency

A tariff rider for energy efficiency allows for a periodic rate adjustment to account for the difference between planned costs (included in rates) and actual costs.

System Benefits Charge

In implementing retail competition, several states added a separate charge to customer bills to collect funds for energy efficiency programs; several other states have adopted this idea as well. A system benefits charge (SBC) is designed to provide a stable stream of funds for public purposes, like energy efficiency. SBCs do have disadvantages. If the funds enter the purview of state government, they can be vulnerable to decisions to use the funds for general government purposes. Also, the charge appears to be an add-on to bills, which can irritate some consumers. This distinct funding stream can lead to a disconnection in resource planning between energy efficiency and other resources. Regulators and utilities might need to take steps to ensure a comprehensive planning process when dealing with this type of funding.[7]

[7] This device might also pool funds for other public benefit purposes, such as renewable energy system deployment and bill assistance for low-income consumers.

Providing Incentives for Energy Efficiency Investment

Some suggest that if energy efficiency is a cost-effective resource, utilities should invest in it for that reason, with no reason for added incentives. Others say that for effective results, incentives should be considered because utilities are not rewarded financially for energy efficiency resources as they are for supply-side resources. This section reviews options for utility incentives to promote energy efficiency.

When utilities invest in hard assets, they depreciate these costs over the useful lives of the assets. Consumers pay a return on investment for the un-depreciated balance of costs not yet recovered, which spreads the rate effect of the asset over time. Utilities often do not have any opportunity to earn a return on energy efficiency spending, as they do with hard assets. This lack of opportunity for profit can introduce a bias against efficiency investment. Incentives for energy efficiency should be linked to achieving performance objectives to avoid unnecessary expenditures, and be evaluated by regulators based on their ability to produce cost-effective program performance. Performance objectives can also form the basis of penalties for inferior program performance. Financial incentives for utilities should represent revenues above those that would normally be recovered in a revenue requirement from a rate case.

Energy Efficiency Costs: Capitalize or Expense?

In most jurisdictions, energy efficiency costs are expensed, which means all costs incurred for energy efficiency are placed into rates during the year of the expense. When a utility introduces an energy efficiency program, or makes a significant increase or decrease in energy efficiency spending, rates must change to collect all annual costs. An increase in rates might be opposed by consumer advocates and other stakeholders, especially if parties disagree on whether the energy efficiency programs are cost-effective.

To moderate the rate effect of efficiency, regulators could capitalize efficiency costs, at least in part.[8] Capitalizing helps the utility by allowing for cost recovery over time but can cost consumers more than expensing in the long run. Some efficiency programs can meet short term rate-oriented cost-effectiveness tests if costs are capitalized. However, if the choice is made to capitalize, the regulator still has to decide the appropriate amortization period for program costs, balancing concern for immediate rate impacts and long term costs.[9] Capitalizing energy efficiency investments may be limited by the magnitude of "regulatory assets" that is appropriate for a utility. Bond ratings might decline if the utility asset account has too many assets that are not backed by physical capital. The limit on capitalized efficiency investment varies depending on the rest of the utility balance sheet.

Some argue that capitalizing energy efficiency is too costly and that rate effects from expensing are modest. Others note that in some places, capitalizing energy efficiency is the only way to deal with transitional rate effects and can provide a match over time between the costs and benefits of the efficiency investments (Arthur Rosenfeld, personal communication, February 20, 2006).

In some cases, it might be appropriate to consider encouraging unregulated utility affiliates to invest in and benefit from energy efficiency and other distributed resources.

Bonus Return, Shared Savings

To encourage energy efficiency investments over supply investments, regulators can authorize a return on investment that is slightly higher (e.g., 5 percent) for energy efficiency investments or offer a bonus return on equity investment for superior performance. Another approach is to share a percentage of the energy savings value, perhaps 5 to 20 percent, with the utility. A shared savings system has the virtue of linking the magnitude of the

[8] Capitalizing energy efficiency also reinforces the idea of efficiency as a substitute to supply and transmission.

[9] Iowa and Vermont initially capitalized energy efficiency spending, but transitioned to expense in the late 1990s.

reward with the level of program performance. A variation is to hold back some of the funds allocated to energy efficiency for award to shareholders for achieving energy efficiency targets. Where this incentive is used, the holdback can run between 3 and 8 percent of the program budget. Some of these funds can be channeled to employees to reward their efforts (Arthur Rosenfeld, personal communication, February 20, 2006; Plunkett, 2005).

Bonus returns, shared savings, and other incentives can raise the total cost of energy efficiency. However, if the incentives are well-designed and effective, they will encourage the utility to become proficient at achieving energy efficiency savings. The utility might be motivated to provide greater savings for consumers through more cost-effective energy efficiency.

Energy Efficiency Lowers Risk

Energy efficiency can help the financial ratings of utilities if it reduces the risks associated with regulatory uncertainty, long-term investments in gas supply and transport and electric power and transmission, and the risks associated with fossil fuel market prices that are subject to volatility and unpredicted price increases. By controlling usage and demand, utilities can also control the need for new infrastructure and exposure to commodity markets, providing risk management benefits. To the extent that a return on efficiency investments is likely and the chance of a disallowance of associated costs is minimized, investors will be satisfied. Decoupling tends to stabilize actual utility revenues, providing a better match to actual cost, which should further benefit utility bond ratings.

Reversing a Short-Term Resource Acquisition Focus: Focus on Bills, Not Just Rates

Policy-makers tend to focus on electric rates because they can be easily compared across states. They become a measure for business-friendliness, and companies consider rate levels in manufacturing siting and expansion decisions. But rates are not the only measure of service. A short-term focus on low rates can lead to costly missed investment opportunities and higher overall costs of electricity service over the long run.

Over the long term, energy efficiency benefits can extend to all consumers. Eventually, reduced capital commitments and lower energy costs resulting from cost-effective energy efficiency programs benefit all consumers and lower overall costs to the economy, freeing customer income for more productive purposes, like private investment, savings, and consumption. Improved rate stability and risk management from limited sales growth tends to improve the reputation of the utility. Incentives and removing the throughput incentive make it easier for utilities to embrace stable or declining sales.

A commitment to energy efficiency means accepting a new cost in rates over the short-term to gain greater system benefits and lower long-term costs, as is the case with other utility investments. State and local political support with a measure of public education might be needed to maintain stable programs in the face of persistent immediate pressure to lower rates.

Related Issues With Wholesale Markets and Long-Term Planning

Regulatory factors can hinder greater investment in cost-effective energy efficiency programs. These factors include the demand-side of the wholesale market not reacting to supply events like shortages or wholesale price spikes, and, for the electric sector, a short-term generation planning horizon, especially in retail competition states. In addition, transmission system planning by regional transmission organizations (RTOs) and utilities tends to focus on wires and supply solutions, not demand resources like efficiency. The value of sustained usage reductions through energy efficiency, demand response and distributed generation is not generally considered, nor compensated for in wholesale tariffs. These are regulatory choices and are discussed further in Chapter 3: Energy Resource Planning Processes.[10]

[10] Planning and rate design implications are more thoroughly discussed in Chapters 3: Energy Resource Planning Processes and Chapter 5: Rate Design.

Energy Efficiency Makes Wholesale Energy Markets Work Better

In the wholesale market venue, the value of energy efficiency would be revealed by a planning process that treats customer load as a manageable resource like supply and transmission, with investment in demand-side solutions in a way that is equivalent to (not necessarily the same as) supply and transmission solutions. Demand response and efficiency can be called forth that specifically reduces demand at peak times or in other strategic ways, or that reduces demand year-round.

Declare Energy Efficiency a Resource

To underscore the importance of energy efficiency, states can declare in statute or regulatory policy that energy efficiency is a resource and that utilities should factor energy efficiency into resource planning and acquisition. States concerned with risks on the supply side can also go one step further and designate that energy efficiency is the preferred resource.

Link Energy and Environmental Regulation

Environmental policy-makers have observed that energy efficiency is an effective and comparatively inexpensive way to meet tightening environmental limits to electric power generation, yet this attribute rarely factors into decisions by utility regulators about deployment of energy efficiency. This issue is discussed further in Chapter 3: Energy Resource Planning Processes.

State and Regional Examples of Successful Solutions to Energy Efficiency Deployment

Numerous states have previously addressed or are currently exploring energy efficiency electric and gas incentive mechanisms. Experiments in incentive regulation occurred through the mid-1990s but generally were overtaken by events leading to various forms of restructuring. States are expressing renewed interest in incentive regulation due to escalating energy costs and a recognition that barriers to energy efficiency still exist. Many state experiences are highlighted in the following text and Table 2-2.

Addressing the Throughput Disincentive

Direction Through Legislation

New Mexico offers a bold statutory statement directing regulation to remove barriers to energy efficiency: "It serves the public interest to support public utility investments in cost-effective energy efficiency and load management by removing any regulatory disincentives that might exist and allowing recovery of costs for reasonable and prudently incurred expenses of energy efficiency and load management programs" (New Mexico Efficient Use of Energy Act of 2005).

Decoupling Net Income From Sales

California adopted decoupling for its investor-owned companies as it restored utility responsibility for acquiring all cost-effective resources. The state has also required these companies to pursue all cost-effective energy efficiency at or near the highest levels in the United States. A balancing account collects forecasted revenues, and rates are reset periodically to adjust for the difference between actual revenues and forecasts. Because some utility cost changes are factored into most decoupling systems, rate cases can become less frequent, because revenues and costs track more closely over time.[11]

[11] See, for example, orders in California PUC docket A02-12-027. http://www.cpuc.ca.gov/proceedings/A0212027.htm. Oregon had used this method successfully for PacifiCorp, but when the utility was acquired by Scottish Power, the utility elected to return to the more familiar regulatory form.

Maryland and **Oregon** have decoupling mechanisms in place for natural gas. In **Maryland**, Baltimore Gas and Electric has operated with decoupling for more than seven years, and Washington Gas recently adopted decoupling, indicating that regulators view decoupling as a success.[12] In **Oregon**, Northwest Natural Gas has a similar decoupling mechanism in place.[13]

The inherently cooperative nature of decoupling is demonstrated by utilities and public interest advocates agreeing on a system that addresses public and private interests. In all these instances, no rate design shift was needed to implement decoupling—the change is invisible to customers. A new proposal for **New Jersey** Natural Gas would adopt a system similar to those in use in Oregon and Maryland.

See Table 2-2 for additional examples of decoupling.

Reducing Cost Recovery Through Volumetric Charges

After **New York** moved to retail competition and separated energy commodity sales from the electricity delivery utility, the distribution utilities' rates were modified to increase fixed cost recovery through per-customer charges, and to decrease the magnitude of variable, volumetric rates. Removing fixed generation costs, as these

Table 2-2. Examples of Decoupling

State	Type of Utility	Key Features	Related Rate Design Shifts?	Political/Administrative Factors
California	Investor-owned electric and gas	Balancing account to collect forecasted revenue; annual true-up.	No	Driven by commission, outcome of energy crisis; consensus oriented.
	http://www.epa.gov/cleanrgy/pdf/keystone/PrusnekPresentation.pdf http://www.cpuc.ca.gov/Published/Final_decision/15019.htm			
Maryland	Investor-owned gas only	Revenue per customer cap; monthly true-up.	No	Revenue stability primary motive of utility; frequent true-ups.
	http://www.energetics.com/madri/pdfs/timmerman_101105.pdf http://www.bge.com/vcmfiles/BGE/Files/Rates%20and%20Tariffs/Gas%20Service%20Tariff/Brdr_3.doc			
Oregon	Investor-owned gas only at present; investor-owned electric in the past	Revenue per customers cap; annual true-up.	No	Revenue stability primary motive of utility; renewed in 2005.
	http://www.raponline.org/Pubs/General/OregonPaper.pdf http://www.advisorinsight.com/pub/indexes/600_mi/nwn_ir.htm http://www.nwnatural.com/CMS300/uploadedFiles/24190ai.pdf http://apps.puc.state.or.us/orders/2002ords/02-633.pdf			
New Jersey	Investor-owned gas (proposed)	Revenue per customer.	No	Explicit intent of utility to promote energy efficiency and stabilize fixed cost recovery.
	http://www2.njresources.com/news/trans/newsrpt.asp?Year=2005 (see 12/05/05)			
Vermont	Investor-owned electric (proposed)	Forecast revenue cap and costs; balancing account and true-ups.	No	Legislative change promoted utility proposal; small utility looking for stability.
	http://www.greenmountainpower.biz/atyourservice/2006ratefiling.shtml			

[12] BG&E's "Monthly Rate Adjustment" tariff rider is downloadable at http://www.bge.com/portal/site/bge/menuitem.6b0b25553d65180159c031e0da6176a0/.

[13] The full agreement can be found in Appendix A of Order 02-634, available at http://apps.puc.state.or.us/orders/2002ords/02-634.pdf. See also Hansen and Braithwait (2005) for an independent assessment of the Northwest Natural Gas decoupling plan prepared for the commission.

assets were divested, dampened the effects on consumers. In combination with tracking and deferral mechanisms to protect the utility from unanticipated costs and savings, the utilities have little incentive to increase electric sales.

Using a Lost Revenue Adjustment

Minnesota provided Xcel Energy with lost revenue adjustments for energy efficiency through 1999, and then moved to a performance-based incentive. **Iowa** currently provides utilities with lost revenue adjustments for energy efficiency. **Connecticut** allows lost revenue recovery for all electric energy efficiency. **Massachusetts** allows lost revenue recovery for all gas energy efficiency, requiring the accumulated lost revenues to be recovered within three years to prevent large accumulated balances. **Oregon** allows lost revenue recovery for utility efficiency programs. Lost revenue adjustments have been removed in many states because of their cost to consumers. **New Jersey** is in the midst of a transition to a state-run administrator and provides lost revenue for utility-run programs in the meantime.

Non-Utility Administration

Several states have taken over the administration of energy efficiency, including **Wisconsin** (Focus on Energy), **Maine** (Efficiency Maine), **New Jersey**, and **Ohio**. In other states, a third party has been set up to administer programs, including **Vermont** (Efficiency Vermont) and **Oregon** (Energy Trust of Oregon). The **New York** State Energy Research and Development Authority (NYSERDA), a public authority, fits into both categories. There is no retail competition in Vermont or Wisconsin; this change was based entirely on an expectation of effectiveness. **Oregon** combines natural gas and electric efficiency programs, but only for the larger companies in each sector. Statewide branding of energy efficiency programs is a dividend of non-utility administration. **Connecticut** introduced an aspect of non-utility administration by vesting its Energy Conservation Management Board, a state board including state officials, utility managers, and others, with responsibility to approve energy efficiency plans and budgets.

Recovering Costs / Providing Funding for Energy Efficiency Programs

Revenue Requirement

When energy efficiency programs first began, they were funded as part of a utility revenue requirement. In many states, like Iowa, this practice has continued uninterrupted. In California, retail competition interrupted this method of acquiring energy efficiency, but since 2003, California is again funding energy efficiency along with other resources through the revenue requirement, a practice known there as "procurement funding." California also funds energy efficiency through SBC funding.

Capitalizing Energy Efficiency Costs

Oregon allows capitalization of costs, and the small electrics do so. Washington, Vermont, and Iowa capitalized energy efficiency costs when programs began in the 1980s to moderate rate effects. **Vermont**, for example, amortized program costs over five years. In the late 1990s, however, as program spending declined, these states ended the practice of capitalizing energy efficiency costs, electing to expense all costs. Currently, **Vermont** stakeholders are discussing how to further increase efficiency spending beyond the amount collected by the SBC, and they are reconsidering moderating new rate effects through capitalizing costs.

Spending Budgets, Tariff Riders, and System Benefits Charges

Several states have specified percentages of net utility revenue or a specific charge per energy unit to be spent for energy efficiency resources. **Massachusetts**, for example, specifies 2.5 mills per kilowatt-hour (kWh) (while spending for natural gas energy efficiency is determined case by case). In **Minnesota**, there is a separate percentage designated for electric (1.5 percent of gross operating revenues) and for natural gas (0.5 percent) utilities. **Vermont** adopted a statewide SBC for its vertically integrated electric sector, while its gas energy efficiency costs remain embedded in the utility revenue requirement. Strong statutory protections guard funds from government appropriation. Wisconsin requires a charge, but leaves the commission to determine the appropriate level for each utility. There is a history of SBC funds being used for general government within the state; 2005 legislation apparently intended to make funding more secure (Wisconsin Act 141 of 2005).

The **New York** commission chose to establish an annual spending budget for its statewide effort (exclusive of the public authorities and utilities), increasing it to $150 million in 2001 and to $175 million in 2006. **Washington** tariffs include a rider that allows adjustment of rates to recover energy efficiency costs that diverge from amounts included in rates, with annual true-ups.

Providing Incentives for Energy Efficiency Investment

Performance Incentives

In **Connecticut**, the two electric utilities managing energy efficiency programs are eligible for "performance management fees" tied to performance goals approved by the regulators, including lifetime energy savings, demand savings, and other measures. Incentives are available for a range of outcomes from 70 to 130 percent of pre-determined goals. In 2004, the two utilities collectively reached 130 percent of their energy savings goals and 124 percent of their demand savings goals. They received performance management fees totaling $5.27 million. The 2006 joint budget anticipates $2.9 million in performance incentives.

In 1999, the **Minnesota** Commission adopted performance incentives for the electric and natural gas investor-owned utilities that began at 90 percent of performance targets and are awarded for up to 150 percent of target levels. Performance targets for Minnesota utilities spending more than the minimum spending requirement are adjusted to the minimum spending level for purposes of calculating the performance incentive.

Rhode Island and **Massachusetts** offer similarly structured incentives. **Rhode Island** sets aside roughly 5 percent of the efficiency budget for performance incentives. This amount is less than the amount that would probably be justified if a lost revenue adjustment were used. A collaborative group of stakeholders recommends performance indicators and levels to qualify for incentives. In **Massachusetts**, utilities achieving performance targets earn 5 percent on money spent for efficiency (in addition to being able to expense efficiency costs).

Efficiency Vermont operates under a contract with the **Vermont** Public Service Board. The original contract called for roughly 3 percent of the budget for efficiency programs to be held back and paid if Efficiency Vermont meets a variety of performance objectives.

Shared Savings

Before retail competition, **California** used a shared savings approach, in which the utilities received revenue equal to a portion of the savings value produced by the energy efficiency programs. A similar mechanism might be reinstated in 2006 (Arthur Rosenfeld, personal communication, February 20, 2006).

Bonus Rate of Return

Nevada allows a bonus rate of return for demand-side management that is 5 percent higher than authorized rates of return for supply investments. Regulations specify programs that qualify and the process to account for qualifying investments (Nevada Regulation of Public Utilities Generally, 2004).

Lower Risk of Disallowance Through Multi-Stakeholder Collaborative

California, **Rhode Island**, and other states employ stakeholder collaboratives to resolve important program and administrative issues and to provide settlements to the regulator.

See Table 2-3 for additional examples of incentives for energy efficiency investments.

Table 2-3. Examples of Incentives for Energy Efficiency Investments

State	Type of Utility	Key Features	Political/Administrative Factors
California	Investor-owned electric	Shared savings	Encouraged by energy commission and utilities. Incentive proportionate to value of savings; no cap.
	http://www.raponline.org/Conferences/Minnesota/Presentations/PrusnekCAEEMinnesota.pdf		
Connecticut	Investor-owned electric	Performance incentives	Part of retail competition bargain; incentive limited to a percentage of program budget; simple to compare results to performance goals.
	http://www.state.ct.us/dpuc/ecmb/index.html		
Massachusetts, Rhode Island	Investor-owned electric	Performance incentives	Part of retail competition bargain; incentive limited to a percentage of program budget; simple to compare results to performance goals.
	http://www.mass.gov/dte/electric/04-11/819order.pdf (Docket 04-11) http://www.ripuc.org/eventsactions/docket/3463_NEC-2004DSMSettle(9.12.03).pdf		
Minnesota	Investor-owned electric and natural gas	Performance incentives	Utility-specific plan arising to resolve other regulatory issues; incentive awarded on a sliding scale of performance compared with goals; decoupling not authorized by statute.
	http://www.raponline.org/Pubs/RatePayerFundedEE/RatePayerFundedMN.pdf		
Nevada	Investor-owned electric	Bonus rate of return on equity	Process to establish bonus is statutory.
	See http://www.leg.state.nv.us/NAC/NAC-704.html#NAC704Sec9523		
Vermont	Efficiency utility	Performance incentives	Incentive structure set by contract; result of bargain between commission and third-party efficiency provider.
	http://www.state.vt.us/psb/eeucontract.html		

Regulatory Drivers for Efficiency in Resource Planning and Energy Markets

Declare Energy Efficiency a Resource

In **New Mexico**, the legislature has declared a goal of "decreasing electricity demand by increasing energy efficiency and demand response, and meeting new generation needs first with renewable and distributed generation resources, and second with clean fossil-fueled generation." (New Mexico Efficient Use of Energy Act of 2005)

In **California**, the state has made it very clear that energy efficiency is the most important resource (California SB 1037, 2005). After the crises of 2000 and 2001, state leaders used energy efficiency to dampen demand growth and market volatility. An Energy Action Plan, adopted in 2003 by the California Public Utilities Commission (CPUC), the California Energy Commission (CEC), and the power authority, developed a "loading order" for new electric resources; the Energy Action Plan has been revised but the energy efficiency preference remains firm. The intent of the loading order is to "decreas(e) electricity demand by increasing energy efficiency and demand response, and meeting new generation needs first with renewable and distributed generation resources, and second with clean fossil-fueled generation" (CEC, 2005). As a result, utilities are acquiring energy efficiency in amounts well in excess of those that would be procured with the SBC alone. Further, the utilities are integrating efficiency into their resource plans and using efficiency to solve resource problems.

Clarifying the primary regulatory status of efficiency makes it clear that sympathetic regulation and cost recovery policies are important. **California** has adopted decoupling of net income and sales for its investor-owned utilities to remove regulatory barriers to a full financial commitment to energy efficiency.

One device for implementing this policy is an energy efficiency supply curve. The CEC created such a curve based on an assessment of energy efficiency potential to provide guidance as it reintroduced energy efficiency procurement expectations for the utilities in 2003. Furthermore, the CPUC cooperated with the CEC to set energy savings targets for each of the California investor-owned utilities based on an assessment of cost-effectiveness potential.

A different approach to declaring energy efficiency a resource is to establish a portfolio or performance standard for energy efficiency. In 2005, **Pennsylvania** and **Connecticut** included energy efficiency in their resource portfolio standards. Requiring all retail sellers to acquire sufficient certificates of energy savings will allocate revenue to efficiency providers in an economically efficient way (Pennsylvania Alternative Energy Portfolio Standards Act of 2004; Connecticut Act Concerning Energy Independence of 2005).

As an outcome of its electric restructuring law, **Texas** is using energy efficiency as a resource to reduce demand. Texas' spending for energy efficiency is intended to produce savings to meet 10% of forecasted electric demand growth. Performance is exceeding this level.

Consider Energy Efficiency As a System Reliability Solution

In New England, Independent System Operator New England (ISO-NE) faced a reliability problem in southwest **Connecticut**. A transmission line to solve the problem was under development, but would not be ready in time. New central station generation could not be sited in this congested area. Because the marketplace was not providing a solution, ISO-NE issued a Request for Proposal (RFP) for any resources that would address the reliability problem and be committed for four years. One energy efficiency bid was selected—a commercial office building lighting project worth roughly 5 megawatts (MW). Conditions of the award were very strict about availability of the capacity savings. This project will help to demonstrate how energy efficiency does deliver capacity. While ISO-NE deemed the RFP an emergency step that it would not undertake routinely, this process demonstrates that energy efficiency can be important to meeting reliability goals and can be paid for through federal jurisdictional tariffs.

Other states, including **Indiana**, **Vermont**, and **Minnesota** direct that energy efficiency be considered as an alternative when utilities are proposing a power line project (Indiana Resource Assessment, 1995; Vermont Section 248; Minnesota Certificate of need for large energy facility, 2005.)

Key Findings

This chapter reviews opportunities to make energy efficiency an attractive business prospect by modifying electric and gas utility regulation, and by the way that utilities collect revenue and make a profit. Key findings of this chapter indicate:

- There are real financial disincentives that hinder all utilities in their pursuit of energy efficiency as a resource, even when it is cost-effective and would lead to a lower cost energy system. Regulation, which is a key source of these disincentives, can be modified to remove these barriers.

- Many states have experience in addressing financial disincentives in the following areas:

— Overcoming the throughput incentive.

— Providing reliable means for utilities to recover energy efficiency costs.

— Providing a return on investment for efficiency programs that is competitive with the return utilities earn on new generation.

— Addressing the risk of program costs being disallowed and other risks.

— Recognizing the full value of energy efficiency to the utility system.

Recommendations and Options

The National Action Plan for Energy Efficiency Leadership Group offers the following recommendations as ways to overcome many of the barriers to energy efficiency in utility ratemaking and revenue requirements, and provides a number of options for consideration by utilities, regulators, and stakeholders *(as presented in the Executive Summary):*

Recommendation: Modify policies to align utility incentives with the delivery of cost-effective energy efficiency and modify ratemaking practices to promote energy efficiency investments. Successful energy efficiency programs would be promoted by aligning utility incentives in a manner that encourages the delivery of energy efficiency as part of a balanced portfolio of supply, demand, and transmission investments. Historically, regulatory policies governing utilities have more commonly compensated utilities for building infrastructure (e.g., power plants, transmission lines, pipelines) and selling energy, while discouraging energy efficiency, even when the energy-saving measures might cost less. Within the existing regulatory processes, utilities, regulators, and stakeholders have a number of opportunities to create the incentives for energy efficiency investments by utilities and customers. A variety of mechanisms have already been used. For example, parties can decide to provide incentives for energy efficiency similar to utility incentives for new infrastructure investments, and provide rewards for prudent management of energy efficiency programs.

Options to Consider:

- Addressing the typical utility throughput incentive and removing other regulatory and management disincentives to energy efficiency.
- Providing utility incentives for the successful management of energy efficiency programs.

Recommendation: Make a strong, long-term commitment to implement cost-effective energy efficiency as a resource. Energy efficiency programs are most successful and provide the greatest benefits to stakeholders when appropriate policies are established and maintained over the long-term. Confidence in long-term stability of the program will help maintain energy efficiency as a dependable resource compared to supply-side resources, deferring or even avoiding the need for other infrastructure investments, and maintain customer awareness and support.

Options to Consider:

- Establishing funding requirements for delivering long-term, cost-effective energy efficiency.
- Designating which organization(s) is responsible for administering the energy efficiency programs.

Recommendation: Broadly communicate the benefits of and opportunities for energy efficiency. Experience shows that energy efficiency programs help customers save money and contribute to lower cost energy systems. But these benefits are not fully documented nor recognized by customers, utilities, regulators, or policymakers. More effort is needed to establish the business case for energy efficiency for all decision-makers and to show how a well-designed approach to energy efficiency can benefit customers, utilities, and society by (1) reducing customers' bills over time, (2) fostering financially healthy utilities (e.g., return on equity, earnings per share, and debt coverage ratios unaffected), and (3) contributing to positive societal net benefits overall. Effort is also necessary to educate key stakeholders that although energy efficiency can be an important low-cost resource to integrate into the energy mix, it does require funding, just as a new power plant requires funding.

Options to Consider:

- Establishing and educating stakeholders on the business case for energy efficiency at the state, utility, other appropriate level addressing customer, utility, and societal perspectives.
- Communicating the role of energy efficiency in lowering customer energy bills, and system costs and risks over time.

Recommendation: Provide sufficient, timely, and stable program funding to deliver energy efficiency where cost-effective. Energy efficiency programs require consistent and long-term funding to effectively compete with energy supply options. Efforts are necessary to establish this consistent long-term funding. A variety of mechanisms have been, and can be used, based on state, utility, and other stakeholder interests. It is important to ensure that the efficiency program providers have sufficient long-term funding to recover program costs, and implement the energy efficiency measures that have been demonstrated to be available and cost-effective. A number of states are now linking program funding to the achievement of energy savings.

Options to Consider:

- Deciding on, and committing to, a consistent way for program administrators to recover energy efficiency costs in a timely manner.
- Establishing funding mechanisms for energy efficiency from among the available options, such as revenue requirement or resource procurement funding, SBCs, rate-basing, shared-savings, incentive mechanisms, etc.
- Establishing funding for multi-year periods.

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3: Energy Resource Planning Processes

Including energy efficiency in the resource planning process is essential to realizing its full value and setting resource savings and funding targets accordingly. Many utilities, states, and regions are estimating and verifying the wide range of benefits from energy efficiency and are successfully integrating energy efficiency into the resource planning process. This chapter of the National Action Plan for Energy Efficiency Report discusses the barriers that obstruct incorporating energy efficiency in resource planning and presents six regional approaches to demonstrate how those barriers have been successfully overcome.

Overview

Planning is a core function of all utilities: large and small, natural gas and electric, public and private. The decisions made in planning affect customer costs, reliability of service, risk management, and the environment. Many stakeholders are closely involved and participate in planning processes and related decisions. Active participants often include utilities, utility regulators, city councils, state and local policy-makers, regional organizations, environmental groups, and customer groups. Regional planning processes organized through regional transmission organizations (RTOs) also occur with the collaborations of utilities and regional stakeholders.

Different planning processes are employed within each utility, state, and region. Depending on a utility's purpose and context (e.g., electric or gas utility, vertically integrated or restructured), different planning decisions must be made. Local and regional needs also affect planning and resource requirements and the scope of planning processes. Further, the role of states and regions in planning affects decisions and prescribes goals for energy portfolios, such as resource priority, fuel diversity, and emissions reduction.

Through different types of planning processes, utilities analyze how to meet customer demands for energy and capacity using supply-side resource procurement (including natural gas supply contracts and building new generation), transmission, distribution, and demand-side resources (including energy efficiency and demand response). Such planning often requires iteration and testing to find the combination of resources that offer maximum value over a range of likely future scenarios, for the short- and long-term. The value of each of these resources is determined at the utility, local, state and regional level, based on area-specific needs and policy direction. In order to fully integrate the value of all resources into planning—including energy efficiency—resource value and benefits must be determined early in the planning process and projected over the life of the resource plan.

Planning processes focus on two general areas: (1) energy-related planning, such as electricity generation and wholesale energy procurement; and (2) capacity-related planning, such as construction of new pipelines, power plants, or electric transmission and distribution projects. The value of energy efficiency can be integrated into resource planning decisions for both of these areas.

Leadership Group Recommendations Applicable to Energy Resource Planning Processes

- Recognize energy efficiency as a high-priority energy resource.
- Make a strong, long-term commitment to implement cost-effective energy efficiency as a resource.
- Broadly communicate the benefits of, and opportunities for, energy efficiency.
- Provide sufficient, timely, and stable program funding to deliver energy efficiency where cost-effective.

A more detailed list of options specific to the objective of promoting energy efficiency in resource planning processes is provided at the end of this chapter.

This chapter identifies common challenges for integrating energy efficiency into existing planning processes and describes examples of successful energy efficiency planning approaches that are used in six regions of the country. Finally, this chapter summarizes ways to address barriers, and offers recommendations and several options to consider for specific actions that would facilitate incorporation of energy efficiency into resource planning.

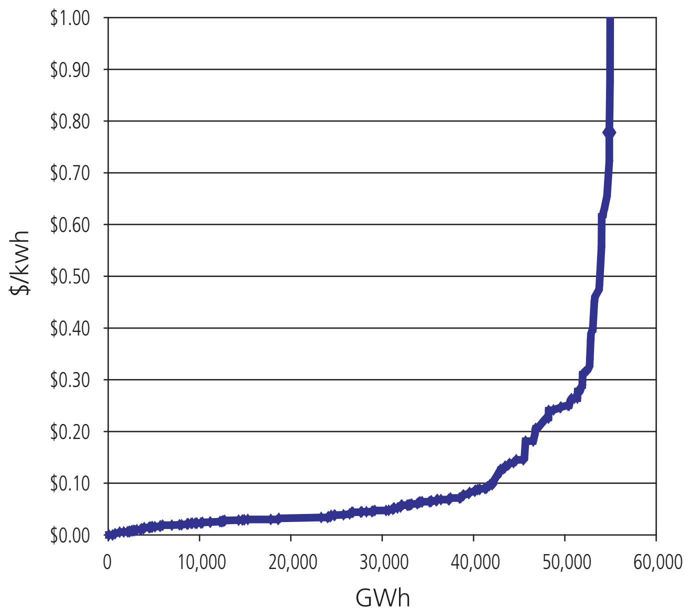
Challenges to Incorporating Energy Efficiency Into Planning

The challenges to incorporating energy efficiency into resource planning have common themes for a wide range of utilities and markets. This section describes these challenges in the context of two central questions: A) determining the value of energy efficiency in the resource planning, and B) setting energy efficiency targets and allocating budgets, which are guided by resource planning, as well as regulatory and policy decisions.

Determining the Value of Energy Efficiency

It is generally accepted that well-designed efficiency measures provide measurable resource savings to utilities. However, there are no standard approaches on how to appropriately quantify and incorporate those benefits into utility resource planning. Also, there are many different types of energy efficiency programs with different characteristics and target customers. Energy efficiency can include utility programs (rebates, audits, education, and outreach) as well as building efficiency codes and standards improvements for new construction. Each type of program has different characteristics that should be considered in the valuation process. The program information gathered in an energy efficiency potential study can be used to create an energy efficiency supply curve, as illustrated in Figure 3-1.

Figure 3-1. Energy Efficiency Supply Curve - Potential in 2011 (Levelized Cost in $/kilowatt-hours [kWh] Saved)



Source: McAuliffe, 2003

Common Challenges to Incorporating Energy Efficiency Into Planning
A. Determining the Value of Energy Efficiency
Energy Procurement
Estimating energy savings
Valuing energy savings
Capacity & Resource Adequacy
Estimating capacity savings
Valuing capacity benefits
Factors in achieving benefits
Other Benefits
Incorporating non-energy benefits
B. Setting Targets and Allocating Budget
Quantity of EE to implement
Estimating program effectiveness
Institutional difficulty in reallocating budget
Cost expenditure timing vs. benefits
Ensuring program costs are recaptured

The analysis commonly used to value energy efficiency compares the costs of energy efficiency resources to the costs of the resources that are displaced by energy efficiency. The sidebar shows the categories of benefits for electric and gas utilities that are commonly evaluated. The approach is to forecast expected future costs with and without energy efficiency resources and then estimate the level of savings that energy efficiency will provide. This analysis can be conducted with varying levels of sophistication depending on the metrics used to compare alternative resource plans. Typically, the evaluation is made based on the expected cost difference; however, "portfolio" approaches also evaluate differences in cost variance and reliability, which can provide additional rationale for including energy efficiency as a resource.

The resource benefits of energy efficiency fall into two general categories:

(1) Energy-related benefits that affect the procurement of wholesale electric energy and natural gas, and delivery losses.

(2) Capacity-related benefits that affect wholesale electric capacity purchases, construction of new facilities, and system reliability.

The energy-related benefits of energy efficiency are relatively easy to forecast. Because utilities are constantly adjusting the amount of energy purchased, short-term deviations in the amount of energy efficiency achieved can be accommodated. The capacity-related benefits occur when construction of a facility needed to reliably serve customers can be delayed or avoided because the need has already been met. Therefore, achieving capacity benefits requires much more certainty in the future success of energy efficiency programs (particularly the measures targeting peak loads) and might be harder to achieve in practice. However, the ability to provide capacity benefits has been a focus in California, the Pacific Northwest, and other regions, and it should become easier to assess capacity savings as more programs gain experience, and capacity savings are measured and verified. Current methods for estimating energy benefits and capacity benefits are presented here.

Estimating Energy Benefits

Estimating energy benefits requires established methods for estimating the quantity of energy savings and the benefits of these savings to the energy system.

- *Estimating Quantity of Energy Savings.* Savings estimates for a wide variety of efficiency measures have been well studied and documented. Approaches to estimate the level of free-riders and program participants who would have implemented the energy efficiency on their own have been established. Similarly, the expected useful lives of energy efficiency measures and their persistence are commonly evaluated and included in the analysis. Detailed databases of efficiency measures have been developed for several regions, including California and the Pacific Northwest. However, it is often necessary to investigate and validate the methods and assumptions behind those estimates to build consensus around measured savings that all stakeholders find credible. Savings estimates can be verified through measurements and load research. Best practices for measurement and verification (M&V) are discussed in more detail in Chapter 6: Energy Efficiency Program Best Practices.

Benefits of Energy Efficiency in Resource Planning

	Electricity	Natural Gas
Energy-related benefits	Reduced wholesale energy purchases	Reduced wholesale natural gas purchases
	Reduced line losses	Reduced losses and unaccounted for gas
	Reduced air emissions	Reduced air emissions
Capacity-related benefits	Generation capacity/ resource adequacy/ regional markets	Production and liquified natural gas facilities
	Operating reserves and other ancillary services	Pipeline capacity
	Transmission and distribution capacity	Local storage and pressure
Other benefits	Market price reductions (consumer surplus)	
	Lower portfolio risk	
	Local/in-state jobs	
	Low-income assistance and others	

- *Quantifying Value of Energy Savings.* The most readily available benchmark for the value of energy savings is the prevailing price of wholesale electricity and natural gas. Even for a vertically integrated utility with its own production, energy efficiency might decrease the need to make market purchases; or if the utility has excess energy, energy efficiency can allow the utility to sell more into the market. In cases when the market prices are not appropriate benchmarks (because of contract limitations on reselling energy or limited market access), contract prices or production costs can be used. In addition, the value of losses and other variable costs associated with energy delivery can be quantified and are well known.

The challenge that remains is in forecasting future energy costs beyond the period when market data are available or contracts are in place. Long-run forecasts vary in complexity from a simple escalation rate to market-based approaches that forecast the cost of new resource additions, to models that simulate the system of existing resources (including transmission constraints) and evaluate the marginal cost of operating the system as new generation is added to meet the forecasted load growth. Most utilities have an established approach to forecast long-term market prices, and the same forecasting technique and assumptions should be used for energy efficiency as are used to evaluate supply-side resource options. In addition to a forecast of energy prices, some regions include the change in market prices as a result of energy efficiency. Estimating these effects requires modeling of complex interactions in the energy market. Furthermore, reduced market prices are not necessarily a gain from a societal perspective, because the gains of consumers result in an equal loss to producers; therefore, whether to include these savings is a policy decision.

Estimating Capacity Benefits

Estimating capacity benefits requires estimating the level of capacity savings and the associated benefits. If energy efficiency's capacity benefits are not considered in the resource plan, the utility will overinvest in capital assets, such as power plants and transmission and distribution, and underinvest in energy efficiency.

- *Estimating Capacity Savings.* In addition to energy savings, electric efficiency reduces peak demand and the need for new investments in generation, transmission, and distribution infrastructure. Natural gas efficiency can reduce the need for a new pipeline, storage, liquefied natural gas (LNG) facility, or other investments necessary to maintain pressure during high-load periods. Because of the storage and pressure variation possible in the natural gas system, capacity-related costs are not as extreme in the natural gas system as they are for electricity. In both cases, estimating reductions of peak demand is more difficult for electricity than it is for natural gas, and timing is far more critical. For peak demand savings to actually be realized, the targeted end-use load reductions must occur, and the efficiency measure must provide savings coincident with the utility's peak demand. Therefore, different energy efficiency measures that reduce load at different times of day (e.g., commercial vs. residential lighting) might have different capacity values. Area- and time-specific marginal costing approaches have been developed to look at the value of coincident peak load reductions, which have significantly higher value during critical hours and in constrained areas of the system (see sidebar on page 3-5).

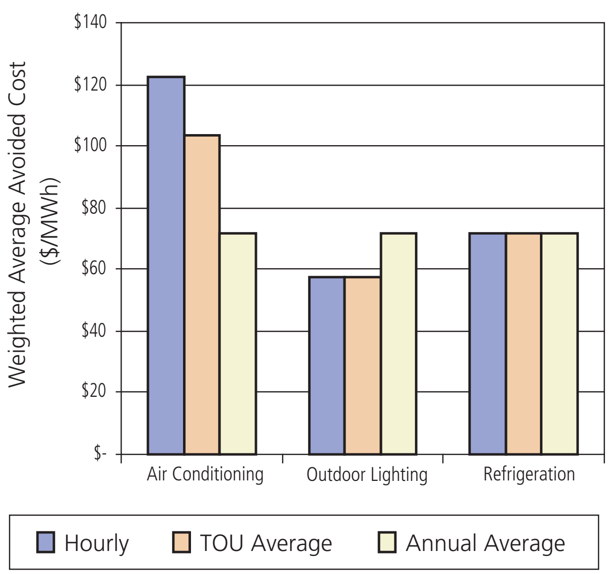
  A critical component of the resource planning process, whether focused on demand- or supply-side resources, is accurate, unbiased load forecasting. Inaccurate load forecasts either cause excessive and expensive investment in resources if too aggressive, or create costly shortages if too low. Similarly, tracking and validation of energy efficiency programs are important for increasing the accuracy of estimates of their effects in future resource plans.

  Estimating the capacity savings to apply to load growth forecasts requires estimating two key factors. The first is determining the amount of capacity reduced by energy efficiency during critical or peak hours. The second factor is estimating the "equivalent reliability" of the load reduction. This measure captures both the probability that the savings will actually occur, and that the savings will occur during system-constrained hours. Applying estimates of equivalent reliability to various types of resources allows comparison on an equal basis with traditional capacity investments. This approach is similar in concept to the equivalent capacity factor used to compare renewable resources such as wind and solar with traditional fossil-fueled generation. In markets where capacity is purchased, "counting" rules for different resource types determine the equivalent reliability. The probability that savings will actually occur during peak periods is easier to estimate with some certainty for a large number of distributed efficiency measures (e.g., air conditioners) as opposed to a limited number of large, centralized measures (e.g., water treatment plants).

California Avoided Costs by Time and Location

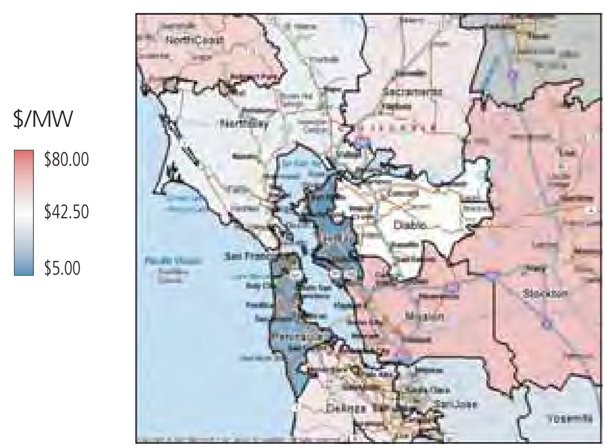
California is a good example of the effect of area and time-differentiation for efficiency measures that have dramatically different impact profiles. The average avoided cost for efficiency (including energy and capacity cost components) in California is $71/megawatt-hour (MWh). Applying avoided costs for each of six time of use (TOU) periods (super-peak, mid-peak and off-peak

Comparison of Avoided Costs for Three Implementation Approaches



for summer and winter seasons) increases the value of air conditioning to $104/MWh or 45 percent and lowers the value of outdoor lighting to $57/MWh or 20 percent. Refrigeration, with its consistent load profile throughout the day and year, is unaffected. Applying avoided costs by hour captures the extreme summer peak prices and increases the value of air conditioning savings still further to $123/MWh. Incorporating hourly avoided costs increases the total benefits of air conditioning load reduction by more than $50/MWh. This type of hourly analysis is currently being used in California's avoided cost proceedings for energy efficiency.

Greater San Francisco Bay Area Avoided Distribution Costs



Avoided distribution capacity costs are also estimated by region in California. The Greater San Francisco Bay Area region is shown above in detail. In San Francisco and Oakland, avoided capacity costs are low because those areas are experiencing little load growth and have little need for new distribution investment. The Stockton area, on the other hand, is experiencing high growth and has significant new distribution infrastructure requirements.

- *Valuing Capacity Benefits.* The value of capacity benefits lies in the savings of not having to build or purchase new infrastructure, or make payments to capacity markets for system reliability. Because reliability of the nation's energy infrastructure is critical, it is difficult to make the decision to defer these investments without some degree of certainty that the savings will be achieved. Disregarding or undervaluing the transmission and generation capacity value of energy efficiency can, however, lead to underinvestment in energy efficiency. Realizing energy efficiency's capacity savings requires close coordination between efficiency and resource planners[1] to ensure that specific planned investments can actually be deferred as a result of energy efficiency programs. In the long term, lower load levels will naturally lead to lower levels of infrastructure requirements without a change in existing planning processes.

Targeted implementation of energy efficiency designed to defer or eliminate traditional reliability investments in the short term (whether generation, transmission, or distribution) requires that energy efficiency ramp up in time to provide sufficient peak load savings before the new infrastructure is needed. States with existing efficiency programs can use previous experience to estimate future adoption rates. In states that do not have previous experience with energy efficiency, however, the adoption rate of efficiency measures is difficult to estimate, making it hard to precisely quantify the savings that will be achieved by a certain date. Therefore, if the infrastructure project is critical for reliability, it is difficult to rely on energy as an alternative. The value of the targeted reductions and project deferrals can also be a challenge to quantify because of the uncertainty in the future investment needs and costs. However, there are examples of how to overcome this challenge, such as the Bonneville Power Administration (BPA) transmission planning process (described later). Vermont Docket 7081 is another collaborative process—initiated at the direction of the legislature—that is working on a new transmission planning process that will explicitly incorporate energy efficiency (Vermont Public Service Board, 2005). Both BPA and Vermont Docket 7081 stress the need to start well in advance of the need for reductions to allow the energy efficiency program to be developed and validated. In addition, by starting early, conventional alternatives can serve as a back-stop if needed. Starting early is also easier organizationally if alternatives are initiated before project proponents are vested in building new transmission lines.

The deferral of capacity expenditures can produce the same reliability level for customers. In cases when an energy efficiency program changes the expected reliability level (either higher or lower), the value to customers must be introduced as either a benefit or cost. A typical approach is to use the customer's Value of Lost Load (VOLL) as determined through Value of Service (VOS) studies and multiply by the expected change in customer outage hours. However, VOS studies based on customer surveys typically show wide-ranging results and are often difficult to substantiate.

In regions with established capacity markets, the valuation process is easier because the posted market prices are the value of capacity. The approach to value these benefits is therefore similar to the market price forecasting approach described to value energy benefits. Regional planning processes can also include energy efficiency in their resource planning. Regional electricity planning processes primarily focus on developing adequate resources to meet regional reliability criteria as defined in each of the North American Electric Reliability Council (NERC) regions. Establishing capacity and ancillary service market rules that allow energy efficiency and customer load response to participate can bring energy efficiency into the planning process. For example, Independent System Operator New England (ISO-NE) Demand Resources Working Group will be including

[1] The transmission planning process requires collaboration of regional stakeholders including transmission owners, utilities, and regulators. Distribution planning departments of electric utilities typically make the decisions for distribution-level and local transmission facilities. Planning and development of high-voltage transmission facilities on the bulk-supply system is done at the independent system operator (ISO)/RTO and North American Electric Reliability Council (NERC) regional levels. At a minimum, transmission adequacy must uphold the established NERC reliability standards.

energy efficiency and demand response as qualifying resources for the New England Forward Capacity Market. Another example is PJM Interconnection (PJM), which has recently made its Economic Load Response Program a permanent feature of the PJM markets (in addition to the Emergency Load Response Program that was permanently established in 2002) and has recently opened its Synchronized and Non-Synchronized Reserve markets to demand response providers.

Other Benefits

Energy efficiency provides several types of non-energy benefits not typically included in traditional resource planning. These benefits include environmental improvement, support for low-income customers, economic development, customer satisfaction and comfort, and other potential factors such as reduced costs for bill collection and service shut-offs, improvements in household safety and health, and increased property values. As an economic development tool, energy efficiency attracts and retains businesses, creates local jobs, and helps business competitiveness and area appeal.

Environmental benefits, predominantly air emissions reductions, might or might not have specific economic value, depending on the region and the pollutant. The market price of energy will include the producer's costs of obtaining required emission allowances (e.g., nitrogen oxides [NO_X], sulfur dioxide [SO_2]), and emission reduction equipment. Emissions of carbon dioxide (CO_2), also are affected by planning decisions of whether to consider the value of unregulated emissions. The costs of CO_2 were included in California's assessment of energy efficiency on the basis that these costs might become priced in the future and the expected value of future CO_2 prices should be considered when making energy efficiency investments.[2] Even without regulatory policy guidance, several utilities incorporate the estimated future costs of emissions such as CO_2 into their resources planning process to control the financial risks associated with future regulatory changes.[3] For example, Idaho Power Company includes an estimated future cost of CO_2 emissions in its resource planning, and in determining the cost-effectiveness of efficiency programs.

Many of these benefits do not accrue directly to the utility, raising additional policy and budgeting issues regarding whether, and how, to incorporate those benefits for planning purposes. Municipal utilities and governmental agencies have a stronger mandate to include a wider variety of non-energy benefits in energy efficiency planning than do investor-owned utilities (IOUs). Regulators of IOUs might also determine that these benefits should be considered. Many of the benefits are difficult to quantify. However, non-energy benefits can also be considered qualitatively when establishing the overall energy efficiency budget, and in developing guidelines for targeting appropriate customers (e.g., low income or other groups).

Setting Energy Efficiency Targets and Allocating Budget

One of the biggest barriers to energy efficiency is developing a budget to fund energy efficiency, particularly at utilities or in states that haven't had significant programs, historically. This is a not strictly a resource planning issue, but a regulatory, policy, and organizational issue as well. The two main organizational approaches for funding energy efficiency are resource planning processes, which establish the energy efficiency budget and targets within the planning process, and public goods-funded charges, which create a separate budget to support energy efficiency through a rate surcharge. There are successful examples of both approaches, as well as examples that use both mechanisms (California, BPA, PacifiCorp, and Minnesota).

Setting targets for energy efficiency resource savings and budgets is a collaborative process between resource planning staff, which evaluates cost-effectiveness, and other key stakeholders. Arguably, all energy efficiency

[2] California established a cost of $8/ton of CO2 in 2004, escalating at 5% per year (CPUC, 2005).

[3] For further discussion, see Bokenkamp, et al., 2005.

measures identified as cost effective in an integrated resource plan (IRP) should be implemented.[4] In practice, a number of other factors must be considered. For example, the achievable level of savings and costs, expertise and labor, and ability to ramp up programs also affects the size, scope, and mix of energy efficiency programs. All of these considerations, plus the cost-effectiveness of energy efficiency, should be taken into account when establishing the funding levels for energy efficiency. The funding process might also require an iterative process that describes the alternative plans to regulators and other stakeholders. Some jurisdictions use a policy directive such as "all cost-effective energy efficiency" (California) while others allocate a fixed budget amount (New York), specify a fixed percentage of utility revenue (Minnesota and Oregon), or a target load reduction amount (Texas).

Implementation of a target for electric and gas energy savings, or Energy Efficiency Resources Standard (EERS) or Energy Efficiency Portfolio Standard (EEPS), such as the Energy Efficiency Goal adopted in Texas (PUCT Subst. R. §25.181), is an emerging policy tool adopted or being considered in a number of states (ACEEE, 2006). Some states have adopted standards with flexibility for how utilities meet such targets, such as savings by end users, improvements in distribution system efficiency, and market-based trading systems.

Resource Planning Process

If energy efficiency is considered as a resource, then the appropriate amount of energy efficient funding will be allocated through the utility planning process, based on cost-effectiveness, portfolio risk, energy and capacity benefits, and other criteria. Many utilities find that a resource plan that includes energy efficiency yields a lower cost portfolio, so overall procurement costs should decline more than the increase in energy efficiency program costs, and the established revenue requirement of the utility will be sufficient to fund the entire supply and demand-side resource portfolio.

A resource planning process that includes energy efficiency must also include a mechanism to ensure cost-recovery of energy efficiency spending. Most resource planning processes are collaborative forums to ensure that stakeholders understand and support the overall plan and its cost recovery mechanism. In some cases, utility costs might have to be shifted between utility functions (e.g., generation and transmission) to enable cost recovery for energy efficiency expenditures. For example, transmission owners might not see energy efficiency as a non-wires solution to transmission system deficiencies because it is unclear to what extent energy efficiency costs can be collected in the Federal Energy Regulatory Commission (FERC) transmission tariff. Therefore, even if energy efficiency is less costly than the transmission upgrade, it is unclear whether the transmission upgrade budget can be shifted to energy efficiency and still collected in rates. Another challenge for collecting efficiency funding in the transmission tariff is allocation of energy efficiency costs across multiple transmission owners, particularly if energy efficiency costs are incurred by a single transmission owner, while transmission costs are shared among several owners.

These examples demonstrate that in order to implement integrated resource planning, the regulatory agency responsible for determining rates must allow rates designed to support transmission, distribution, or other functions to be used for efficiency. The transmission companies in Connecticut have been allowed to include reliability-driven energy efficiency in tariffs, although this is noted as an emergency situation not to be repeated as a normal course of business. These interactions between regulatory policy and utility resource planning demonstrate that utilities cannot be expected to act alone in increasing energy efficiency through their planning process.

Public Purpose- or System Benefits Charge-Funded Programs

One way to fund energy efficiency is to develop a separate funding mechanism, collected in rates, to support

[4] Established cost-effectiveness tests, such as the total resource cost (TRC) test, are commonly used to determine the cost-effectiveness of energy efficiency programs. Material from Chapter 6: Energy Efficiency Program Best Practices describes these tests in more detail.

investment in energy efficiency. In deregulated markets with unbundled rates, this mechanism can appear as a separate customer charge, often referred to as a system benefits charge (SBC). Establishing a public purpose charge has the advantage of ensuring policy-makers that there is an allocation of funding towards energy efficiency, and can be necessary in deregulated markets where the delivery company cannot capture the savings of energy efficiency. This approach separates the energy efficiency budget from the resource planning process, however.

Developing a new rate surcharge or expanding an existing surcharge also raises many of the questions addressed in Chapter 2: Utility Ratemaking & Revenue Requirements. For example, are the customer segments paying into SBCs receiving a comparable level of energy efficiency assistance in return, or are the increases a cross-subsidy? Often, industrial customers prefer to implement their own efficiency rather than contribute to a pool. Also, if the targets are used to set shareholder incentives, the incentives should be appropriate for the aggressiveness of the program. Additionally, because the targeted budget allocation in public purpose-funded programs is often set independently of the utility's overall resource planning process (and is not frequently changed), utilities might not have funding available to procure all cost-effective savings derived from energy efficiency measures. This type of scenario can result in potentially higher costs for customers than would occur if each cost-effective efficiency opportunity were pursued.

Overcoming Challenges: Alternative Approaches

Successful incorporation of energy efficiency into the resource planning process requires utility executives, resource planning staff, regulators, and other stakeholders to value energy efficiency as a resource, and to be committed to making it work within the utility or regional resource portfolio. To illustrate approaches to overcoming these barriers, we highlight several successful energy efficiency programs by California, the New York State Energy Research and Development Authority (NYSERDA), BPA, Minnesota, Texas, and PacifiCorp. The energy efficiency programs in these six regions demonstrate several different ways to incorporate energy efficiency into planning processes; in each example, the economics generally work well for efficiency programs.

The primary driver of energy efficiency in planning is the low levelized cost of energy savings. Table 3-1 shows the reported levelized cost of electricity and natural gas efficiency from three of the regions surveyed. The reported utility cost of efficiency ranges between \$0.01/kilowatt-hour (kWh) and \$0.03/kWh for Pacific Gas & Electric (PG&E), NYSERDA, and the Northwest Power and Conservation Council (NWPCC). When including both utility program costs and customer costs, the range is \$0.03/kWh to \$0.05/kWh. The range of reported benefits for electric energy efficiency is from \$0.06/kWh to \$0.08/kWh. For natural gas, only P&GE reported specific natural gas efficiency measures; these show similarly low levelized costs relative to benefits.

Table 3-1: Levelized Costs and Benefits From Four Regions

	Electric (\$/kWh)			Natural Gas (\$/therm)		
	Utility Cost	Utility & Customer Cost	Benefit	Utility Cost	Utility & Customer Cost	Benefit
PG&E [1]	0.03	0.05	0.08	0.28	0.56	0.81
NYSERDA [2]	0.01	0.03	0.06	N/A	N/A	N/A
NWPCC [3]	0.024	N/A	0.060	N/A	N/A	N/A
Texas [4]	0.025[5]	N/A	0.060[6]	N/A	N/A	N/A

1 PG&E, 2005

2 NYSERDA, 2005

3 NWPCC, 2005

4 Calculated based on Texas Utility Avoided Cost (PUCT Substantive Rule §25.18 of 2000). \$0.0268/kWh for energy and \$78.50/kW-year for capacity converted to \$/kWh based on assumption of 10-year measure life, load factor of 26.4 percent, which is calculated from Texas' 2004 efficiency-based reductions of 193 MW of peak demand and 448 GWh of energy (Frontier Associates, 2005).

5 Based on 2004 spending of \$87 million, 448 GWh annual. Assumed life of 10 years (PUCT Substantive Rule §25.181 of 2000).

6 Based on Public Utility Commission of Texas (PUCT) Deemed Avoided Costs of \$0.0268/kWh for energy and \$78.50/kW-year for capacity; 448GWh and 193MW of peak load reduction.

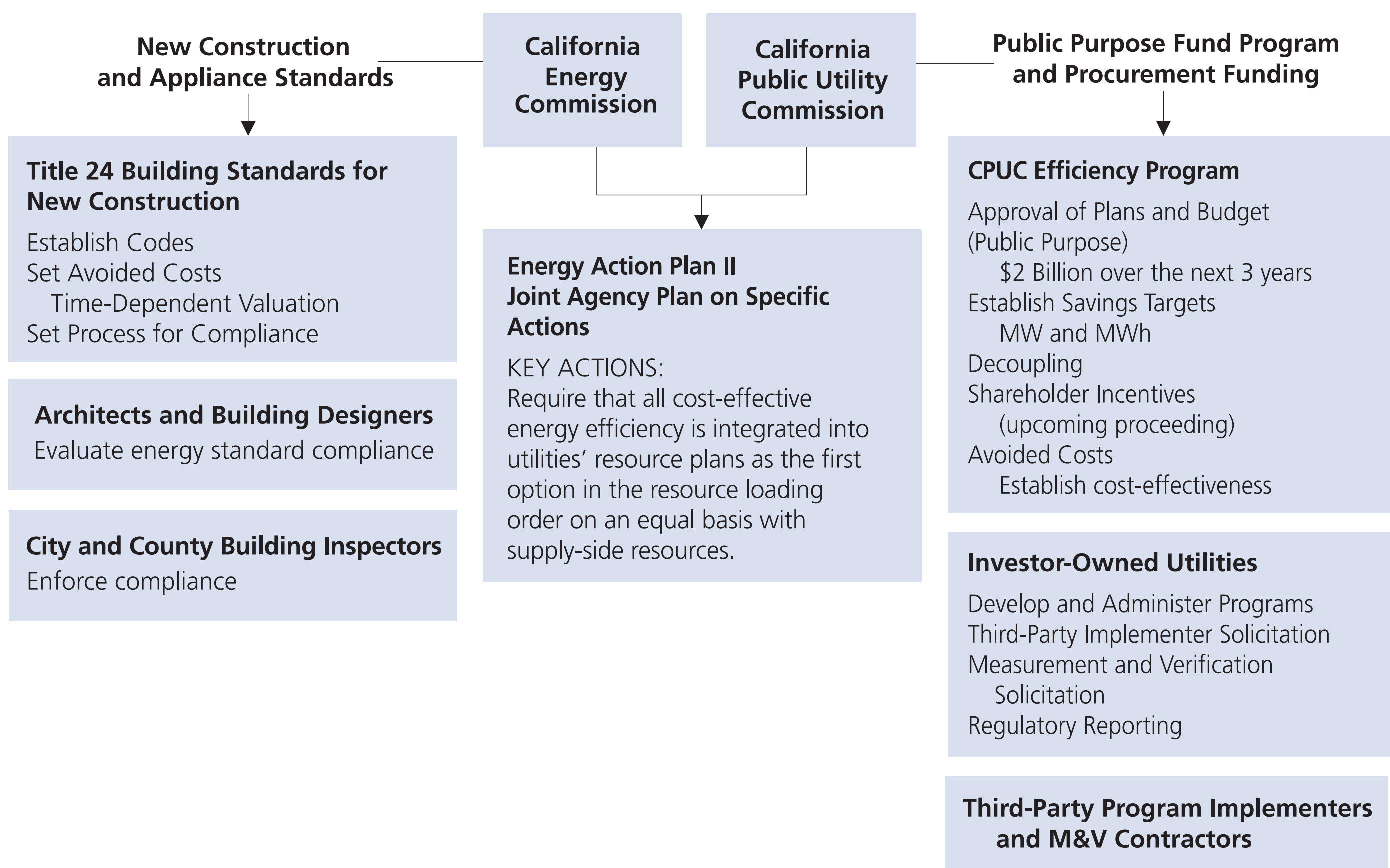
California

California has had a continued commitment to energy efficiency since the late 1970s. Two major efforts are currently being coordinated in the state that address energy use in new buildings as well as efficiency upgrades in existing buildings. Figure 3-2 shows the policy structure, with the California Energy Commission (CEC) leading the building codes and standards process, and the California Public Utility Commission (CPUC) leading the IOU and third-party administered efficiency programs. Jointly, the agencies publish the Energy Action Plan that explicitly states a goal to integrate "all cost-effective energy efficiency." Recently, the CPUC approved an efficiency budget of $2 billion over the next three years to serve a population of approximately 35 million.

The process for designing and implementing efficiency programs in California by the IOUs is to develop the programs (either by the utility or through third-party solicitation), evaluate cost-effectiveness, establish and gain approval for the program funding, and evaluate the program's success through M&V. Figure 3-2 illustrates this approach.

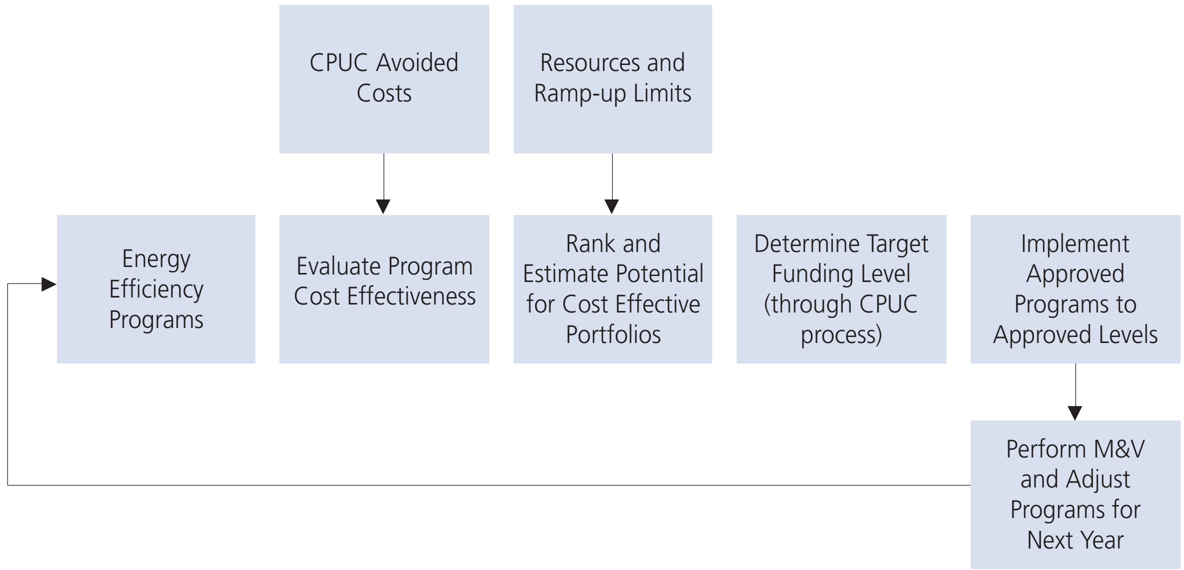
Table 3-2 describes how California addresses barriers for incorporating energy efficiency in planning for the IOU process.

Figure 3-2. California Efficiency Structure Overview



Source: Energy and Environmental Economics, Inc.

Figure 3-3. California Investor-Owned Utility (IOU) Process



Source: Energy and Environmental Economics, Inc.

Table 3-2. Incorporation of Energy Efficiency in California's Investor-Owned Utilities' Planning Processes

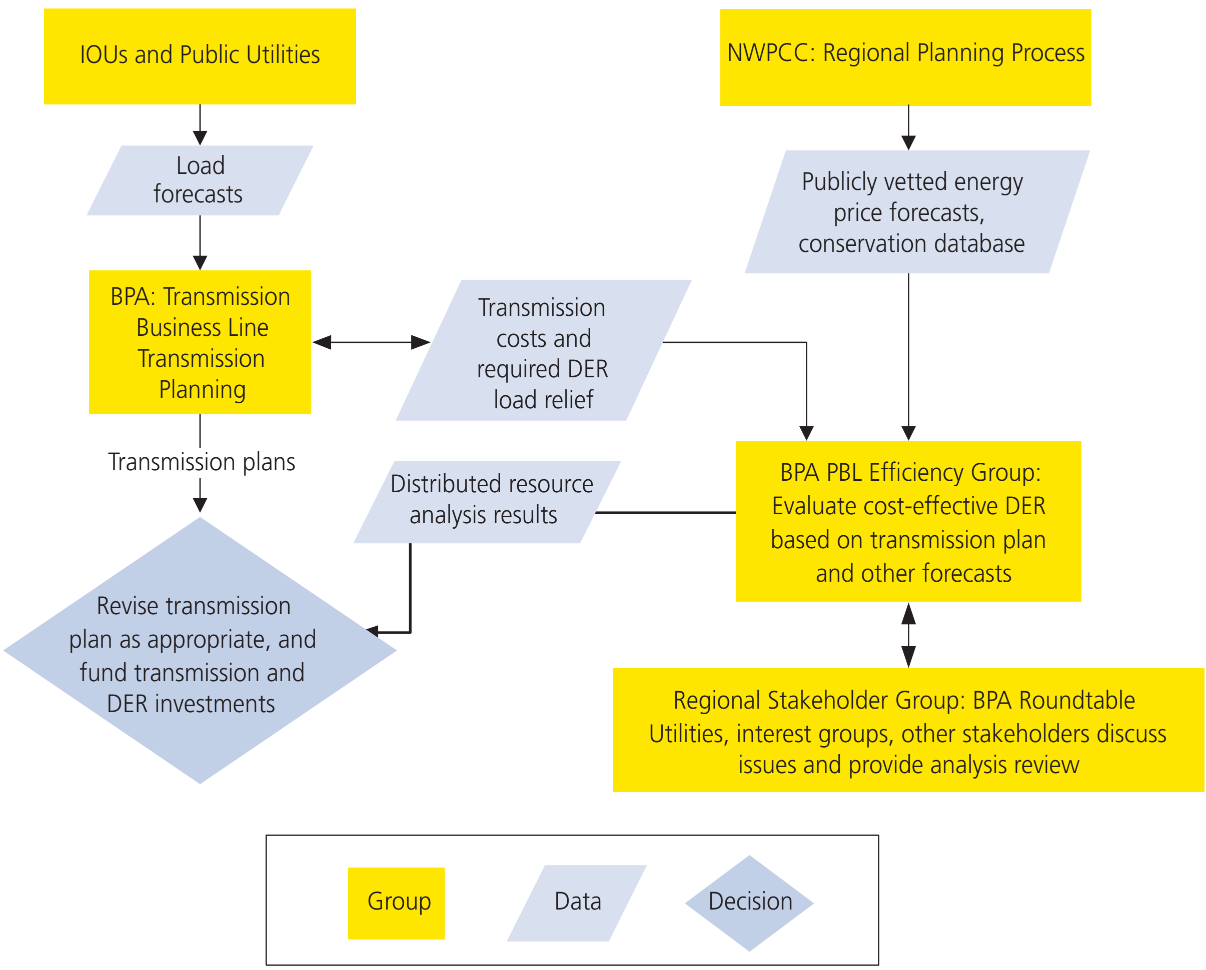
Barriers	California CPUC-Administered Programs
A. Determining the Value of Energy Efficiency	
Energy Procurement	
Estimated energy savings	Customer adoption rates are forecast into the energy efficiency plans with monthly or quarterly reporting of program success for tracking.
Valuing energy savings	Energy savings are based on market prices of future electricity and natural gas, adjusted by loss factors. Emission savings are based on expected emission rates of marginal generating plants in each hour (electricity) or emissions for natural gas.
Capacity & Resource Adequacy	
Estimating capacity savings	Capacity savings are evaluated using the load research data for each measure.
Valuing capacity benefits	Each capacity-related value is estimated by climate zone of the state and incorporated into an "all-in" energy value. Transmission and distribution capacity for electricity is allocated based on weather in each climate zone, and by season for natural gas. California's energy market (currently) includes both energy and capacity so there is no explicit capacity value for electric generation.
Factors in achieving benefits	Capacity benefits are based on the best forecast of achieved savings. There is no explicit link between forecasted benefits of energy efficiency and actual capacity savings.
Other Benefits	
Incorporating non-energy benefits	Non-energy benefits are considered in the development of the portfolio of energy efficiency, but not explicitly quantified in the avoided cost calculation.
B. Setting Targets and Allocating Budget	
Quantity of energy efficiency to implement	CPUC has approved budget and targets for the state's efficiency programs, which are funded through both a public purpose charge and procurement funding.
Estimating program effectiveness	A portion of the public purpose funds are dedicated to evaluation, measurement, and verification with the goal of improving the understanding and quantification of savings and benefit estimates.
Institutional difficulty in reallocating budget	By using public purpose funds, budget doesn't have to be reallocated from other functions for energy efficiency.
Cost expenditure timing vs. benefits	Capacity benefits are based on the best forecast of achieved savings.
Ensuring the program costs are recaptured	CPUC requires that the utilities integrate energy efficiency into their long-term procurement plans to address this issue.

Bonneville Power Administration Transmission Planning and Regional Roundtable

In the Northwest, BPA has been leading an industry roundtable to work with distribution utilities, local and state government, environmental interests, and other stakeholders to incorporate energy efficiency and other distributed energy resources (DER) into transmission planning. DER includes energy efficiency as well as distribution generation and other nonwires solutions. Figure 3-4 illustrates the analysis approach and data sources. Within BPA, the Transmission Business Line (TBL) works with the energy efficiency group in Power Business Line (PBL) to develop an integrated transmission plan. The process includes significant stakeholder contributions in both input data assumptions (led by NWPCC) and in reviewing the overall analysis at the roundtable.[5]

Table 3-3 describes how BPA works with stakeholders to address barriers for incorporating energy efficiency in planning processes.

Figure 3-4. BPA Transmission Planning Process



Source: Energy and Environmental Economics, Inc.

5 NWPCC conducts regional energy efficiency planning. More information can be found at <http://www.nwcouncil.org>.

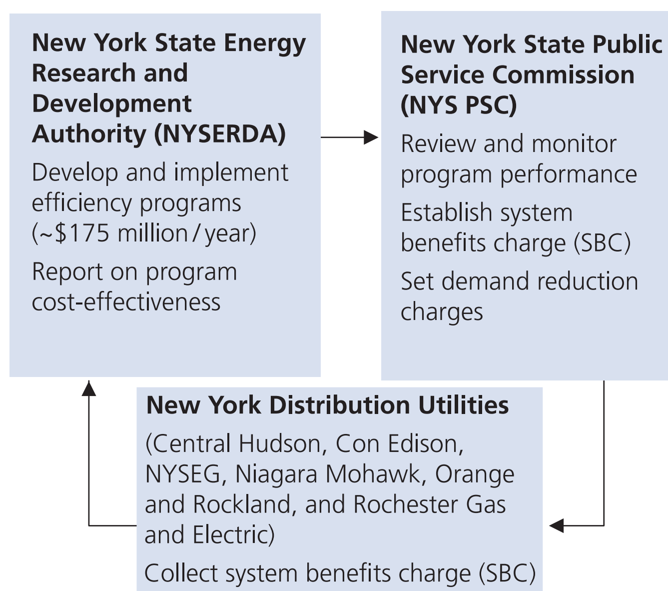
Table 3-3. Incorporation of Energy Efficiency in BPA's Planning Processes	
Barriers	**BPA-Administered Programs**
A. Determining the Value of Energy Efficiency	
Energy Procurement	
Estimated energy savings	The process uses the NWPCC database to define the measure impact and costs. NWPCC maintains a publicly available regional efficiency database that is well regarded and has its own process for stakeholder collaboration. Adoption rates are estimated based on a range of historical program success.
Valuing energy savings	Energy savings are valued based on the NWPCC long-run forecast of energy value for the region, plus marginal losses.
Capacity & Resource Adequacy	
Estimating capacity savings	Capacity savings are based on expected NWPCC efficiency measure coincident peak impacts.
Valuing capacity benefits	The deferral value of transmission investments is used to evaluate the transmission capacity value, which is the focus of these studies. The approach is to calculate the difference in present value revenue requirement before and after the energy efficiency investment (Present Worth Method).
Factors in achieving benefits	The BPA energy efficiency and transmission planning staff work together to ensure that the revised plan with Non-Construction Alternatives (NCAs) satisfies reliability criteria. Ultimately the decision to defer transmission and rely on NCAs will be approved by transmission planning.
Other Benefits	
Incorporating non-energy benefits	The analysis includes an evaluation of the environmental externalities, but no other non-energy benefits.
B. Setting Targets and Allocating Budget	
Quantity of energy efficiency to implement	The target for NCAs is established by the amount of load that must be reduced to defer the transmission line and maintain reliability. This target is driven by the load growth forecasts of the utilities in the region.
Estimating program effectiveness	BPA has been doing demonstrations and pilots of high-potential NCAs to refine the estimates of program penetration, cost, necessary timeline for achieving load reductions, customer acceptance, and other factors. The results of these pilots will help to refine the estimates used in planning studies.
Institutional difficulty in reallocating budget	If NCAs have lower cost than transmission, transmission capital budget will be reallocated to support NCA investments up to the transmission deferral value. Additional costs of NCAs that are justified based on energy value are supported by other sources (BPA energy efficiency, local utility programs, and customers).
Cost expenditure timing vs. benefits	Both transmission and NCAs require upfront investments so there is no significant time lag between costs and benefits. The transmission savings benefit is achieved concurrently with the decision to defer the transmission investment. Energy benefits, on the other hand, occur over a longer timeframe and are funded like other energy efficiency programs.
Ensuring the program costs are recaptured	By developing an internal planning process to reallocate budget, it is easier to ensure that the savings occur.

New York State Energy Research and Development Authority (NYSERDA)

In the mid-1990s, New York restructured the electric utilities and moved responsibility for implementing energy efficiency programs to the NYSERDA. The following figure shows an overview of the NYSERDA process. The programs are funded through the SBC funds (approximately $175 million per year), and NYSERDA reports on the program impact and cost-effectiveness to the New York State Public Service Commission (NYS PSC) annually.

Table 3-4 describes how NYSERDA addresses the barriers to implementing energy efficiency.

Figure 3-5. New York Efficiency Structure Overview



Source: Energy and Environmental Economics, Inc.

Table 3-4. Incorporation of Energy Efficiency in NYSERDA s Planning Processes	
Barriers	**NYSERDA-Administered Programs**
A. Determining the Value of Energy Efficiency	
Energy Procurement	
Estimating energy savings	NYSERDA internally develops estimates of savings for individual energy efficiency programs and the portfolio in aggregate. In addition, NYSERDA accounts for free-riders and spillover effects ("net to gross" ratio) when estimating energy savings. Savings estimates are verified and refined with an M&V program.
Valuing energy savings	A long-run forecast of electricity demand is developed using a production simulation model, which is then calibrated to market prices. An estimate of reduced market prices due to decreased demand is also included as a benefit.
Capacity & Resource Adequacy	
Estimating capacity savings	Similar to energy savings, capacity savings are estimated for individual energy efficiency programs and the portfolio in aggregate. Savings estimates are verified and refined with an M&V program.
Valuing capacity benefits	The value of generation capacity in New York is established by examining historical auction clearing prices in the NYISO's unforced capacity market. The baseline values are then escalated over time using a growth rate derived from NYSERDA's electric system modeling results. These capacity costs are used to value those NYSERDA programs that effectively lower system peak demand.
Factors in achieving benefits	The capacity value is included as the best estimate of future capacity savings by New York utilities. There is no direct link, however, between the forecasted savings and the actual change in utility procurement budgets.
Other Benefits	
Incorporating non-energy benefits	The cost-effectiveness of NYSERDA programs is estimated using four scenarios of increasing NEB levels from (1) energy savings benefits, (2) adding market price effects, (3) adding non-energy benefits, and (4) adding macro-economic effects of program spending.
B. Setting Energy Efficiency Targets	
Quantity of energy efficiency to implement	The overall size of the NYSERDA program is determined by the aggregate funding level established by the NYS PSC. NYSERDA, with advice from the SBC Advisory Group, recommends specific sub-program funding levels for approval by the staff at NYS PSC.
Estimating program effectiveness	NYSERDA prepares an annual report on program effectiveness including estimated and verified impacts and cost effectiveness, which is then reviewed by the SBC Advisory Group and submitted to the NYS PSC.
Institutional difficulty in reallocating budget	By establishing a separate state research and development authority to administer energy efficiency, the institutional problems of determining and allocating budget towards energy efficiency are eliminated. NYSERDA is supported primarily by SBCs collected by the utilities at the direction of NYS PSC.
Cost expenditure timing vs. benefits	Similarly, by funding the programs through an SBC, the customers are directly financing the program, thereby making the timing of benefits less important.
Ensuring the program costs are recaptured	Forecasts of savings are based on the best estimate of future savings. There is no direct link to ensure these savings actually occur.

Minnesota

The Minnesota legislature passed the Conservation Improvement Program (CIP) in 1982. State law requires that (1) electric utilities that operate nuclear-power plants devote at least 2 percent of their gross operating revenue to CIP, (2) other electric utilities devote at least 1.5 percent of their revenue, and (3) natural gas utilities devote at least 0.5 percent. Energy is supplied predominantly by two utilities: Xcel, which provides 49 percent of the electricity and 25 percent of the natural gas, and CenterPoint Energy, which provides 45 percent of the natural gas. Facilities with a peak electrical demand of at least 20 megawatts (MW) are permitted to opt out of CIP and avoid paying the program's rate adjustment in their electric and natural gas bills (10 facilities have done so). While the Minnesota Department of Commerce oversees the CIP programs of all utilities in the state, the department only has the authority to order changes in the programs of the IOUs.

Utilities are required to file an IRP every 2 years, using 5-, 10- and 15-year planning horizons to determine the need for additional resources. The statutory emphasis is on demand-side management (DSM) and renewable resources. A utility must first show why these resources will not meet future needs before proposing traditional utility investments. The plans are reviewed and approved by the Minnesota Public Utilities Commission. CIP is the

Table 3-5. Incorporation of Energy Efficiency in Minnesota's Planning Processes	
Barriers	**Minnesota-Administered Programs**
A. Determining the Value of Energy Efficiency	
Energy Procurement	
Estimating energy savings	Energy savings and avoided costs are determined independently by each utility, resulting in a wide range of estimates that are not consistent. Energy costs are considered a trade secret and not disclosed publicly.
Valuing energy savings	
Capacity & Resource Adequacy	
Estimating capacity savings	Capacity savings and avoided costs are determined independently by each utility, resulting in a wide range of estimates that are not consistent. Power plant, transmission, and distribution costs are considered trade secrets and are not disclosed publicly.
Valuing capacity benefits	
Factors in achieving benefits	There is no direct link between the forecasted capacity savings and the actual change in utility procurement budgets.
Other Benefits	
Incorporating non-energy benefits	Differences in the utilities' valuation methods produce varying estimates. In addition, the Department of Commerce incorporates an externality avoided cost in the electric societal cost benefit test, providing utilities with values in $/ton for several emissions, which the utilities translate to amounts in $/MWh based on each utility's emissions profile.
B. Setting Targets and Allocating Budget	
Quantity of energy efficiency to implement	The Department of Commerce approves budget and targets for each utility. Funding levels are determined by state law, which requires 0.5 percent to 2 percent of utility revenues be dedicated to conservation programs, depending on the type of utility.
Estimating program effectiveness	Program effectiveness is handled by each utility. Minnesota's IOUs rely on the software tools DSManager and BENCOST to measure electric and gas savings respectively.
Institutional difficulty in reallocating budget	Budget is not reallocated from other functions. Funding is obtained via a surcharge on customer bills.
Cost expenditure timing vs. benefits	By using a percentage of revenue set-aside, utility customers are directly financing the program; therefore timing of benefits is not critical.
Ensuring the program costs are recaptured	State law requires that each utility file an IRP with the Public Utilities Commission. The conservation plans approved by the Department of Commerce are the primary mechanism by which utilities meet conservation targets included in their IRPs.

primary mechanism by which the electric utilities achieve the conservation targets included in their IRPs.

The Department of Commerce conducts a biennial review of the CIP plan for each investor-owned utility. Interested parties may file comments and suggest alternatives before the department issues a decision approving or modifying the utility's plan. Utilities that meet or exceed the energy savings goals established by the Department of Commerce receive a financial bonus, which they are permitted to collect through a rate increase. Both electric utilities have exceeded their goals for the last several years. Table 3-5 describes how the Minnesota Department of Commerce addresses barriers to implementing energy efficiency.

Texas

Texas Senate Bill 7 (1999), enacted in the 1999 Texas legislature, mandates that at least 10 percent of an investor-owned electric utility's annual growth in electricity demand be met through energy efficiency programs each year. The Public Utility Commission of Texas (PUCT) Substantive Rule establishes procedures for meeting this legislative mandate, directing the transmission and distribution (T&D) utilities to hire third-party energy efficiency providers to deliver energy efficiency services to every customer class, using "deemed savings" estimates for each energy efficiency measure (PUCT, 2000). Approved program costs are included in the IOU's transmission and distribution rates, and expenditures are reported separately in the IOU's annual energy efficiency report to the PUCT. Actual energy and capacity savings are verified by independent experts chosen by the PUCT. Incentives are based on prescribed avoided costs, which are set by

Table 3-6. Incorporation of Energy Efficiency in Texas' Planning Processes	
Barriers	**Texas-Administered Programs**
A. Determining the Value of Energy Efficiency	
Energy Procurement	
Estimating energy savings	Energy savings are based on either deemed savings or through M&V. All savings estimates are subject to verification by a commission-appointed M&V expert.
Valuing energy savings	Avoided costs shall be the estimated cost of new gas turbine, which for energy was initially set in PUCT section 25.181-5 to be $0.0268 /kWh saved annually at the customer's meter.
Capacity & Resource Adequacy	
Estimating capacity savings	Capacity savings are based on either deemed savings or through M&V. All savings estimates are subject to verification by a commission-appointed M&V expert.
Valuing capacity benefits	Avoided costs shall be the estimated cost of new gas turbine, which for capacity was initially set in PUCT section 25.181-5 to be $78.5/kW saved annually at the customer's meter.
Other Benefits	
Incorporating non-energy benefits	Environmental benefits of up to 20 percent above the cost effectiveness standard can be applied for projects in an area that is not in attainment of ambient air quality standards.
B. Setting Energy Efficiency Targets	
Quantity of energy efficiency to implement	Senate Bill 7 (SB7) mandates that, beginning in 2004, at least 10 percent of an investor-owned electric utility's annual growth in electricity demand be met through energy efficiency programs each year (based on historic five-year growth rate for the firm). Funding for additional programs is available if deemed cost-effective.
Estimating program effectiveness	Each year, the utility submits to the PUCT an energy efficiency plan for the year ahead and an energy efficiency report for the past year. The plan must be approved by the commission, and the year-end report must include information regarding the energy and capacity saved. Also, independent M&V experts selected by the commission to verify the achieved savings as reported in each utility's report.
Institutional difficulty in reallocating budget	Funds required for achieving the energy efficiency goal are included in transmission and distribution rates, and energy efficiency expenditures are tracked separately from other expenditures.
Cost expenditure timing vs. benefits	By using a percentage of revenue set aside, utility customers directly finance the program; therefore timing of benefits is not critical.
Ensuring the program costs are recaptured	The annual energy efficiency report submitted by the IOU to the PUCT includes energy and capacity savings, program expenditures, and unspent funds. There is no verification that the estimated avoided costs are captured in utility savings.

the PUCT. El Paso Electric Company will be included in the program beginning with an efficiency target of 5 percent of growth in 2007 and 10 percent of growth in 2008.

The 2004 report on Texas' program accomplishments highlights the level of savings and success of the program: "In 2004, the investor-owned utilities in Texas achieved their statewide goals for energy efficiency once again. 193 MW of peak demand reduction was achieved, which was 36% above its goal of 142 MW. In addition, 448 gigawatt-hours (GWh) of demand eduction was achieved. These energy savings correspond to a reduction of 1,460,352 pounds of nitrogen oxide (NO_X) emissions. Incentives or rebates were provided to project sponsors to offset the costs of a variety of energy efficiency improvements. Two new energy efficiency programs were voluntarily introduced by the Texas utilities." Table 3-6 describes how Texas utilities address barriers to implementing energy efficiency.

PacifiCorp

PacifiCorp is an investor-owned utility with more than 8,400 MW of generation capacity that serves approximately 1.6 million retail customers in portions of Utah, Oregon, Wyoming, Washington, Idaho, and California. PacifiCorp primarily addresses its energy efficiency planning objectives as part of its IRP process. Efficiency-based measures are evaluated based on their effect on the overall cost of PacifiCorp's preferred resource portfolio, defined as the overall supply portfolio with the best balance of cost and risk.

Additionally, some states that are in PacifiCorp's service territory, such as Oregon and California, also mandate that the company allocate funds for efficiency under related statewide public goods regulations. "In Oregon, SB 1149 requires that investor-owned electric companies collect from all retail customers a public purpose charge equal to 3% of revenues collected from customers. Of this amount, 57% (1.7% of revenues) goes toward Class 2 [energy efficiency-based] demand side management (DSM). The Energy Trust of Oregon (ETO) was set up to determine the manner in which public purpose funds will be spent"(PacifiCorp, 2005). Using the IRP model to determine investment in energy efficiency, however, PacifiCorp allocates more money to efficiency than required by state statute.

As of the 2004 IRP, PacifiCorp planned to implement a base of 250 average megawatts (aMW) of energy efficiency, and to seek an additional 200 aMW of new efficiency programs if cost-effective options could be identified. PacifiCorp models the impact of energy efficiency as a shaped load reduction to their forecasted load, and computes the change in supply costs with, and without, the impact of DSM. This approach allows different types of DSM to receive different values based on the alternative supply costs in different parts of the PacifiCorp service territory. For example, the IRP plan indicates that "residential air conditioning decrements produce the highest value [in the East and West].

Table 3-7. Incorporation of Energy Efficiency in PacifiCorp's Planning Processes

Barriers	PacifiCorp-Administered Programs
A. Determining the Value of Energy Efficiency	
Energy Procurement	
Estimating energy savings	The load forecast in the IRP is reduced by the amount of energy projected to be saved by existing programs, existing programs that are expanded to other states, and new cost-effective programs that resulted from the 2003 DSM request for proposals (RFPs). These load decrements have hourly shapes based on the types of measures installed for each program.
Valuing energy savings	Efficiency-based (or Class 2) DSM programs are valued based on cost effectiveness from a utility cost test perspective, minimizing the present value revenue requirement. The IRP (using the preferred portfolio of supply-side resources) is run with and without these DSM decrements, and their value in terms of cost-savings is calculated as the difference in revenue requirements for that portfolio with and without these Class 2 load reductions.
Capacity & Resource Adequacy	
Estimating capacity savings	PacifiCorp explicitly evaluates the capacity value of dispatchable and price-based DSM, or 'Class 1' DSM, and the ability to hit target reserve margins in the system with these resources. The IRP resulted in a recommendation to defer three different supply-side projects. The capacity benefits of more traditional energy efficiency programs are not explicitly evaluated; however, the planned energy efficiency reductions are used to update the load forecast in the next year's IRP, which could result in additional deferrals.
Valuing capacity benefits	Capacity savings are valued at the forecasted costs of displaced generation projects. By integrating the evaluation of DSM into the overall portfolio, the value of energy efficiency is directly linked to specific generation projects. It does not appear that PacifiCorp evaluates the potential for avoided transmission and distribution capacity.
Other Benefits	
Incorporating non-energy benefits	Non-energy benefits are considered in the selection of a preferred portfolio of resources, but the non-energy benefits of efficiency are not explicitly used in the IRP.
B. Setting Energy Efficiency Targets	
Quantity of energy efficiency to implement	As part of the 2004 IRP, PacifiCorp determined that a base of 250 aMW of efficiency should be included in the goals for the next 10 years, and that an additional 200 aMW should be added if cost-effective programs could be identified.
Estimating program effectiveness	Measurement methodology for new projects is not explicitly identified in the IRP, but values from existing programs and the forecasted load shapes for PacifiCorp's customers will be used to predict benefits.
Institutional difficulty in reallocating budget	Funding is integrated into the overall process of allocating budget to resource options (both supply side and demand side), and faces only challenges associated with any resource option, namely proof of cost-effective benefit to the resource portfolio.
Cost expenditure timing vs. benefits	The IRP process for PacifiCorp seeks to gain the best balance of cost and risk using the present value of revenue requirements, which accounts for timing issues associated with any type of resource evaluated, including efficiency.
Ensuring the program costs are recaptured	Successive IRPs will continue to evaluate the cost-effectiveness of energy efficiency programs to determine their effect on overall costs of the resource portfolio.

Programs with this end use impact provide the most value to PacifiCorp's system because they reduce demand during the highest use hours of the year, summer heavy load hours. The commercial lighting and system load shapes with the highest load factors provide the lowest avoided costs." It does not appear that PacifiCorp recomputes the overall risk of its portfolio with increased energy efficiency. Table 3-7 describes how PacifiCorp addresses barriers to implementing energy efficiency.

Key Findings

This section describes the common themes in the approaches used to navigate and overcome the barriers to incorporating energy efficiency in the planning process. While there are many approaches to solving each issue, the following key findings stand out:

- *Cost and Savings Data for Energy Efficiency Measures Are Readily Available.* Given the long history of energy efficiency programs in several regions, existing resources to assist in the design and implementation of energy efficiency programs are widely available. Both California and the Northwest maintain extensive, publicly available online databases of energy efficiency measures and impacts: the Database for Energy Efficiency Resources (DEER) in California[6] and NWPCC Database in the Northwest.[7] DEER includes both electricity and natural gas measures while NWPCC contains only electricity measures. These databases incorporate a number of factors affecting savings estimates, including climate zones, building type, building vintage, and customer usage patterns. Energy efficiency and resource planning studies containing detailed information on efficiency measures are available for regions throughout the United States. It is often possible to adjust existing data for use in a specific utility service area with relatively straightforward assumptions.

- *Energy, Capacity, and Non-Energy Benefits Can Justify Robust Energy Efficiency Programs.* Energy savings alone are usually more than sufficient to justify and fund a wide range of efficiency measures for electricity and natural gas. However, the capacity and non-energy benefits of energy efficiency are important factors to consider in assessing energy efficiency measures on an equal basis with traditional utility investments. In practice, policy, budget, expertise, and human resources are the more limiting constraints to effectively incorporating energy efficiency into planning.

— Estimating the quantity and value of energy savings is relatively straightforward. Well-established methods for estimating the quantity and value of energy savings have been used in many regions and forums. All of the regional examples for estimating energy and capacity savings for energy efficiency evaluate the savings for an individual measure using either measurements or engineering simulation, and then aggregate these by the expected number of customers who will adopt the measure. Both historical and forward market prices are readily available, particularly for natural gas where long-term forward markets are more developed.

— Estimating capacity savings is more difficult, but challenges are being overcome. Capacity savings depend more heavily on regional weather conditions and timing of the peak loads and, therefore, are difficult to estimate. Results from one region do not readily transfer to another. Also, publicly available market data for capacity are not as readily available as for energy, even though the timing and location of the savings are critical. Because potential capacity savings are larger for electricity energy efficiency than natural gas, capturing capacity value is a larger issue for electric utilities. Production simulation can explicitly evaluate the change in power plant investment and impact of such factors as re-dispatch due to transmission constraints, variation in load growth,

[6] The DEER Web site, description, and history can be found at: http://www.energy.ca.gov/deer/. The DEER database of measures can be found at: http://eega.cpuc.ca.gov/deer/.

[7] The NWPCC Web site, comments, and efficiency measure definition can be found at: http://www.nwcouncil.org/comments/default.asp.

and other factors. But these models are analytically complex and planning must be tightly integrated with other utility planning functions to accurately assess savings. These challenges can and have been overcome in different ways in regions with a long track-record of energy efficiency programs (e.g., California, BPA, New York).

— Estimating non-energy benefits is an emerging approach in many jurisdictions. Depending on the jurisdiction, legislation and regulatory commission policies might expressly permit, and even require, the consideration of non-energy benefits in cost-effectiveness determinations. However, specific guidelines regarding the quantification and inclusion of non-energy benefits are still under discussion or in development in most jurisdictions. The consideration of both non-energy and capacity benefits of energy efficiency programs is relatively new, compared to the long history of valuing energy savings.

- *A Clear Path to Funding Is Needed to Establish a Budget for Energy Efficiency Resources.* There are three main approaches to funding energy efficiency investments: 1) utility resource planning processes, 2) public purpose funding, and 3) a combination of both. In a utility resource planning process, such as the BPA non-construction alternatives process, efficiency options for meeting BPA's objectives are compared to potential supply-side investments on an equal basis when allocating the available budget. In this type of resource planning process, budget is allocated to efficiency measures from each functional area according to the benefits provided by efficiency programs. The advantage of this approach is that the budget for efficiency is linked directly to the savings it can achieve; however, particularly in the case of capacity-related benefits, which have critical timing and load reduction targets to maintain reliability, it is a difficult process.

  The public purpose funding and SBC approaches in New York, Minnesota, and other states are an alternative to budget reallocation within the planning process. In California, funding from both planning processes and public purpose funding is used. Public purpose funds do not have the same direct link to energy savings, so programs might not capture all the savings attributed to the program. Funding targets might be set before available efficiency options have been explored, so if other cost-effective efficiency measures are later identified, additional funding might not be available. This situation can result in customer costs being higher than they would have been if all cost-effective efficiency savings opportunities had been supported. Using public purpose funding significantly simplifies the planning process, however, and puts more control over the amount of energy efficiency in the control of regulators or utility boards. As compared to resource planning, far less time and effort are required on the part of regulators or legislators to direct a specific amount of funding to cost-effective efficiency programs.

- *Integrate Energy Efficiency Early in the Resource Planning Process.* In order to capture the full value of deferring the need for new investments in capacity, energy efficiency must be integrated early in the planning process. This step will avoid sunk investment associated with longer lead-time projects. Efficiency should also be planned to target investments far enough into the future so that energy efficiency programs have the opportunity to ramp up and provide sufficient load reduction. This timeline will allow the utility to build expertise and establish a track record for energy efficiency, as well as be able to monitor peak load reductions. Starting early also allows time to gain support of the traditional project proponents before they are vested in the outcome.

Recommendations and Options

The National Action Plan for Energy Efficiency Leadership Group offers the following recommendations as ways to overcome many of the barriers to energy efficiency in resource planning, and provides a number of options for consideration for consideration by utilities, regulators and stakeholders *(as presented in the Executive Summary)*.

Recommendation: Recognize energy efficiency as a high priority energy resource. Energy efficiency has not been consistently viewed as a meaningful or dependable resource compared to new supply options, regardless of its demonstrated contributions to meeting load growth. Recognizing energy efficiency as a high-priority energy resource is an important step in efforts to capture the benefits it offers, and lower the overall cost of energy services to customers. Based on jurisdictional objectives, energy efficiency can be incorporated into resource plans to account for the long-term benefits from energy savings, capacity savings, potential reductions of air pollutants and greenhouse gases, as well as other benefits. The explicit integration of energy efficiency resources into the formalized resource planning processes that exist at regional, state, and utility levels can help establish the rationale for energy efficiency funding levels and for properly valuing and balancing the benefits. In some jurisdictions, these existing planning processes might need to be adapted or even created to meaningfully incorporate energy efficiency resources into resource planning. Some states have recognized energy efficiency as the resource of first priority due to its broad benefits.

Options to Consider:

- Establishing policies to establish energy efficiency as a priority resource.
- Integrating energy efficiency into utility, state, and regional resource planning activities.
- Quantifying and establishing the value of energy efficiency, considering energy savings, capacity savings, and environmental benefits, as appropriate.

Recommendation: Make a strong, long-term commitment to implement cost-effective energy efficiency as a resource. Energy efficiency programs are most successful and provide the greatest benefits to stakeholders when appropriate policies are established and maintained over the long-term. Confidence in long-term stability of the program will help maintain energy efficiency as a dependable resource compared to supply-side resources, deferring or even avoiding the need for other infrastructure investments, and maintain customer awareness and support. Some steps might include assessing the long-term potential for cost-effective energy efficiency within a region (i.e., the energy efficiency that can be delivered cost-effectively through proven programs for each customer class within a planning horizon); examining the role for cutting-edge initiatives and technologies; establishing the cost of supply-side options versus energy efficiency; establishing robust M&V procedures; and providing for routine updates to information on energy efficiency potential and key costs.

Options to Consider:

- Establishing appropriate cost-effectiveness tests for a portfolio of programs to reflect the long-term benefits of energy efficiency.
- Establishing the potential for long-term, cost-effective energy efficiency savings by customer class through proven programs, innovative initiatives, and cutting-edge technologies.
- Establishing funding requirements for delivering long-term, cost-effective energy efficiency.
- Developing long-term energy saving goals as part of energy planning processes.
- Developing robust M&V procedures.
- Designating which organization(s) is responsible for administering the energy efficiency programs.
- Providing for frequent updates to energy resource plans to accommodate new information and technology.

Recommendation: Broadly communicate the benefits of, and opportunities for, energy efficiency. Experience shows that energy efficiency programs help customers save money and contribute to lower cost energy systems. But these benefits are not fully documented nor recognized by customers, utilities, regulators, or policy-makers. More effort is needed to establish the business case for energy efficiency for all decision-makers and to show how a well-designed approach to energy efficiency can benefit customers, utilities, and society by (1) reducing customers' bills over time, (2) fostering financially healthy utilities (e.g., return on equity, earnings per share, and debt coverage ratios unaffected), and (3) contributing to positive societal net benefits overall. Effort is also necessary to educate key stakeholders that although energy efficiency can be an important low-cost resource to integrate into the energy mix, it does require funding just as a new power plant requires funding.

Options to Consider:

- Establishing and educating stakeholders on the business case for energy efficiency at the state, utility, and other appropriate level addressing customer, utility, and societal perspectives.

- Communicating the role of energy efficiency in lowering customer energy bills and system costs and risks over time.

Recommendation: Provide sufficient, timely, and stable program funding to deliver energy efficiency where cost-effective. Energy efficiency programs require consistent and long-term funding to effectively compete with energy supply options. Efforts are necessary to establish this consistent long-term funding. A variety of mechanisms has been and can be used based on state, utility, and other stakeholder interests. It is important to ensure that the efficiency program providers have sufficient long-term funding to recover program costs and implement the energy efficiency measures that have been demonstrated to be available and cost-effective. A number of states are now linking program funding to the achievement of energy savings.

Options to Consider:

- Deciding on and committing to a consistent way for program administrators to recover energy efficiency costs in a timely manner.

- Establishing funding mechanisms for energy efficiency from among the available options, such as revenue requirements or resource procurement funding, SBCs, rate-basing, shared-savings, incentive mechanisms, etc.

- Establishing funding for multi-year periods.

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4: Business Case for Energy Efficiency

A well-designed approach to energy efficiency can benefit utilities, customers, and society by (1) fostering financially healthy utilities, (2) reducing customers' bills over time, and (3) contributing to positive societal net benefits overall. By establishing and communicating the business case for energy efficiency across utility, customer, and societal perspectives, cost-effective energy efficiency can be better integrated into the energy mix as an important low-cost resource.

Overview

Energy efficiency programs can save resources, lower utility costs, and reduce customer energy bills, but they also can reduce utility sales. Therefore, the effect on utility financial health must be carefully evaluated, and policies might need to be modified to keep utilities financially healthy (return on equity [ROE], earnings per share, debt coverage ratios unaffected) as they pursue efficiency. The extent of the potential economic and environmental benefits from energy efficiency, the impact on a utility's financial results, and the importance of modifying existing policies to support greater investment in these energy efficiency programs depend on a number of market conditions that can vary from one region of the country to another.

To explore the potential benefits from energy efficiency programs and the importance of modifying existing policies, a number of business cases have been developed. These business cases show the impact of energy efficiency investments on the utility's financial health and earnings, customer energy bills, and social resources such as net

Leadership Group Recommendation Applicable to the Business Case for Energy Efficiency

- Broadly communicate the benefits of and opportunities for energy efficiency.

A more detailed list of options specific to the objective of promoting the business case for energy efficiency is provided at the end of this chapter.

Key Findings From the Eight Business Cases Examined

- For both electric and gas utilities, energy efficiency investments consistently lower costs over time for both utilities and customers while providing positive net benefits to society. When enhanced by ratemaking policies to address utility financial barriers to energy efficiency, such as decoupling the utility's revenues from sales volumes, utility financial health can be maintained while comprehensive, cost-effective energy efficiency programs are implemented.

- The costs of energy efficiency and reduced sales volume might initially raise gas or electricity bills due to slightly higher rates from efficiency investment and reduced sales. However, as the efficiency gains help participating customers lower their energy consumption, the decreased energy use offsets higher rates to drive their total energy bills down. In the eight cases examined, average customer bills were reduced by 2 percent to 9 percent over a ten year period, compared to the no-efficiency scenario.

- Investment in cost-effective energy efficiency programs yield a net benefit to society—on the order of hundreds of millions of dollars in net present value (NPV) for the illustrative case studies (small- to medium-sized utilities).

efficiency costs and pollutant emissions. The business cases were developed using an Energy Efficiency Benefits Calculator (Calculator) that facilitates evaluation of the financial impact of energy efficiency on its major stakeholders—utilities, customers, and society. The Calculator allows users to examine efficiency investment scenarios across different types of utilities using transparent input assumptions (see Appendix B for detailed inputs and results).[1] Policies evaluated with the Calculator are discussed in more detail in Chapter 2: Utility Ratemaking & Revenue Requirements and Chapter 3: Energy Resource Planning Processes.

Eight business cases are presented to illustrate the impact of comprehensive energy efficiency programs on utilities, their customers, and society. The eight cases represent a range of utility types under different growth and investment situations. Each case compares the consequences of three scenarios—no energy efficiency programs without a decoupling mechanism, energy efficiency without decoupling, and energy efficiency with decoupling. Energy efficiency spending was assumed to be equal to 2 percent of electricity revenue and 0.5 percent of natural gas revenue across cases, regardless of the decoupling assumption; these assumptions are similar to many of the programs being managed in regions of the country today.[2] In practice, decoupling and shareholder incentives often lead to increased energy efficiency investments by utilities, increasing customer and societal benefits.

Business Cases Evaluated

Cases 1 and 2: Investor-Owned Electric and Natural Gas Utilities

- Case 1: Low-Growth
- Case 2: High-Growth

Cases 3 and 4: Electric Power Plant Deferral

- Case 3: Low-Growth
- Case 4: High-Growth

Cases 5 and 6: Investor-Owned Electric Utility Structure

- Case 5: Vertically Integrated Utility
- Case 6: Restructured Delivery-Only Utility

Cases 7 and 8: Publicly and Cooperatively Owned Electric Utilities

- Case 7: Minimum Debt Coverage Ratio
- Case 8: Minimum Cash Position

Table 4-1 provides a summary of main assumptions and results of the business cases.

Table 4-1 summarizes assumptions about the utility size, energy efficiency program, and each business case. All values shown compare the savings with and without energy efficiency over a 15-year horizon. The present value calculations are computed over 30 years, to account for the lifetime of the energy efficiency investments over 15 years.

1 The Calculator was designed to assess a wide variety of utility types using easily obtainable input data. It was not designed for applications requiring detailed data for specific applications such as rate setting, comparing different types of energy efficiency policies, cost-effectiveness testing, energy efficiency resource planning, and consumer behavior analysis.

2 See Chapter 6: Energy Efficiency Program Best Practices for more information on existing programs.

3 Cumulative and NPV business case results are calculated using a 5 percent discount rate over 30 years to include the project life term for energy efficiency investments of 15 years. All values are in nominal dollars with NPV reported in 2007 dollars (year 1 = 2007). Consistent rates are assumed in year 0 and then adjusted by the Calculator for case-specific assumptions. Reductions in utility revenue requirement do not change with decoupling in the Calculator, but might in practice if decoupling motivates the utility to deliver additional energy efficiency. In these cases, societal benefits conservatively equals only the savings from reduced wholesale electricity purchases and capital expenditures minus utility and participant costs of energy efficiency. Energy efficiency program costs given in $/megawatt-hour (MWh) for electric utilities and $/million British thermal units (MMBtu) for gas utilities.

Table 4-1. Summary of Main Assumptions and Results for Each Business Case Analyzed[3]

	Case 1: Low Growth Electric Utility	Case 2: Low Growth Electric Utility	Case 3: Low Growth with 2009 Power Plant	Case 4: Low Growth with 2009 Power Plant	Case 5: Vertical Utility	Case 6: Delivery Utility	Case 7: Electric Public/Coop Debt Coverage Ratio	Case 8: Electric Public/Coop No Debt	Case 1: High Growth Gas Utility	Case 2: Low Growth Gas Utility
Utility Size										
Annual Revenue ($MM) - Year 0	$284	$284	$284	$284	$284	$284	$237	$237	$344	$344
Peak Load (MW) or Sales (BcF) - Year 0	600 MW	600 MW	600 MW	600 MW	600 MW	600 MW	600 MW	600 MW	33 BcF	33 BcF
Parameter Tested	Load Growth	Load Growth	Load Growth	Load Growth	Vertical Utility	Delivery Utility	Debt Coverage Ratio	Cash Position	Load Growth	Load Growth
Assumptions That Differ Between Cases										
Load Growth Assumption	1%	5%	1%	5%	2%	2%	2%	2%	0%	2%
Average Rate - Year 1	$0.12/MWh	$0.12/MWh	$0.12/MWh	$0.12/MWh	$0.12/MWh	$0.12/MWh	$0.10/MWh	$0.10/MWh	$1/therm	$1/therm
EE Program	EE Program Results do not change when decoupling is activated									
Cumulative Savings (EE vs No EE case)	8,105 GWh	8,105 GWh	8,105 GWh	8,105 GWh	8,105 GWh	8,105 GWh	6,754 GWh	6,754 GWh	31 BcF	31 BcF
Utility Spending as Percent of Revenue (%)	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	0.5%	0.5%
Annual Utility Spending (NPV in $MM)	$70	$70	$70	$70	$70	$70	$58	$58	$21	$21
EE Project Life Term (years)	15	15	15	15	15	15	15	15	15	15
Percent of Growth Saved	142%	21%	142%	21%	66%	66%	55%	55%	410%	18%
Total Cost of EE in Year 0 ($/MWh or $/MMBtu)	$35.00	$35.00	$35.00	$35.00	$35.00	$35.00	$35.00	$35.00	$3.00	$3.00
Utility Cost in Year 0 ($/MWh or $/MMBtu)	$20.00	$20.00	$20.00	$20.00	$20.00	$20.00	$20.00	$20.00	$1.50	$1.50
Customer Cost in Year 0 ($/MWh or $/MMBtu)	$15.00	$15.00	$15.00	$15.00	$15.00	$15.00	$15.00	$15.00	$1.50	$1.50
Business Case Results (NPV in $MM)	Revenue Requirement and Net Societal Savings do not change with decoupling. Business Case results are the difference between the No EE and EE cases.									
Reduction in Revenue Requirement ($MM)	$396	$318	$476	$338	$372	$348	$288	$270	$211	$142
% of Total Revenue Requirement	5.5%	3.0%	6.0%	3.0%	4.1%	4.4%	4.0%	4.3%	3.8%	2.2%
Net Customer Savings - no decoupling ($MM)	$504	$372	$608	$375	$447	$437	$459	$266	$258	$156
% of Total Customer Bills	7.0%	3.5%	7.7%	3.3%	6.4%	5.6%	6.4%	4.2%	4.6%	2.4%
Net Customer Savings - decoupling ($MM)	$344	$266	$424	$286	$320	$296	$245	$226	$158	$90
% of Total Customer Bills	4.8%	2.5%	5.4%	2.5%	4.5%	3.8%	43.4%	3.6%	2.8%	1.4%
Net Societal Savings ($MM)	$289	$258	$332	$269	$282	$271	$225	$225	$143	$119
% of Total Societal Cost	237.5%	211.9%	272.6%	221.0%	6.7%	222.2%	222.2%	222.2%	338.0%	282.6%
Air Emission Savings	Air Emission Savings are the difference between No EE and EE cases and do not change when decoupling is activated									
1000 Tons CO_2	311	311	311	311	311	311	259	259	128	128
Tons NO_x	61	61	61	61	61	61	51	51	107	107

BcF = billion cubic feet; CO_2 = carbon dioxide; EE = energy efficiency; GWh = gigawatt-hour; NO_x = nitrous oxides; $MM = million dollars; MMBtu = million British thermal units; MWh = megawatt-hour; NPV = net present value

While these eight business cases are not comprehensive, they allow some generalizations about the likely financial implications of energy efficiency investments. These generalizations depend upon the three different perspectives analyzed:

- *Utility Perspective.* The financial health of the utility is modestly impacted because the introduction of energy efficiency reduces sales. If energy efficiency is accompanied with mechanisms to protect shareholders—such as a decoupling mechanism to buffer revenues and profits from sales volumes—the utility's financial situation can remain neutral to the efficiency investments.[4] This effect holds true for both public and investor-owned utilities.

- *Customer Perspective.* Access to energy efficiency drives customer bills down over time. Across the eight case studies, energy bills are reduced by 2 percent to 9 percent over a 10 to 15-year period. Even though the efficiency investment and decreased sales drives *rates* slightly higher, this increase is more than offset in average customer bills due to a reduction in energy usage.

- *Societal Perspective.* The monetary benefits from energy efficiency exceed costs and are supplemented by other benefits such as lower air emissions.

Generalizations may also be made about the impact of policies to remove the throughput incentive, such as decoupling mechanisms, across these business cases.[5] These generalizations include:

- *Utility Perspective.* Policies that remove the throughput incentive can provide utilities with financial protection from changes in throughput due to energy efficiency, by smoothing the utility's financial performance while lowering customer bills. Generally, the business case results show that a decoupling mechanism benefits utilities more if the energy savings from efficiency are a greater percent of load growth. Also, because small reductions in throughput have a greater effect on the financial condition of distribution utilities, decoupling generally benefits distribution utilities more than vertically integrated utilities. A utility's actual results will depend on the structure of its efficiency program, as well as the specific decoupling and attrition mechanisms.

- *Customer Perspective.* Decoupling generates more frequent, but smaller, rate adjustments over time because variations in throughput require periodic rate "true-ups." Decoupling leads to modestly higher rates earlier for customers, when efficiency account for a high percent of load growth. In all cases, energy efficiency reduces average customer bills over time, with and without decoupling.

- *Societal Perspective.* The societal benefits of energy efficiency are tied to the amount of energy efficiency implemented. Therefore, to the extent that decoupling encourages investment in energy efficiency, it is a positive from a societal perspective. Decoupling itself does not change the societal benefits of energy efficiency.

While these cases are a good starting point, each utility will have some unique characteristics, such as differences in fuel and other costs, growth rates, regulatory structure, and required capital expenditures. These and other inputs can be customized in the Calculator so users can consider the possible impacts of energy efficiency on their unique situations. The Calculator was developed to aid users in promoting the adoption of energy efficiency programs, and the results are therefore geared for education and outreach purposes.[6]

4 Though not modeled in these business case scenarios, incentive mechanisms can also be used to let shareholders profit from achieving efficiency goals, further protecting shareholders. Such incentives can increase the utility and shareholder motivations for increased energy efficiency investment.

5 The decoupling mechanism assumed by the Calculator is a "generic" balancing account that adjusts rates annually to account for reduced sales volumes, thereby maintaining revenue at target projections. Differences in utility incentives that alternative decoupling mechanisms provide are discussed in Chapter 2: Utility Ratemaking & Revenue Requirements, but are not modeled. The decoupling mechanism does not protect the utility from cost variations.

6 The Calculator was designed to assess a wide variety of utility types using easily obtainable input data. It was not designed for applications requiring detailed data for specific applications such as rate setting, comparing different types of energy efficiency policies, cost effectiveness testing, energy efficiency resource planning, and consumer behavior analysis.

Business Case Results

The eight cases evaluated were designed to isolate the impact of energy efficiency investments and decoupling mechanisms in different utility contexts (e.g., low-growth and high-growth utilities, vertically integrated and restructured utility, or cash-only and debt-financed publicly and cooperatively owned utilities). For each case, three energy efficiency scenarios are evaluated (no efficiency without decoupling, efficiency without decoupling, and efficiency with decoupling), while holding all other utility conditions and assumptions constant. The eight scenarios are divided into four sets of two cases each with contrasting assumptions.

An explanation of the key results of the business cases is provided below, with further details provided for each case in Appendix B.

Cases 1 and 2: Low-Growth and High-Growth Utilities

In this first comparison, the results of implementing energy efficiency on two investor-owned electric and natural gas distribution utilities are contrasted. These utilities are spending the same percent of revenue on energy efficiency and vary only by load growth. The low-growth electric utility (Case 1) has a 1 percent sales growth rate and the low-growth gas utility has a 0 percent sales growth rate, while the high-growth electric utility (Case 2) has a 5 percent sales growth rate and the high-growth gas utility has a 2 percent sales growth rate. Table 4-2 compares the results for electric utilities, and Table 4-3 compares the results for the natural gas utilities. In both cases (and all other cases examined), the Calculator assumes a 'current year' test year for rate-setting. When rate adjustments are needed, the rates are set based on the costs and sales in that same year. Therefore, differences between forecasted and actual growth rates do not affect the results.

Both electric and natural gas utilities show similar trends. With low load growth, the same level of energy efficiency investment offsets a high percentage of load growth, and utility return on equity (ROE) falls below target until the next rate case unless decoupling is in place.[7] In contrast, the high-growth utility has an ROE that exceeds the target rate of return until the rates are decreased to account for the increasing sales. In both cases, energy efficiency reduces the utility return from what it would have been absent energy efficiency. Generally speaking, energy efficiency investments that account for a higher percentage of load growth expose an electric or natural gas utility to a greater negative financial effect unless decoupling is in place.

These cases also look at the difference between the two utilities with and without a decoupling mechanism. Both utilities earn their target ROE in rate case years, with and without the energy efficiency in place. (Note that in practice, decoupling does not guarantee achieving the target ROE.) For the low-growth utility, the decoupling mechanism drives a rate adjustment to reach the target ROE, and the utility has higher ROE than without decoupling (Case 1). In the high-growth case, decoupling decreases ROE relative to the case without decoupling (Case 2), and prevents the utility from earning slightly above its target ROE from increased sales in between rate cases, allowing customer rates to decline sooner in the high-growth electric case if decoupling is in place.

In both electric and natural gas Case 1 and Case 2, average customer bills decline over time. The average bill is lower beginning in year 3 in the electric utility with no decoupling comparison, and in year 5 with decoupling. A similar pattern is found for the gas utility example. Average bills decrease more when the efficiency is a higher percent of load growth, even though rates slightly increase due to efficiency investments and reduced sales. The average customer bill declines more smoothly when a decoupling mechanism is used due to more frequent rate adjustments.

For both electricity and natural gas energy efficiency, the net societal benefit is computed as the difference of the total benefits of energy efficiency, less the total costs. From a societal perspective, the benefits include the value of reduced expenditure on energy (including market price reductions—

7 In Cases 1 and 2, the electric utility invests 2 percent of revenue in energy efficiency and the gas utility invests 0.5 percent of revenue.

Table 4-2. High- and Low-Growth Results: Electric Utility

Case 1: Low-Growth (1%)

Return on Equity (ROE)

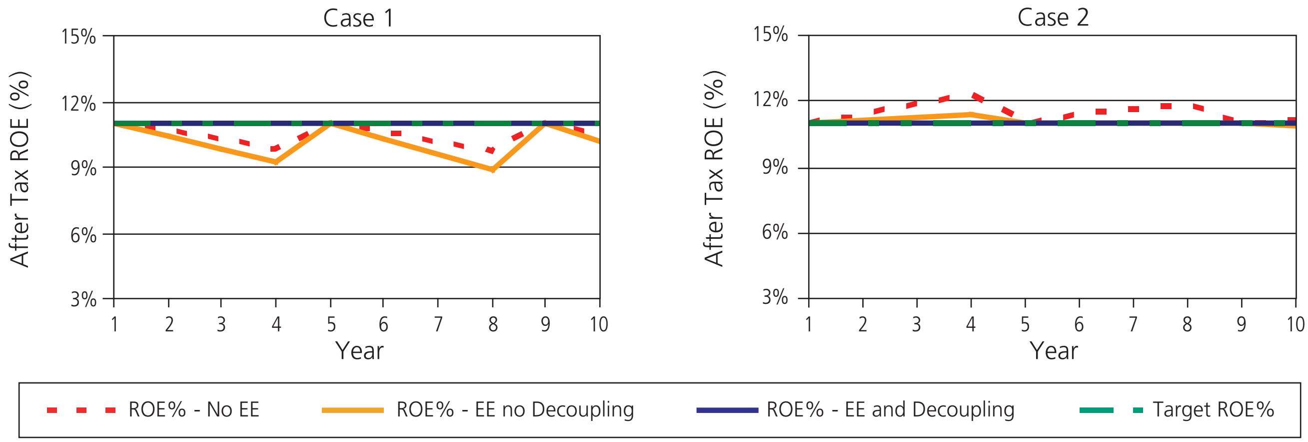
Without efficiency and decoupling, the low sales drive ROE below the target return. Target ROE is achieved with energy efficiency (EE) and decoupling. Increasing energy efficiency without decoupling decreases ROE.

Case 2: High-Growth (5%)

Return on Equity (ROE)

With high load growth, without decoupling, the utility achieves greater than the target ROE until rates are adjusted. With energy efficiency, sales and earnings are reduced, reducing ROE.

Investor-Owned Utility Comparison of Return on Equity



Case 1: Low-Growth (1%)

Rates

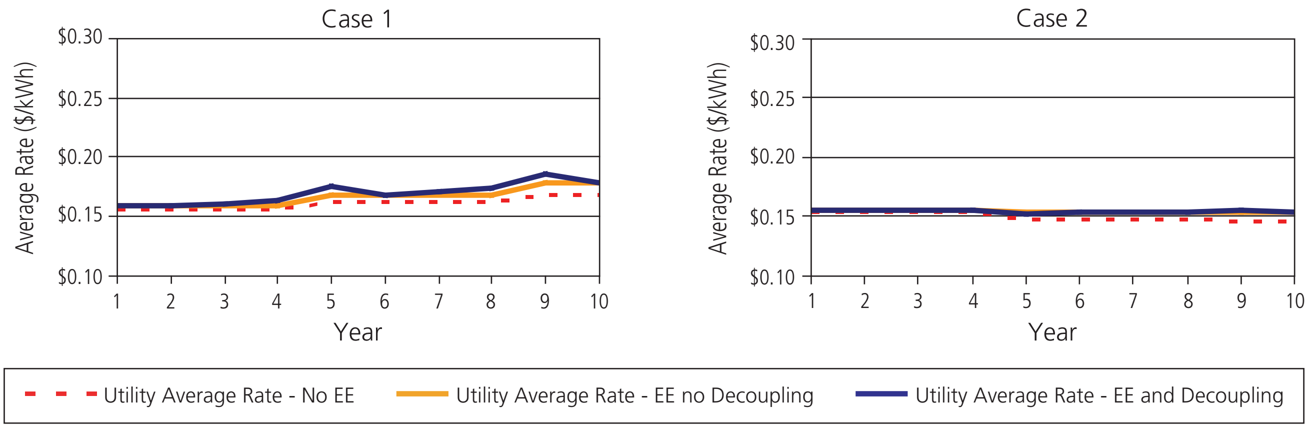
Without energy efficiency, the utility sells higher volumes than in the no efficiency scenarios and has slightly lower rates. Rates in the energy efficiency scenario increase primarily due to lower throughput; rates are slightly higher in the decoupling scenario due to increase earnings to the target ROE.

Case 2: High-Growth (5%)

Rates

In the high-growth case, rates are relatively flat. Without energy efficiency, the utility sells higher volumes and has slightly lower rates. Decoupling does not have a great impact in this case because the ROE is near target levels without any rate adjustments.

Comparison of Average Rate



if any), reduced losses, reduced capital expenditures, and reduced air emissions (if emissions are monetized).[8] The costs include both utility program and administration costs as well as the participant costs of energy efficiency. If the net societal benefits are positive, the energy efficiency is cost-effective from a societal perspective. In both Case 1 and Case 2 (and all other cases evaluated using the tool), the net societal benefits are positive for investments in energy

Table 4-2. High- and Low-Growth Results: Electric Utility (continued)

Case 1: Low-Growth (1%)

Bills

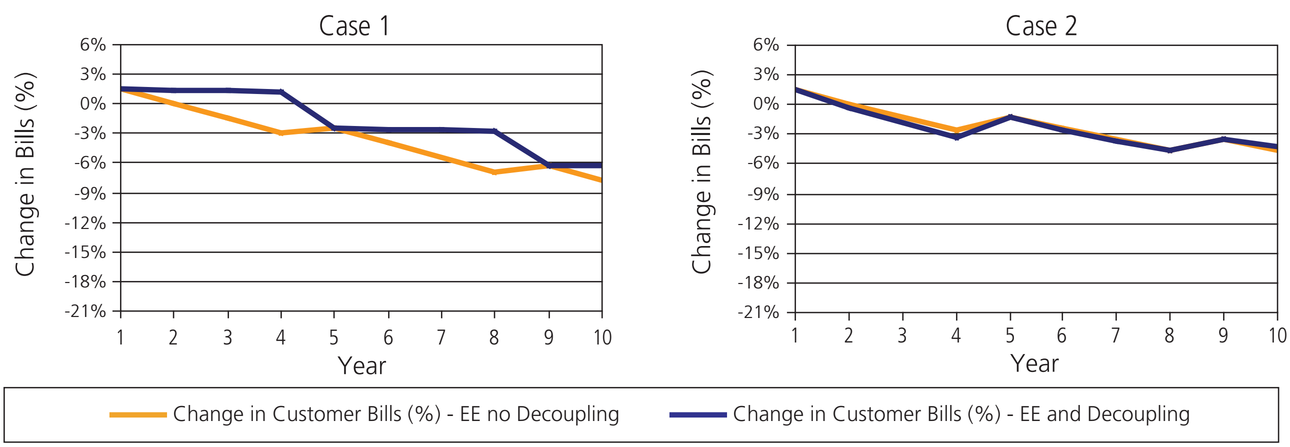
Total customer bills with energy efficiency programs decline over time, indicating customer savings resulting from lower energy consumption. Rate increases through the decoupling mechanism reduce the pace of bill savings in the decoupling case.

Case 2: High-Growth (5%)

Bills

Total customer bills with energy efficiency decline over time, indicating customer savings resulting from lower energy consumption. There is little difference between the decoupling and no decoupling cases in the high-growth scenario.

Percent Change in Customer Bills



Case 1: Low-Growth (1%)

Net Societal Benefits

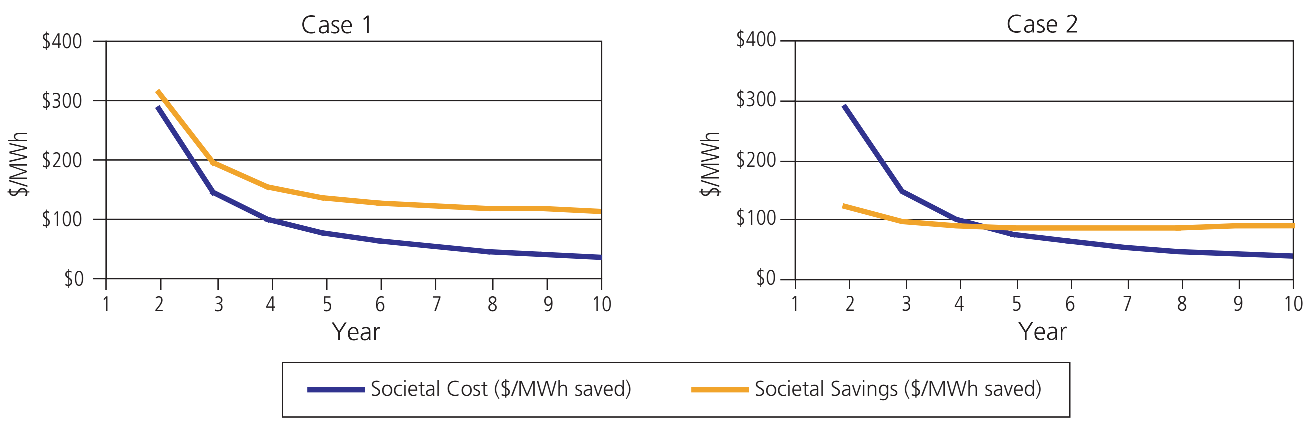
Over time, the savings from energy efficiency exceed the annual costs. The societal cost and societal savings are the same, with and without decoupling.

Case 2: High-Growth (5%)

Net Societal Benefits

Over time, the savings from energy efficiency exceed the annual costs. The societal cost and societal savings are the same, with and without decoupling.

Delivered Costs and Benefits of EE



8 The cases discussed in this document include conservative assumptions and do not include market price reductions or monetize air emissions in net societal benefits.

efficiency. In the low-growth case, the savings exceed costs within two years for both the electric and natural case cases. In the high-growth case, the savings exceed costs within five years for the electric utility cases and four years for the natural gas utility cases. Energy efficiency has a similar effect upon natural gas utilities, as shown in Table 4-3.

Table 4-3. High- and Low-Growth Results: Natural Gas Utility

Case 1: Low-Growth (0%)

Return on Equity (ROE)

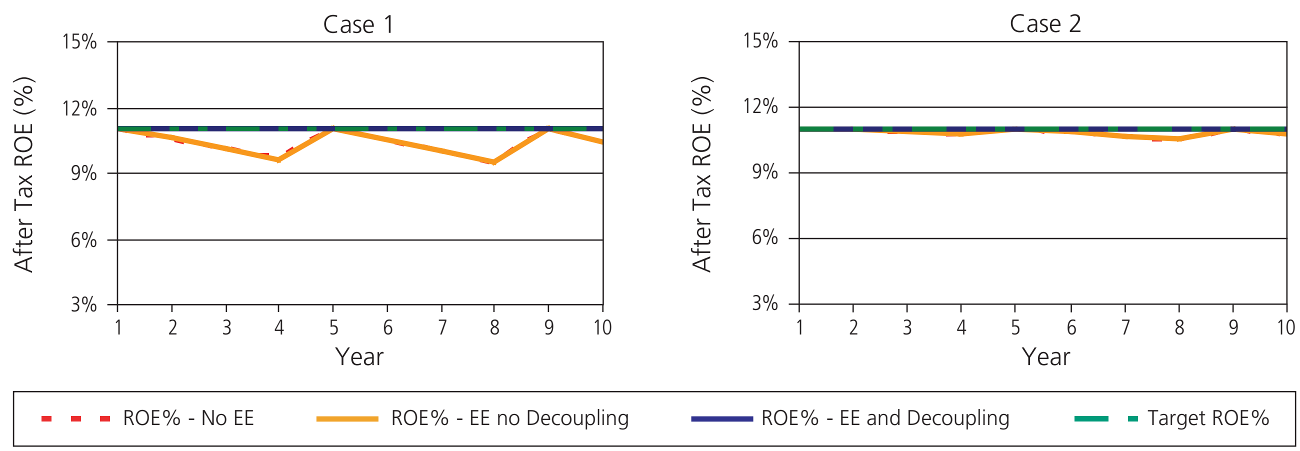
Without efficiency and decoupling, the low sales result in ROE falling below the target return. Similarly, energy efficiency without decoupling drops utility return below target ROE. Target ROE is achieved with decoupling.

Case 2: High-Growth (2%)

Return on Equity (ROE)

With high load growth, energy efficiency has less impact on total sales and earnings. Thus, the utility achieves close to its target ROE in the early years, although without decoupling, ROE falls slightly in later years as energy efficiency reduces sales over time.

Investor-Owned Utility Comparison of Return on Equity



Case 1: Low-Growth (0%)

Rates

Rates increase over time because of increasing rate base and low sales growth. Without energy efficiency, the utility sells higher volumes and has lower rates. Decoupling increases rates when sales volumes are below target.

Case 2: High-Growth (2%)

Rates

Without energy efficiency, the utility sells higher volumes and has lower rates. Energy efficiency increases rates slightly in later years by reducing sales volumes.

Comparison of Average Rate

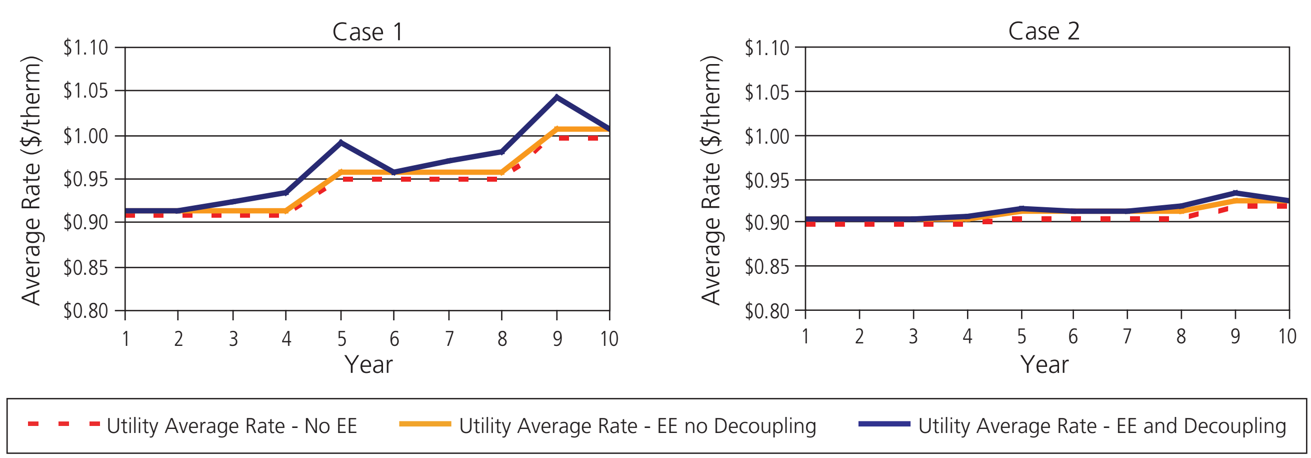


Table 4-3. High- and Low-Growth Results: Natural Gas Utility (continued)

Case 1: Low-Growth (0%)

Customer Bills

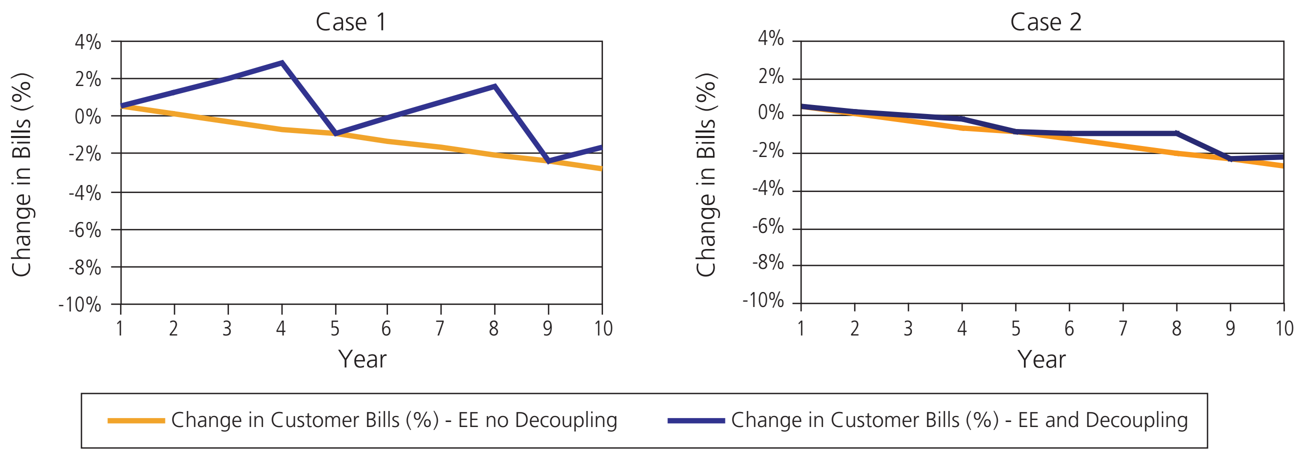
Total customer bills with energy efficiency decline over time, indicating customer savings resulting from lower energy consumption. Customer utility bills initially increase slightly with decoupling as rates are increased to hold ROE at the target level and spending increases on efficiency.

Case 2: High-Growth (2%)

Customer Bills

Customer utility bills with energy efficiency reflect the more limited impact of efficiency programs on rate profile. Total customer bills decline over time, indicating customer savings resulting from lower energy consumption.

Percent Change in Customer Bills



Case 1: Low-Growth (0%)

Net Societal Benefits

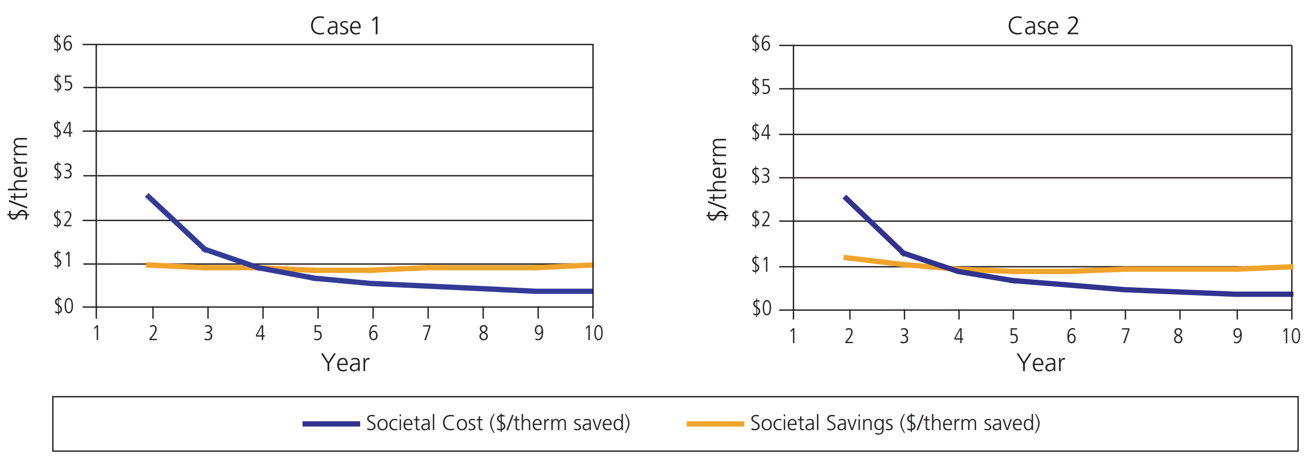
Over time, the savings from energy efficiency exceed the annual costs. The societal cost and societal savings are the same, with and without decoupling.

Case 2: High-Growth (2%)

Net Societal Benefits

Over time, the savings from energy efficiency exceed the annual costs. The societal cost and societal savings are the same, with and without decoupling.

Delivered Costs and Benefits of EE



Cases 3 and 4: Electric Power Plant Deferral

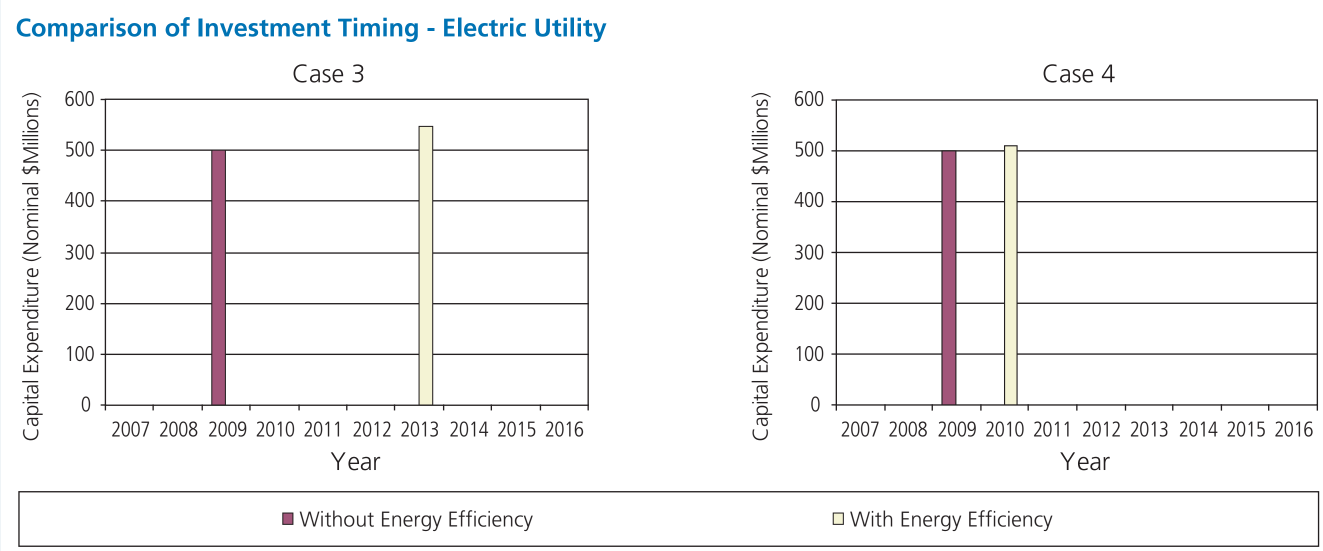
This case study examines an electric investor-owned utility with a large capital project (modeled here as a 500-MW combined-cycle power plant, although the conclusions are similar for other large capital projects), planned for construction in 2009.[9] Again the effect of a 1 percent growth rate (Case 3) is compared with a 5 percent growth rate (Case 4) with identical energy efficiency investments of 2 percent of electric utility revenues.

Figure 4-1 shows the capital expenditure for the project with and without an aggressive energy efficiency plan and a summary of the net benefits from each perspective. The length of investment deferral is based on the percent of peak load reduced due to energy efficiency investments. The vertical axis shows how the expenditure in nominal dollars starts at $500 million in 2009, or slightly higher (due to inflation) after deferral. With Case 3, energy efficiency investments account for a higher percentage of peak load growth, and can defer the project until 2013. With higher growth and the same level of efficiency savings (Case 4), the same efficiency investment only defers the project until 2010.

In Case 3, the energy efficiency program causes a greater reduction in revenue requirement—a 30-year reduction of $476 million rather than a Case 4 reduction of $338 million—providing benefits from a customer perspective. From a societal perspective, the low-growth case energy efficiency program yields higher net societal benefit as well: $332 million versus $269 million.

Figure 4-1. Comparison of Deferral Length with Low- and High-Growth

Case 3: Low-Growth Investment Timing **Case 4: High-Growth Investment Timing**



30-year savings impact from EE	Low-Growth Utility	High-Growth Utility
Decrease in Revenue Requirement (net present value [NPV], million dollars [$MM])	$476	$338
Net Customer Savings – decoupling (NPV, $MM)	$319	$275
Net Societal Benefit (NPV, $MM)	$332	$269

9 This illustration demonstrates how energy efficiency can be used, including efforts to reduce peak capacity requirements, to defer a single 500 MW combined cycle power plant. Energy efficiency can also be used to defer other, smaller investments.

Table 4-4 compares the reduction in revenue requirement due to the deferral of the power plant investment between the two cases. In Case 3, the reduction in revenue requirement due to the deferral to 2013 results in present value savings of $36 million over the three years that the plant was deferred. In Case 4, the deferral provides present value savings of $11 million for the one-year deferral.

Although the project is deferred longer in the low-growth case, fewer sales overall and higher installed capital costs result in higher rates over time relative to the high-growth case. In both cases, the increase in rates from energy efficiency programs, starting in year 1, is significantly less than the rate increase that occurs after the new power plant investment is made, leading to lower customer bills. Customer bill savings are greatest during the years that the plant is deferred.[10]

Cases 5 and 6: Vertically Integrated Utility vs. Restructured Delivery Company

In this example, a vertically integrated electric utility (Case 5) is compared with the restructured electric delivery

Table 4-4. Power Plant Deferral Results

Case 3: Low-Growth (1%)

Revenue Requirement
2009 project deferred to 2013, resulting in a reduction in revenue requirement due to deferring the power plant over three years of PV$36 million.

Other Capital Expenditures
The low-growth case leads to the savings of other capital expenditures compared to the high-growth case.

Retail Rates
With low load growth, a given amount of energy efficiency defers so much load growth that the new power plant can be deferred for three years, allowing the utility to conserve capital and postpone rate increases for several years.

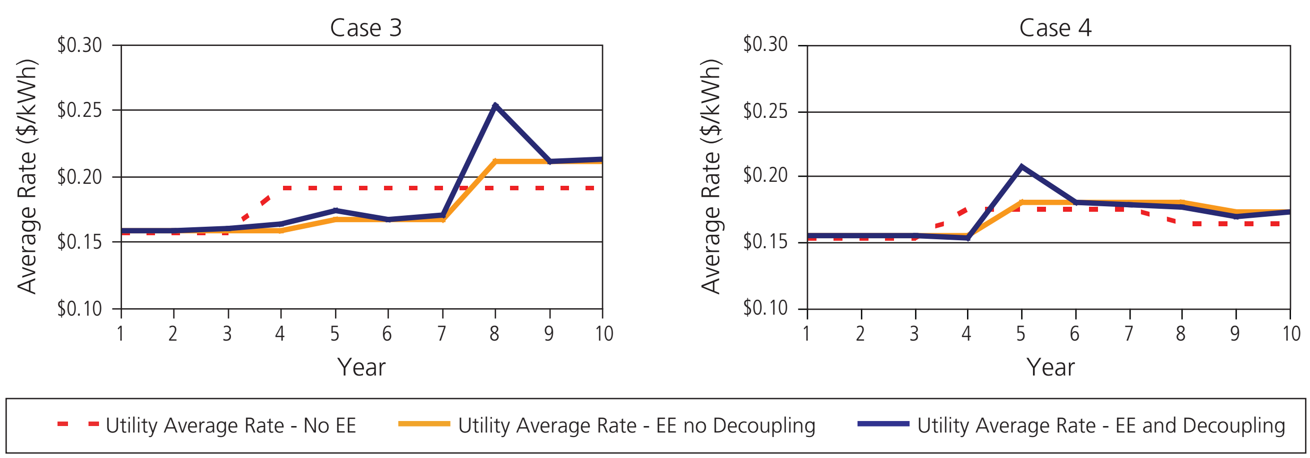
Case 4: High-Growth (5%)

Revenue Requirement
2009 project deferred to 2010, resulting in a reduction in revenue requirement from deferring the power plant over a year of PV$11 million.

Other Capital Expenditures
The low-growth case leads to the savings of other capital expenditures compared to the high-growth case.

Retail Rates
With high load growth, energy efficiency reduces load growth enough to defer the new power plant investment by one year, slowing implementation of a relatively smaller rate increase.

Comparison of Average Rate



[10] The Calculator assumes that a rate case occurs in the year following a large capital investment. When a decoupling mechanism is used, a higher rate adjustment (and immediate decrease in bill savings) occurs once a new major infrastructure investment is brought online. This charge is due to the new level of capital expenditures at the same time a positive decoupling rate adjustment is making up for previous deficiencies.

company (Case 6); both experiencing a 2 percent growth rate and investing 2 percent of revenue in energy efficiency. These cases assume that the vertically integrated utility has more capital assets and larger annual capital expenditures than a restructured delivery utility. In general, the financial impact of energy efficiency on delivery utilities is more pronounced than on vertically integrated utilities with the same number of customers and

Table 4-4. Power Plant Deferral Results (continued)

Case 3: Low-Growth (1%)

Customer Bills

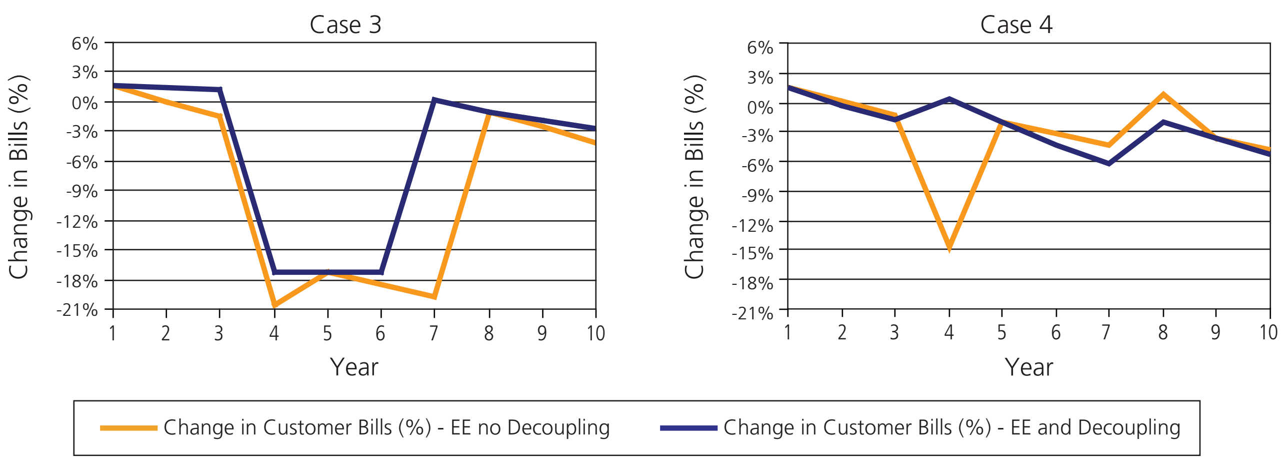
Although rates rise with large capital expenditures, bills continue to fall over time as energy efficiency drives customer volume down to offset the higher rates.

Case 4: High-Growth (5%)

Customer Bills

Although rates rise with large capital expenditures, bills continue to fall over time as energy efficiency drives customer volume down to offset the higher rates.

Percent Change in Customer Bills



Case 3: Low-Growth (1%)

Load Impact

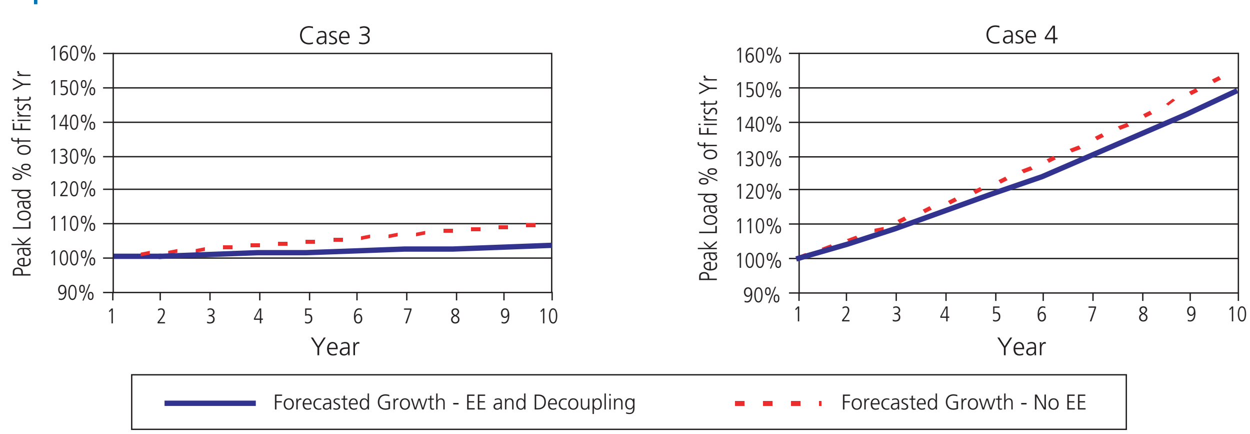
Energy efficiency significantly reduces load growth and reduces the need for new capital investment.

Case 4: High-Growth (5%)

Load Impact

With high growth, energy efficiency has a limited impact on peak load, and defers a modest amount of new capital investment.

Comparison of Peak Load Growth



sales. Once divested of a generation plant, the distribution utility is a smaller company (in terms of total rate base and capitalization), and fluctuations in throughput and earnings have a relatively larger impact on return.

Table 4-5 summarizes the comparison of ROE, rates, bills and societal benefits. Without implementing energy efficiency, both utilities are relatively financially healthy, achieving near their target rate of return in each year;

Table 4-5. Vertically Integrated and Delivery Company Results

Case 5: Vertically Integrated

Return on Equity (ROE)

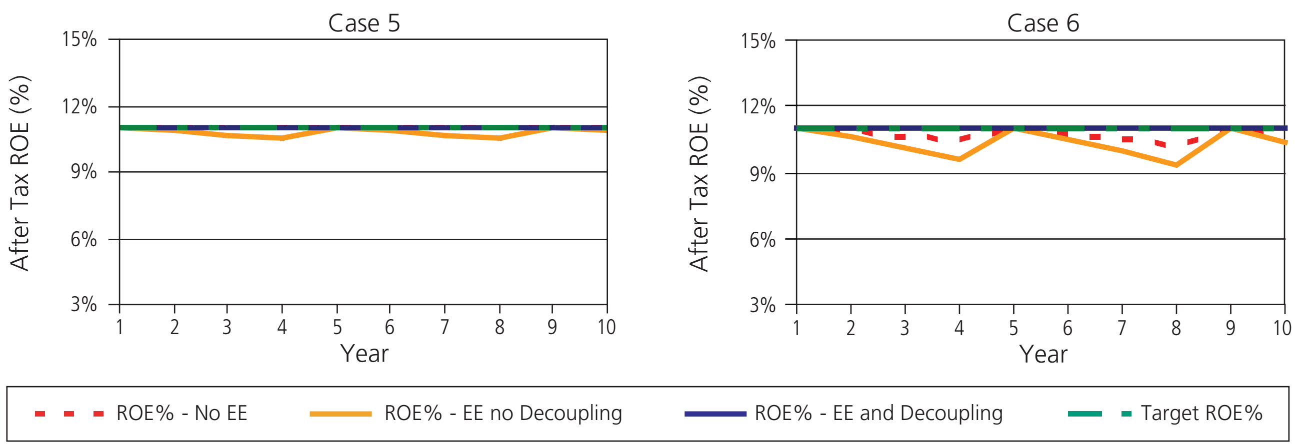
Because the vertically integrated utility has a large rate base, the impact of energy efficiency upon total earnings is limited and it has little impact upon ROE (with or without decoupling).

Case 6: Delivery Utility

Return on Equity (ROE)

With a smaller rate base and revenues only from kWh deliveries, energy efficiency has a larger impact on a ROE without decoupling than a vertically integrated utility.

Investor-Owned Utility Comparison of Return on Equity



Case 5: Vertically Integrated

Rates

Without energy efficiency, the utility sells higher volumes and has lower rates. Total retail rates, including delivery and energy, are similar for the vertically integrated and restructured utilities.

Case 6: Delivery Utility

Rates

Without energy efficiency, the utility sells higher volumes and has lower rates. Total retail rates, including delivery and energy, are similar for the vertically integrated and restructured utilities.

Comparison of Average Rate

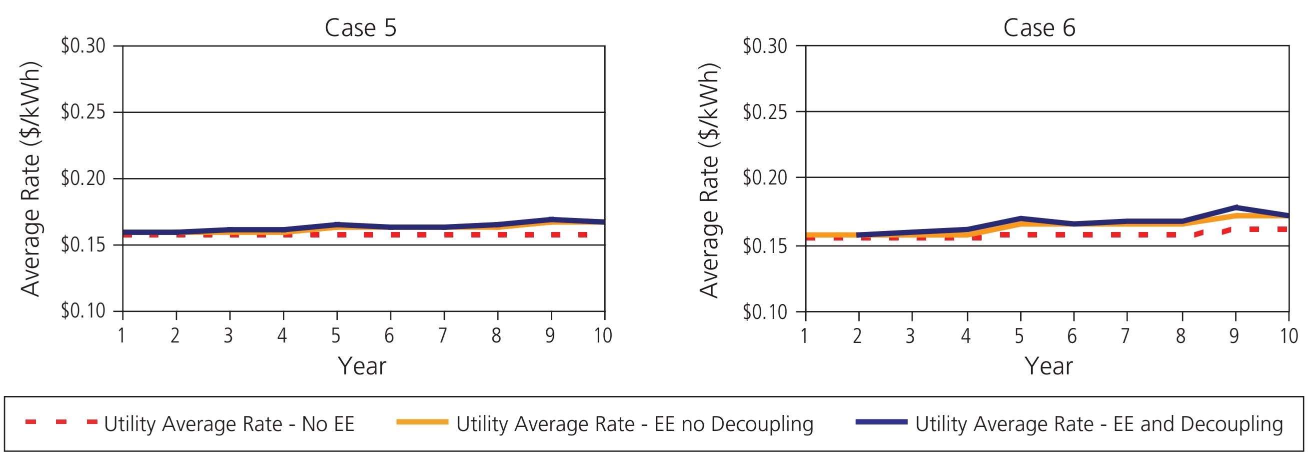


Table 4-5. Vertically Integrated and Delivery Company Results (continued)

Case 5: Vertically Integrated

Bills

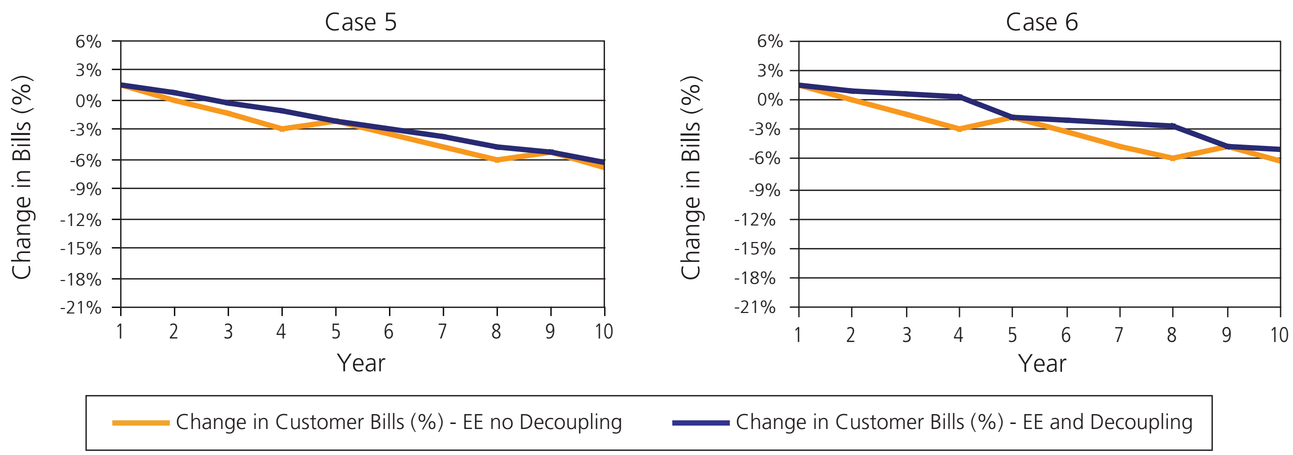
Total customer bills with energy efficiency programs decline over time, indicating average customer savings resulting from lower energy consumption. Customer utility bills decrease more smoothly with decoupling as a result of the more frequent rate adjustments.

Case 6: Delivery Utility

Bills

Total customer bills with energy efficiency programs decline over time, indicating average customer savings resulting from lower energy consumption. Customer utility bills decrease more slowly in the decoupling case, because rates are increased earlier to offset reduced sales.

Percent Change in Customer Bills



Case 5: Vertically Integrated

Net Societal Benefits

Over time, the savings from energy efficiency exceed the annual costs. The societal cost and societal savings are the same, with and without decoupling.

Case 6: Delivery Utility

Net Societal Benefits

As with the vertically integrated utility, savings from energy efficiency exceed the costs over time. The distribution utility has a lower initial societal savings because the distribution company reduces fewer capital expenditures at the outset of the energy efficiency investments. Over time, the societal costs and savings are similar to the distribution company.

Delivered Costs and Benefits of EE

however, introducing energy efficiency reduces ROE and earnings for both utilities unless a decoupling mechanism is put in place. Customer rates increases, bill savings, and societal benefits follow similar trends with energy efficiency, as discussed in Cases 1 and 2.

Cases 7 and 8: Publicly and Cooperatively Owned Electric Utilities

The first six cases used an investor-owned electric utility to illustrate the business case for energy efficiency. The Calculator also can evaluate the impact of efficiency programs on publicly and cooperatively owned electric utilities. Many of the issues related to the impact of growth rates and capital deferral discussed in the investor-owned utility examples apply equally to publicly and cooperatively owned utilities. From a net societal benefit perspective, the results are identical for publicly, cooperatively, and privately owned utilities. The ratemaking and utility financing perspectives are different, however.

The financial position of publicly owned utilities is evaluated primarily based on either the debt coverage ratio (which is critical to maintaining a high bond rating and low cost capital) or the minimum cash position (for utilities with no debt). Table 4-6 shows the results of a publicly or cooperatively owned utility with an energy efficiency program of 2 percent of revenue and load growth of 2 percent. In both cases, the assumption is made that the utility adjusts rates whenever the debt coverage ratio or minimum cash position falls below a threshold. This assumption makes comparisons of different cases more difficult, but the trends are similar to the investor-owned utilities on a regular rate case cycle. The change in utility financial health due to energy efficiency is relatively modest because of the ability to adjust the retail rates to maintain financial health. The publicly and cooperatively owned utilities will experience similar financial health problems as investor-owned utilities if they do not adjust rates.

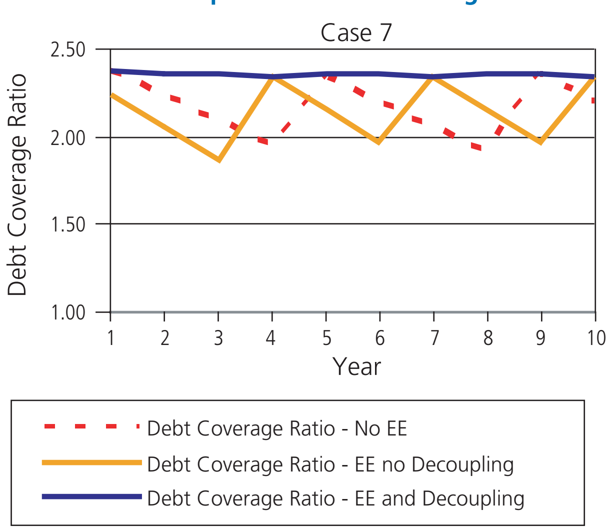
Table 4-6. Publicly and Cooperatively Owned Utility Results

Case 7: Minimum Debt Coverage Ratio

Utility Financial Health

A decoupling mechanism stabilizes the utility's ability to cover debt by adjusting rates for variations in throughput. Without decoupling, rates are adjusted whenever the debt coverage rate falls below a threshold (ratio 2 in the example). The rate adjustment is required earlier in the energy efficiency scenario.

Public Power/Cooperative Debt Coverage Ratio



Case 8: Minimum Cash Position

Utility Financial Health

In the no decoupling cases (with and without energy efficiency), rates are reset if the cash position falls below a minimum threshold ($70 million in this example). With decoupling, the utility adjusts rates to hit the target cash level in each year. The results are similar as long as there is an ability to reset rates when needed to maintain a minimum cash position.

Cash Position at End of Year

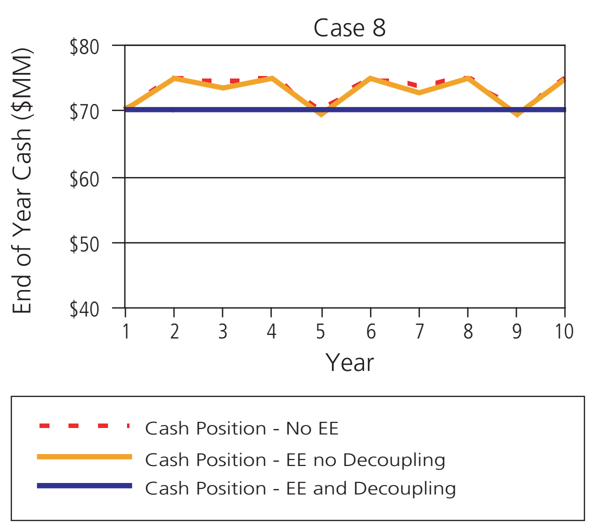


Table 4-6. Publicly and Cooperatively Owned Utility Results (continued)

Case 7: Minimum Debt Coverage Ratio

Customer Rates

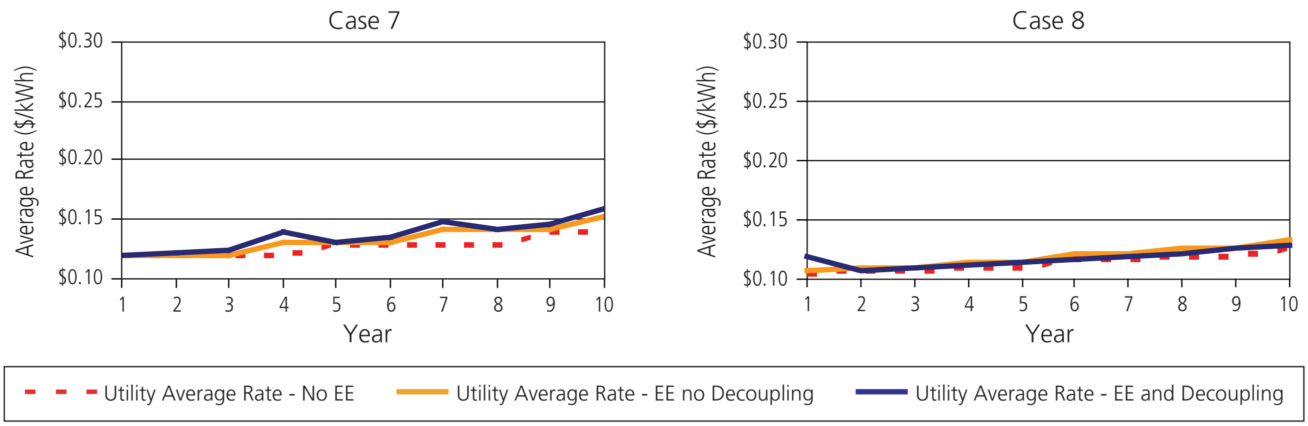
With or without decoupling, rates are adjusted to maintain financial health. Rates are lowest without energy efficiency and highest with energy efficiency and decoupling.

Case 8: Minimum Cash Position

Customer Rates

Once energy efficiency is implemented, retail rate levels are similar, with or without decoupling in place. The decoupling case is slightly smoother with smaller, more frequent rate adjustments.

Comparison of Average Rate



Case 7: Minimum Debt Coverage Ratio

Customer Bills

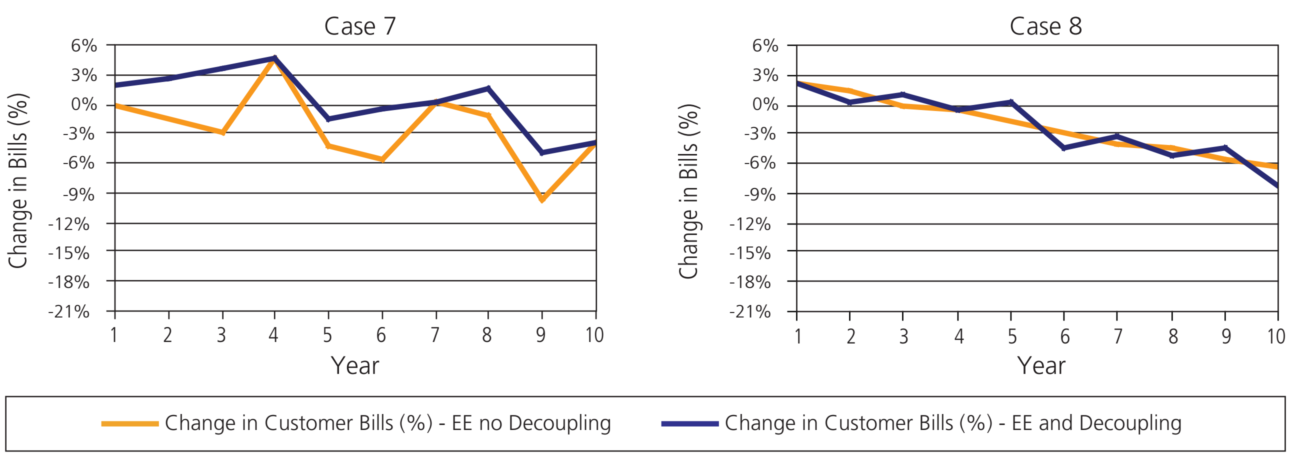
Average customer bills decline with energy efficiency investments, with and without decoupling. The 'randomness' in the bill change is due to different timing of rate adjustments in the energy efficiency and no energy efficiency cases. However, overall the trend is downward.

Case 8: Minimum Cash Position

Customer Bills

Average customer bills decline with energy efficiency investments in both the decoupling and no decoupling cases.

Percent Change in Customer Bills



Key Findings

This chapter summarizes eight business cases for energy efficiency resulting from the Energy Efficiency Benefits Calculator. This Calculator provides simplified results from a utility, customer, and societal perspective. As stated on page 4-1, the key findings from the eight cases examined include:

- For both electric and gas utilities, energy efficiency investments consistently lower costs over time for both utilities and customers, while providing positive net benefits to society. When enhanced by ratemaking policies to address utility financial barriers to energy efficiency, such as decoupling the utility's revenues from sales volumes, utility financial health can be maintained while comprehensive, cost-effective energy efficiency programs are implemented.

- The costs of energy efficiency and reduced sales volume might initially raise gas or electricity bills due to slightly higher rates from efficiency investment and reduced sales. However, as the efficiency gains help participating customers lower their energy consumption, the decreased energy use offsets higher rates to drive their total energy bills down. In the 8 cases examined, average customer bills were reduced by 2 percent to 9 percent over a ten year period, compared to the no-efficiency scenario.

- Investment in cost-effective energy efficiency programs yields a net benefit to society—on the order of hundreds of millions of dollars in NPV for the illustrative case studies (small- to medium-sized utilities).

Recommendations and Options

The National Action Plan for Energy Efficiency Leadership Group offers the following recommendation as a way to overcome many of the barriers to energy efficiency, and provides the following options for consideration by utilities, regulators, and stakeholders (*as presented in the Executive Summary*).

Recommendation: Broadly communicate the benefits of, and opportunities for, energy efficiency. Experience shows that energy efficiency programs help customers save money and contribute to lower cost energy systems. But these impacts are not fully documented nor recognized by customers, utilities, regulators and policy-makers. More effort is needed to establish the business case for energy efficiency for all decision-makers and to show how a well-designed approach to energy efficiency can benefit customers, utilities, and society by (1) reducing customers bills over time, (2) fostering financially healthy utilities (return on equity [ROE], earnings per share, debt coverage ratios unaffected), and (3) contributing to positive societal net benefits overall. Effort is also necessary to educate key stakeholders that, although energy efficiency can be an important low-cost resource to integrate into the energy mix, it does require funding, just as a new power plant requires funding.

Options to Consider:

- Establishing and educating stakeholders on the business case for energy efficiency at the state, utility, and other appropriate level addressing relevant customer, utility, and societal perspectives.

- Communicating the role of energy efficiency in lowering customer energy bills and system costs and risks over time.

Reference

National Action Plan for Energy Efficiency. (2006). *Energy Efficiency Benefits Calculator.* <http://www.epa.gov/cleanenergy/eeactionplan.htm>

5: Rate Design

Retail electricity and natural gas utility rate structures and price levels influence customer consumption, and thus are an important tool for encouraging the adoption of energy-efficient technologies and practices. The rate design process typically involves balancing multiple objectives, among which energy efficiency is often overlooked. Successful rate designs must balance the overall design goals of utilities, customers, regulators, and other stakeholders, including encouraging energy efficiency.

Overview

Retail rate designs with clear and meaningful price signals, coupled with good customer education, can be powerful tools for encouraging energy efficiency. At the same time, rate design is a complex process that must take into account multiple objectives (Bonbright, 1961; Philips, 1988). The main priorities for rate design are recovery of utility revenue requirements and fair apportionment of costs among customers.

Other important regulatory and legislative goals include:

- Stable revenues for the utility.
- Stable rates for customers.
- Social equity in the form of lifeline rates for essential needs of households (PURPA of 1978).
- Simplicity of understanding for customers and ease of implementation for utilities.
- Economic efficiency to promote cost-effective load management.

This chapter considers the additional goal of encouraging investment in energy efficiency. While it is difficult to achieve every goal of rate design completely, consideration of a rate design's impact on adoption of energy efficiency and any necessary trade-offs can be included as part of the ratemaking process.

Using Rate Design to Promote Energy Efficiency

In developing tariffs to encourage energy efficiency, the following questions arise: (1) What are the key rate design issues, and how do they affect rate designs for energy efficiency? (2) What different rate design options are possible, and what are their pros and cons? (3) What other mechanisms can encourage efficiency that are not driven by tariff savings? and (4) What are the most successful strategies for encouraging energy efficiency in different jurisdictions? These questions are addressed throughout this chapter.

Leadership Group Recommendations Applicable to Rate Design

- Modify ratemaking practices to promote energy efficiency investments.
- Broadly communicate the benefits of, and opportunities for, energy efficiency.

A more detailed list of options specific to the objective of promoting energy efficiency in rate design is provided at the end of this chapter.

Background: Revenues and Rates

Utility rates are designed to collect a specific revenue requirement based on natural gas or electricity sales. As rates are driven by sales and revenue requirements, these three aspects of regulation are tightly linked. (Revenue requirement issues are discussed in Chapter 2: Utility Ratemaking & Revenue Requirements.)

Until the 1970s, rate structures were based on the principle of average-cost pricing in which customer prices reflected the average costs to utilities of serving their customer class. Because so many of a utility's costs were fixed, the main goal of rate design up until the 1970s was to promote sales. Higher sales allowed fixed costs to be spread over a larger base and helped push rates down, keeping stakeholders content with average-cost based rates (Hyman et al., 2000).

This dynamic began to change in many jurisdictions in the 1970s, with rising oil prices and increased emphasis on conservation. With the passage of the 1978 Public Utility Regulatory Policies Act (PURPA), declining block rates were replaced by flat rates or even inverted block rates, as utilities began to look for ways to defer new plant investment and reduce the environmental impact of energy consumption.

Key Rate Design Issues

Utilities and regulators must balance competing goals in designing rates. Achieving this balance is essential for obtaining regulatory and customer acceptance. The main rate design issues are described below.

Provide Recovery of Revenue Requirements and Stable Utility Revenues

A primary function of rates is to let utilities collect their revenue requirements. Utilities often favor rate forms that maximize stable revenues, such as declining block rates. The declining block rate has two or more tiers of usage, with the highest rates in the first tier. Tier 1 is typically a relatively low monthly usage level that most customers exceed. This rate gives utilities a high degree of certainty regarding the number of kilowatt-hours (kWh) or therms that will be billed in Tier 1. By designing Tier 1 rates to collect the utility's fixed costs, the utility gains stability in the collection of those costs. At the same time, the lower Tier 2 rates encourage higher energy consumption rather than efficiency, which is detrimental to energy efficiency impacts.[1] Because energy efficiency measures are most likely to change customer usage in Tier 2, customers will see smaller bill reductions under declining block rates than under flat rates. Although many utilities have phased out declining block rates, a number of utilities continue to offer them.[2]

Another rate element that provides revenue stability but also detracts from the incentive to improve efficiency is collecting a portion of the revenue requirement through a customer charge that is independent of usage. Because the majority of utility costs do not vary with changes in customer usage level in the short run, the customer charge also has a strong theoretical basis. This approach has mixed benefits for energy efficiency. On one hand, a larger customer charge means a smaller volumetric charge (per kWh or therm), which lowers the customer incentive for energy efficiency. On the other hand, a larger customer charge and lower volumetric charge reduces the utilities profit from increased sales, reducing the utility disincentive to promote energy efficiency.

Rate forms like declining block rates and customer charges promote revenue stability for the utility, but they create a barrier to customer adoption of energy efficiency because they reduce the savings that customers can realize from reducing usage. In turn, electricity demand is more likely to increase, which could lead to long-term higher rates and bills where new supply is more costly than energy efficiency. To promote energy efficiency, a key challenge is to provide a

1 Brown and Sibley (1986) opine that a declining block structure can promote economic efficiency if the lowest tier rate can be set above marginal cost, while inducing additional consumption by some consumers. A rising marginal cost environment suggests, however, that a declining block rate structure with rates below the increasing marginal costs is economically inefficient.

2 A partial list of utilities with declining block residential rates includes: Dominion Virginia Power, VA; Appalachian Power Co, VA; Indianapolis Power and Light Co., IN; Kentucky Power Co., KY; Cleveland Electric Illum Co., OH; Toledo Edison Co., OH; Rappahannock Electric Coop, VA; Lincoln Electric System, NE; Cuivre River Electric Coop Inc., MO; Otter Tail Power Co., ND; Wheeling Power Co., WV; Matanuska Electric Assn Inc., AK; Homer Electric Association Inc., AK; Lower Valley Energy, NE.

level of certainty to utilities for revenue collection without dampening customer incentive to use energy more efficiently.

Fairly Apportion Costs Among Customers

Revenue allocation is the process that determines the share of the utility's total revenue requirement that will be recovered from each customer class. In regulatory proceedings, this process is often contentious, as each customer class seeks to pay less. This process makes it difficult for utilities to propose rate designs that shift revenues between different customer classes.

In redesigning rates to encourage energy efficiency, it is important to avoid unnecessarily or inadvertently shifting costs between customer classes. Rate design changes should instead focus on providing a good price signal for customer consumption decisions.

Promote Economic Efficiency for Cost-Effective Load Management

According to economic theory, the most efficient outcome occurs when prices are equal to marginal costs, resulting in the maximum societal net benefit from consumption.

Marginal Costs

Marginal costs are the *changes* in costs required to produce one additional unit of energy. In a period of rising marginal costs, rates based on marginal costs more realistically reflect the cost of serving different customers, and provide an incentive for more efficient use of resources (Bonbright, 1961; Kahn, 1970; Huntington, 1975; Joskow, 1976; Joskow, 1979).

A utility's marginal costs often include its costs of complying with local, state, and federal regulations (e.g., Clean Air Act), as well as any utility commission policies addressing the environment (e.g., the use of the societal test for benefit-cost assessments). Rate design based on the utility's marginal costs that promotes cost-effective energy efficiency will further increase environmental protection by reducing energy consumption.

Despite its theoretical attraction, there are significant barriers to fully implementing marginal-cost pricing in electricity, especially at the retail level. In contrast to other commodities, the necessity for generation to match load at all times means that outputs and production costs are constantly changing, and conveying these costs as real time "price signals" to customers, especially residential customers, can be complicated and add additional costs. Currently, about half of the nation's electricity customers are served by organized real-time electricity markets, which can help provide time-varying prices to customers by regional or local area.

Notwithstanding the recent price volatility, exacerbated by the 2005 hurricane season and current market conditions, wholesale natural gas prices are generally more stable than wholesale electricity prices, largely because of the ability to store natural gas. As a result, marginal costs have been historically a less important issue for natural gas pricing.

Short-Run Versus Long-Run Price Signals

There is a fundamental conflict between whether electricity and natural gas prices should reflect short-run or long-run marginal costs. In simple terms, short-run costs reflect the variable cost of production and delivery, while long-run costs also include the cost of capital expansion. For programs such as real-time pricing in electricity, short-run marginal costs are used for the price signals so they can induce efficient operating decisions on a daily or hourly basis.

Rates that reflect long-run marginal costs will promote economically efficient investment decisions in energy efficiency, because the long-run perspective is consistent with the long expected useful lives of most energy efficiency measures, and the potential for energy efficiency to defer costly capital investments. For demand-response and other programs intended to alter consumption on a daily or hourly basis, however, rates based on short-run

Applicability of Rate Design Issues

Implications for Clean Distributed Generation and Demand Response. The rate issues for energy efficiency also apply to clean distributed generation and demand response, with two exceptions. Demand response is focused on reductions in usage that occur for only a limited number of hours in a year, and occur at times that are not known far in advance (typically no more than one day notice, and often no more than a few hours notice). Because of the limited hours of operation, the revenue erosion from demand response is small compared to an energy efficiency measure. In addition, it could be argued that short-run, rather than long-run, costs are the appropriate cost metric to use in valuing and pricing demand response programs.

Public Versus Private Utilities. The rate issues are essentially the same for both public and private utilities. Revenue stability might be a lesser concern for public utilities, as they could approach their city leaders for rate changes. Frequent visits to council chambers for rate changes might be frowned upon, however, so revenue stability will likely remain important to many public utilities as well.

Gas Versus Electric. As discussed above, gas marginal costs are less volatile than electricity marginal costs, so providing prices that reflect marginal costs is generally less of a concern for the gas utilities. In addition, the nature of gas service does not lend itself to complicated rate forms such as those seen for some electricity customers. Nevertheless, gas utilities could implement increasing tier block rates, and/or seasonally differentiated rates to stimulate energy efficiency.

Restructured Versus Non-Restructured Markets. Restructuring has had a substantial impact on the funding, administration, and valuation of energy efficiency programs. It is no coincidence that areas with high retail electricity rates have been more apt to restructure their electricity markets. The higher rates increase the appeal of energy efficiency measures, and the entry of third-party energy service companies can increase customer interest and education regarding energy efficiency options. In a retail competition environment, however, there might be relatively little ratemaking flexibility. In several states, restructuring has created transmission and distribution-only utilities, so the regulator's ability to affect full electricity rates might be limited to distribution costs and rates for default service customers.

marginal cost might be more appropriate. Therefore, in developing retail rates, the goals of short-run and long-run marginal based pricing must be balanced.

Cost Causation

Using long-run marginal costs to design an energy-efficiency enhancing tariff can present another challenge—potential inconsistency with the cost-causation principle that a tariff should reflect the utility's various costs of serving a customer. This potential inconsistency diminishes in the long run, however, because over the long run, some costs that might be considered fixed in the near term (e.g., generation or transmission capacity, new interstate pipeline capacity or storage) are actually variable. Such costs can be reduced through sustained load reductions provided by energy efficiency investment, induced by appropriately designed marginal cost-based rates. Some costs of a utility do not vary with a customer's kWh usage (e.g., hookup and local distribution). As a result, a marginal cost-based rate design may necessarily include some fixed costs, which can be collected via a volumetric adder or a relatively small customer charge. However, utilities that set usage rates near long-run marginal costs will encourage energy efficiency and promote other social policy goals such as affordability for low-income and low-use customers whose bills might increase with larger, fixed charges. Hence, a practical implementation of marginal-cost based ratemaking should balance the trade-offs and competing goals of rate design.

Provide Stable Rates and Protect Low-Income Customers

Rate designs to promote energy efficiency must consider whether or not the change will lead to bill increases. Mitigating large bill increases for individual customers is a fundamental goal of rate design, and in some jurisdictions low-income customers are also afforded particular attention to ensure that they are not adversely affected by rate changes. In some cases, low-income customers are eligible for special rates or rate riders that protect them from large rate increases, as exemplified by the lifeline rates provision in Section 114 of the 1978 PURPA. Strategies to manage bill impacts include phasing-in rate changes to reduce the rate shock in any single year, creating exemptions for certain at-risk customer groups, and disaggregating customers into small customer groups to allow more targeted rate forms.

Because of the concern over bill impacts, new and innovative rates are often offered as voluntary rates. While improving acceptance, voluntary rate structures generally attract a relatively small percentage of customers (less than 20 percent) unless marketed heavily by the utility. Voluntary rates can lead to some "free riders," meaning customers who achieve bill reductions without changing their consumption behavior and providing any real savings to the utility. Rates to promote energy efficiency can be offered as voluntary, but the low participation and free rider issues should be taken into account in their design to ensure that the benefits of the consumption changes they encourage are at least as great as the resulting bill decreases.

Maintain Rate Simplicity

Economists and public policy analysts can become enamored with efficient pricing schemes, but customers generally prefer simple rate forms. The challenge for promoting energy efficiency is balancing the desire for rates that provide the right signals to customers with the need to have rates that customers can understand, and to which they can respond. Rate designs that are too complicated for customers to understand will not be effective at promoting efficient consumption decisions. Particularly in the residential sector, customers might pay more attention to the total bill than to the underlying rate design.

Addressing the Issues: Alternative Approaches

The prior sections listed the issues that stakeholders must balance in designing new rates. This section presents some traditional and non-traditional rate designs and discusses their merits for promoting energy efficiency. The alternatives described below vary by metering/billing requirement, information complexity, and ability to reflect marginal cost.[3]

Rate Design Options

Inclining Tier Block

Inclining tier block rates, also referred to as inverted block rates, have per-unit prices that increase for each successive block of energy consumed. Inclining tiered rates offer the advantages of being simple to understand and simple to meter and bill. Inclining rates can also meet the policy goal of protecting small users, which often include low-income customers. In fact, it was the desire to protect small users that prompted the initiation of increasing tiers in California. Termed "lifeline rates" at the time, the intention was to provide a small base level of electricity to all residential customers at a low rate, and charge the higher rate only to usage above that base level. The concept of lifeline rates continues in various forms for numerous services such as water and sewer services, and can be considered for delivery or commodity rates for electricity and natural gas. However, in many parts of the country, low-income customers are not necessarily low-usage customers, so a lifeline rate might not protect all low-income customers from energy bills.

[3] As part of its business model, a utility may use innovative rate options for the purpose of product differentiation. For example, advanced metering that enables a design with continuously time-varying rates can apply to an end-use (e.g., air conditioning) that is the main contributor to the utility's system peak. Another example is the bundling of sale of electricity and consumer devices (e.g., a 10-year contract for a central air conditioner whose price includes operation cost).

Tiered rates also provide a good fit for regions where the long-run marginal cost of energy exceeds the current average cost of energy. For example, regions with extensive hydroelectric resources might have low average costs, but their marginal cost might be set by much higher fossil plant costs or market prices (for purchase or export).

See Table 5-1 for additional utilities that offer inclining tier residential rates.

Time of Use (TOU)

TOU rates establish varying charges by season or time of day. Their designs can range from simple on- and off-peak rates that are constant year-round to more complicated rates with seasonally differentiated prices for several time-of-day periods (e.g., on-, mid- and off-peak). TOU rates have support from many utilities because of the flexibility to reflect marginal costs by time of delivery.

TOU rates are commonly offered as voluntary rates for residential electric customers,[4] and as mandatory rates for larger commercial and industrial customers. Part of the reason for TOU rates being applied primarily to larger users is the additional cost of TOU metering and billing, as well as the assumed greater ability of larger customers to shift their loads.

TOU rates are less applicable to gas rates, because the natural storage capability of gas mains allows gas utilities to procure supplies on a daily, rather than hourly, basis. Additionally, seasonal variations are captured to a large extent in costs for gas procurement, which are typically passed through to the customer. An area with constrained seasonal gas transportation capacity, however, could merit a higher distribution cost during the constrained season. Alternatively, a utility could recover a higher share of its fixed costs during the high demand season, because seasonal peak demand drives the sizing of the mains.

As TOU rates are typically designed to be revenue-neutral with the status quo rates, a high on-peak price will be accompanied by a low off-peak price. Numerous studies in electricity have shown that while the high on-peak prices do cause a reduction in usage during that period, the low off-peak prices lead to an increase in usage in the low-cost period. There has also been an

Table 5-1. Partial List of Utilities With Inclining Tier Residential Rates

Utility Name	State	Tariff URL
Florida Power and Light	FL	http://www.fpl.com/access/contents/how_to_read_your_bill.shtml
Consolidated Edison	NY	http://www.coned.com/documents/elec/201-210.pdf
Pacific Gas & Electric	CA	http://www.pge.com/res/financial_assistance/medical_baseline_life_support/understanding/index.html#topic4
Southern California Edison	CA	http://www.sce.com/NR/rdonlyres/728FFC8C-91FD-4917-909B-
Arizona Public Service Co	AZ	https://www.aps.com/my_account/RateComparer.html
Sacramento Municipal Util Dist	CA	http://www.smud.org/residential/rates.html
Indiana Michigan Power Co	MI	https://www.indianamichiganpower.com/global/utilities/tariffs/Michigan/MISTD1-31-06.pdf
Modesto Irrigation District	CA	http://www.mid.org/services/tariffs/rates/ums-d-residential.pdf
Turlock Irrigation District	CA	http://www.tid.org/Publisher_PDFs/DE.pdf
Granite State Electric Co	NH	http://www.nationalgridus.com/granitestate/home/rates/4_d.asp
Vermont Electric Cooperative, Inc	VT	http://www.vtcoop.com/PageViewer.aspx?PageName=Rates%20Summary
City of Boulder	NV	http://www.bcnv.org/utilities.html#electric,waterandsewer

4 For a survey of optional rates with voluntary participation, see Horowitz and Woo (2006).

"income effect" observed where people buy more energy as their overall bill goes down, due to switching consumption to lower price periods. The net effect might not be a significant decrease in total electricity usage, but TOU rates do encourage reduced usage when that reduction is the most valuable. Another important consideration with TOU prices is the environmental impact. Depending on generation mix and the diurnal emissions profile of the region, shifting consumption from the on-peak period to off-peak period might provide environmental net benefits.

The Energy Policy Act of 2005 Section 1252 requires states and non-regulated utilities, by August 8, 2007, to consider adopting a standard requiring electric utilities to offer all of their customers a time-based rate schedule such as time-of-use pricing, critical peak pricing, real-time pricing, or peak load reduction credits.

Dynamic Rates

Under a dynamic rate structure, the utility has the ability to change the cost or availability of power with limited, or no, notice. Common forms of dynamic rates include the following:

- Real-time pricing (RTP) rates vary continuously over time in a way that directly reflects the wholesale price of electricity.
- Critical peak pricing (CPP) rates have higher rates during periods designated as critical peak periods by the utility. Unlike TOU blocks, the days in which critical peaks occur are not designated in the tariff, but are designated on relatively short notice for a limited number of days during the year.
- Non-firm rates typically follow the pricing form of the otherwise applicable rates, but offer discounts or incentive payments for customers to curtail usage during times of system need (Horowitz and Woo, 2006). Such periods of system need are not designated in advance through the tariff, and the customer might receive little notice before energy supply is interrupted. In some cases, customers may be allowed to "buy through" periods when their supply will be interrupted by paying a higher energy charge (a non-compliance penalty). In those cases, the non-firm rate becomes functionally identical to CPP rates.

Dynamic rates are generally used to: 1) promote load shifting by large, sophisticated users, 2) give large users access to low "surplus energy" prices, or 3) reduce peak loads on the utility system. Therefore, dynamic rates are complementary to energy efficiency, but are more useful for achieving demand response during peak periods than reducing overall energy usage.

Two-Part Rates

Two-part rates refer to designs wherein a base level of customer usage is priced at rates similar to the status quo (Part 1) and deviations from the base level of usage are billed at the alternative rates (Part 2). Two-part rates are common among RTP programs to minimize the free rider problem. By implementing a two-part rate, customers receive the real time price only for their change in usage relative to their base level of usage. Without the two-part rate form, most low load-factor customers on rates with demand charges would see large bill reductions for moving to an RTP rate.

A two-part rate form, however, could also be combined with other rate forms that are more conducive to energy efficiency program adoption. For example, a two-part rate could be structured like an increasing tiered block rate, with the Tier 1 allowance based on the customer's historical usage. This structure would address many of the rate design barriers such as revenue stability. Of course, there would be implementation issues, such as determining what historical period is used to set Part 1, and how often that baseline is updated to reflect changes in usage. Also, new customers would need to be assigned an interim baseline.

Demand Charges

Demand charges bill customers based on their peak usage rather than their total usage during the month. For electricity, demand charges are based on usage during particular TOU periods (e.g., peak demand) or usage during any period in the month (e.g., maximum demand). Demand charges can also use a percentage of the highest demand over the prior year or prior season as a minimum demand level used for billing. For natural gas, demand can be based on the highest monthly usage over the past year or season.

For both gas and electricity, utilities prefer demand charges over volumetric charges because they provide greater revenue certainty, and encourage more consistent asset utilization. In contrast to a demand charge, a customer charge that covers more of a utility's fixed costs reduces profits from increased sales, and the utility disincentive to promote energy efficiency.

For energy efficiency programs, demand charges could help promote reductions in usage for those end uses that cause the customer's peak.[5] In general, however, volumetric rates are more favorable for energy efficiency promotion. Increasing the demand charges would reduce the magnitude of the price signal that could be sent through a volumetric charge.

Mechanisms Where Customer Benefits Are Not Driven by Tariff Savings

The rate design forms discussed above allow customers to benefit from energy efficiency through bill reductions; however, other types of programs provide incentives that are decoupled from the customer's retail rate.

Discount for Efficiency via Conservation Behavior

In some cases, energy efficiency benefits are passed on to customers through mechanisms other than retail rates. For example, in California the "20/20" program was implemented in 2001, giving customers a 20 percent rebate off their summer bills if they could reduce their electricity consumption by 20 percent compared to the summer period the prior year. The program's success was likely due to a combination of aggressive customer education, energy conservation behavior (reducing consumption through limiting usage of appliances and end-uses) and investment in energy efficiency. Pacific Gas & Electric (PG&E) has just implemented a similar program for natural gas, wherein customers can receive a rebate of 20 percent of their last winter's bill if they can reduce natural gas usage by 10 percent this winter season. The 20/20 program was popular and effective. It was easy for customers to understand, and there might be a psychological advantage to a program that gives you a rebate (a received reward), as opposed to one that just allows you to pay less than you otherwise would have (a lessened penalty). Applying this concept might require some adjustments to account for changes in weather or other factors.

Benefit Sharing

There are two types of benefit sharing with customers.[6] Under the first type of shared savings, a developer (utility or third party) installs an energy-saving device. The customer shares the bill savings with the developer until the customer's project load has been paid off. In the second type of shared savings, the utility is typically the developer and installs an energy efficiency or distributed generation device at the customer site. The customer then pays an amount comparable to what the bill would have been without the device or measures installed, less a portion of the savings of the device based on utility avoided costs. This approach decouples the customer benefits from the utility rate, but it can be complicated to determine what the consumption would have been without the device or energy efficiency.

PacifiCorp in Oregon tackled this problem by offering a cash payment of 35 percent of the cost savings for residential weatherization measures, where the cost savings was based on the measure's expected annual kWh savings and a schedule of lifecycle savings per kWh (PacifiCorp, 2002).

[5] Horowitz and Woo (2006) show that demand charges can be used to differentiate service reliability, thus implementing curtailable and interruptible service programs that are useful for meeting system resource adequacy.

[6] Note that benefit sharing is not the same as "shared savings," used in the context of utility incentives for promoting energy efficiency programs.

Table 5-2. Pros and Cons of Rate Design Forms

Program Type	Criteria				
	Avoided Cost Benefits and Utility Incentives	Energy and Peak Reductions	Customer Incentive and Bill Impact	Impact on Non-Participants	Implementation and Transition Issues
Increasing Tier Block (Inverted block) http://www.pge.com/tariffs/pdf/E-1.pdf http://www.sdge.com/tm2/pdf/DR.pdf http://www.sdge.com/tm2/pdf/GR.pdf	**Pro:** Good match when long-run marginal costs are above average costs. **Con:** Might not be the right price signal if long-run marginal costs are below average costs.	**Pro:** Can achieve annual energy reductions. **Con:** Does not encourage reductions in any particular period (unless combined with a time-based rate like TOU).	**Pro:** Provides strong incentive to reduce usage. **Con:** Could result in large bill increases for users that cannot change their usage level, and could encourage more usage by the smaller customers.	**Pro:** If mandatory, little impact on other customer classes. **Con:** Could not be implemented on a voluntary basis because of free rider losses.	**Pro:** Simple to bill with existing meters. **Con:** Could require phased transition to mitigate bill impacts.
Time of Use (TOU) http://www.nationalgridus.com/masselectric/home/rates/4_tou.asp	**Pro:** (1) Low implementation cost; (2) Tracks expected marginal costs. **Con:** Unclear if marginal costs should be short- or long-run.	**Pro:** Can achieve peak load relief. **Con:** Might not achieve substantial energy reductions or produce significant emissions benefits.	**Pro:** Provides customers with more control over their bills than flat rates, and incentive to reduce peak usage. **Con:** If mandatory, could result in large bill increases for users that cannot change their usage pattern.	**Pro:** If mandatory, little average impact, but can be large on some customers. **Con:** If optional, potentially large impact due to free riders, which can be mitigated by a careful design.	**Pro:** Extensive industry experience with TOU rate. **Con:** (1) If mandatory, likely opposed by customers, but not necessarily the utility; (2) If optional, opposed by non-participants and possibly the utility.
Dynamic Rates: Real Time Pricing (RTP) http://www.exeloncorp.com/comed/library/pdfs/advance_copy_tariff_revision6.pdf http://www.southerncompany.com/gulfpower/pricing/gulf_rates.asp?mnuOpco=gulf&mnuType=com&mnuItem=er#rates http://www.nationalgridus.com/niagaramohawk/non_html/rates_psc207.pdf	**Pro:** (1) Tracks day-ahead or day-of short-run marginal cost for economically efficient daily consumption decisions; (2) RTP rates can be set to help allocate capacity in an economically efficient manner during emergencies. **Con:** No long-run price signal for investment decisions.	**Pro:** Can achieve peak load relief. **Con:** (1) Not applicable to gas; (2) Might not achieve substantial annual energy reductions or produce significant emissions benefits.	Same as above.	Same as above.	**Con:** (1) If mandatory, likely opposed by customers and the utility due to complexity and implementation cost; (2) High implementation cost for metering and information system costs.
Dynamic Rates: Critical Peak Pricing (CPP) http://www.southerncompany.com/gulfpower/pricing/pdf/rsvp.pdf http://www.idahopower.com/aboutus/regulatoryinfo/tariffPdf.asp?id=263&.pdf http://www.pge.com/tariffs/pdf/E-3.pdf	**Pro:** (1) Tracks short-run marginal cost shortly before emergency; (2) If the CPP rates are set at correctly predicted marginal cost during emergency, they ration capacity efficiently. **Con:** High implementation cost.	**Pro:** Likely to achieve load relief. **Con:** Unlikely to provide significant annual energy reductions.	Same as above.	**Pro:** Little impact, unless the utility heavily discounts the rate for the non-critical hours.	**Con:** (1) If mandatory, likely opposed by customers and the utility due to high implementation cost; (2) If optional, few would object, unless the implementation cost spills over to other customer classes.

Table 5-2. Pros and Cons of Rate Design Forms *(continued)*

Program Type	Criteria				
	Avoided Cost Benefits and Utility Incentives	Energy and Peak Reductions	Customer Incentive and Bill Impact	Impact on Non-Participants	Implementation and Transition Issues
Dynamic Rates Nonfirm http://www.pacificorp.com/Regulatory_Rule_Schedule/Regulatory_Rule_Schedule2220.pdf	**Pro:** (1) Provides emergency load relief to support system reliability; (2) Implements efficient rationing. **Con:** (1) Does not track costs; (2) Potentially high implementation cost.	**Pro:** (1) Can achieve load reductions to meet system needs; (2) Applicable to both gas and electric service. **Con:** Unlikely to encourage investment in energy efficiency measures.	**Pro:** Bill savings compensate customer for accepting lower reliability.	**Pro:** Little impact, unless the utility offers a curtailable rate discount that exceeds the utility's expected cost savings.	**Pro:** (1) If optional, non-participants would not object unless discount is "excessive"; (2) If mandatory, different levels of reliability (at increasing cost) would need to be offered. **Con:** Complicated notice and monitoring requirements.
Two-Part Rates http://www.aepcustomer.com/tariffs/Michigan/pdf/MISTD4-28-05.pdf:	**Pro:** Allows rate to be set at utility avoided cost. **Con:** Requires establishing customer baseline, which is subject to historical usage, weather, and other factors.	**Pro:** Can be used to encourage or discourage peak usage depending on characteristics of "part two" rate form.	**Pro:** Provides incentives for changes in customer's usage. Therefore, no change in usage results in the same bill.	**Pro:** Non-participants are held harmless.	**Pro:** Complexity can be controlled through design of "part two" rate form. **Con:** (1) Customers might not be accustomed to the concept; (2) Difficult to implement for many smaller customers.
Demand Charges http://www.sce.com/NR/sc3/tm2/pdf/ce30-12.pdf	**Pro:** Reflects the customer's usage of the utility infrastructure. **Con:** Does not consider the duration of the usage (beyond 15 minutes or one hour for electric).	**Pro:** Can achieve load reductions. **Con:** Might not achieve substantial annual reductions.	**Pro:** Provides customers with incentive to reduce peak usage and flatten their usage profile. **Con:** If mandatory, could result in large bill increases for users who cannot change their usage pattern.	**Pro:** If mandatory, little average impact, but can be large on some customers. **Con:** If optional, potentially large impact due to free riders, but this can be mitigated by a careful design.	**Con:** (1) If mandatory, likely opposed by customers and the utility due to high implementation cost; (2) If optional, few would object, unless the implementation cost spills over to other customer classes.
Discount for Efficiency, Benefit Sharing, etc. http://www.cpuc.ca.gov/PUBLISHED/NEWS_RELEASE/51362.htm http://www.pacificorp.com/Regulatory_Rule_Schedule/Regulatory_Rule_Schedule7794.pdf	**Pro:** Incentive can be tied directly to avoided costs, without the need to change overall rate design. **Con:** Only a portion of the benefits are reflected in the incentive, as rate savings will still be a factor for most options.	**Pro:** Utilities generally have control over what measures are eligible for an incentive, so the mix of peak and energy savings can be determined during program design. **Con:** Impacts might be smaller than those attainable through mandatory rate programs.	**Pro:** (1) Provides direct incentive for program participation, plus ongoing bill reductions (for most options); (2) Does not require rate changes. **Con:** Existing rate forms might impede adoption because of overly low bill savings.	**Pro:** Reflects the characteristics of the underlying rate form.	**Pro:** Implementation simplified by the ability to keep status quo rates. **Con:** Places burden for action on the energy efficiency implementer, whereas a mandatory rate change could encourage customers to seek out efficiency options.
Energy Efficiency Customer Rebate Programs (e.g., 20/20 program in California) www.sce.com/RebatesandSavings/2020 www.sdge.com/tm2/pdf/20-20-TOU.pdf www.pge.com/tariffs/pdf/EZ-2020.pdf	**Pro:** Can avoid more drastic rationing mechanisms when resources are significantly constrained. **Con:** Customer discounts are not set based on utility cost savings, and therefore these programs might over-reward cutomers who qualify.	**Pro:** (1) Links payment of incentive directly to metered energy savings; (2) Easy to measure and verify. **Con:** Focused on throughput and not capacity savings.	**Pro:** (1) Provides a clear incentive to customers to reduce their energy usage, motivates customers, and gets them thinking about their energy usage; (2) Can provide significant bill savings; (3) Doesn't require customers to sign up for any program and can be offered to everyone.	**Con:** Shifts costs to non-participants to the extent that the rebate exceeds the change in utility cost.	**Pro:** Very successful during periods when public interest is served for short-term resource savings, (e.g. energy crisis.) **Con:** Implementation and effectiveness might be reduced after being in place for several years.

On-Bill Financing

The primary function of on-bill financing is to remove the barrier presented by the high first-time costs of many energy efficiency measures. On-bill financing allows the customer to pay for energy efficiency equipment over time, and fund those payments through bill savings. On-bill financing can also deliver financial benefits to the participants by providing them access to low financing costs offered by the utility. An example of on-bill financing is the "Pay As You Save" (PAYS) program, which provides upfront funding in return for a monthly charge that is always less than the savings.[7]

Pros and Cons of Various Designs

Rate design involves tradeoffs among numerous goals. Table 5-2 summarizes the pros and cons of the various rate design forms from various stakeholder perspectives, considering implementation and transition issues. In most cases, design elements can be combined to mitigate weaknesses of any single design element, so the table should be viewed as a reference and starting point.

Successful Strategies

Rate design is one of a number of factors that contribute to the success of energy efficiency programs. Along with rate design, it is important to educate customers about their rates so they understand the value of energy efficiency investment decisions. Table 5-3 shows examples of four states with successful energy efficiency programs and complementary rate design approaches. Certainly, one would expect higher rates to spur energy efficiency adoption, and that appears to be the case for three of the four example states. However, Washington has an active and cost-effective energy efficiency program, despite an average residential rate far below the national average of 10.3 cents per kWh. (EIA, 2006)

Table 5-3. Conditions That Assist Success

	California	Washington State	Massachusetts	New York
Rate Forms and Cost Structures	Increasing tier block rates for residential (PG&E, SCE, and SDG&E). Increasing block rate for residential gas (SDG&E). http://www.pge.com/tariffs/pdf/E-1.pdf http://www.sce.com/NR/sc3/tm2/pdf/ce12-12.pdf http://www.sdge.com/tm2/pdf/DR.pdf http://www.sdge.com/tm2/pdf/GR.pdf	Increasing tier block rates for residential electric (PacifiCorp). Gas rates are flat volumetric (Puget Sound Electric [PSE]). High export value for electricity, especially in the summer afternoon. http://www.pacificorp.com/Regulatory_Rule_Schedule/Regulatory_Rule_Schedule2205.pdf	Flat electricity rates per kWh with voluntary TOU rates for distribution service (Massachusetts Electric). http://www.nationalgridus.com/masselectric/non_html/rates_tariff.pdf	Increasing tier rates for residential (Consolidated Edison). http://www.coned.com/documents/elec/201-210.pdf
Resource and Load Characteristics	Summer electric peaks. Marginal resources are fossil units. High marginal cost for electricity, especially in the summer afternoon. Import transfer capability can be constrained. Winter gas peaks, although electric generation is flattening the difference. http://www.ethree.com/CPUC/E3_Avoided_Costs_Final.pdf	Winter peaking electric loads, but summer export opportunities. Heavily hydroelectric, so resource availability can vary with precipitation. Gas is winter peaking. http://www.nwcouncil.org/energy/powersupply/outlook.asp http://www.nwcouncil.org/energy/powerplan/plan/Default.htm http://www.pse.com/energyEnvironment/supplyPDFs/II--Summary%20Charts%20and%20Graphs.pdf	Part of Indpendant System Operator New England (ISO-NE), which is summer peaking. http://www.nepool.com/trans/celt/report/2005/2005_celt_report.pdf	High summer energy costs and capacity concerns in the summer for the New York City area. http://www.eia.doe.gov/cneaf/electricity/page/fact_sheets/newyork.html

[7] See http://www.paysamerica.org/.

Table 5-3. Conditions That Assist Success *(continued)*

	California	Washington State	Massachusetts	New York
Average Residential Electric Rates	13.7 cents/kWh (EIA, 2006)	6.7 cents/kWh (EIA, 2006)	17.6 cents/kWh (EIA, 2006)	15.7 cents/kWh (EIA, 2006)
Market and Utility Structure	Competitive electric generation and gas procurement. Regulated wires and pipes. http://www.energy.ca.gov/electricity/divestiture.html http://www.cpuc.ca.gov/static/energy/electric/ab57_briefing_assembly_may_10.pdf	Vertically integrated. http://www.wutc.wa.gov/webimage.nsf/63517e4423a08de988256576006a80bc/fe15f75d7135a7e28825657e00710928!OpenDocument	Competitive generation. Regulated wires. http://www.eia.doe.gov/cneaf/electricity/page/fact_sheets/mass.html	Competitive generation. Regulated wires. http://www.nyserda.org/sep/sepsection2-1.pdf
Political and Administrative Actors	Environmental advocacy in the past and desire to avoid another energy capacity crisis. Energy efficiency focuses on electricity. http://www.energy.ca.gov/2005publications/CEC-999-2005-015/CEC-999-2005-015.PDF http://www.energy.ca.gov/2005publications/CEC-999-2005-011/CEC-999-2005-011.PDF http://www.cpuc.ca.gov/PUBLISHED/NEWS_RELEASE/49757.htm http://www.cpuc.ca.gov/static/energy/electric/energy+efficiency/about.htm	Strong environmental commitment and desire to reduce susceptibility to market risks. http://www.nwenergy.org/news/news/news_conservation.html	DSM instituted as an alternative to new plant construction in the late 1980s and early 1990s (integrated resource management). Energy efficiency now under the oversight of Division of Energy Resources. http://www.mass.gov/Eoca/docs/doer/pub_info/ee-long.pdf	PSC established policy goals to promote competitive energy efficiency service and provide direct benefits to the people of New York. On 1/16/06, Governor George E. Pataki unveiled "a comprehensive, multi-faceted plan that will help reduce New York's dependence on imported energy." http://www.getenergysmart.org/AboutNYES.asp http://www.ny.gov/governor/press/06/0116062.html
Demand-Side Management (DSM) Funding	System benefits charge (SBC) and procurement payment. http://www.cpuc.ca.gov/static/energy/electric/energy+efficiency/ee_funding.htm	SBC. http://www.wutc.wa.gov/webimage.nsf/8d712cfdd4796c8888256aaa007e94b4/0b2e39343c0be04a88256a3b007449fe!OpenDocument	SBC. http://www.mass.gov/Eoca/docs/doer/pub_info/ee-long.pdf	SBC. http://www.getenergysmart.org/AboutNYES.asp

Part of Washington's energy efficiency efforts can be explained by the high value for power exports to California, and partly by the regional focus on promoting energy efficiency. Washington and the rest of the Pacific Northwest region place a high social value on environmental protection, so Washington might be a case where the success of energy efficiency is fostered by high public awareness, and the willingness of the public to look beyond the short-term out-of-pocket costs and consider the longer term impacts on the environment.

The other three states shown in Table 5-3 share the common characteristics of high residential rates, energy efficiency funded through a system benefits surcharge, and competitive electric markets. The formation of competitive electric markets could have also encouraged energy efficiency by: (1) establishing secure funding sources or energy efficiency agencies to promote energy efficiency, (2) increasing awareness of energy issues and risks regarding future energy prices, and (3) the entrance of new energy agents promoting energy efficiency.

Key Findings

This chapter summarizes the challenges and opportunities for employing rate designs to encourage utility promotion and customer adoption of energy efficiency. Key findings of this chapter include:

- Rate design is a complex process that balances numerous regulatory and legislative goals. It is important to recognize the promotion of energy efficiency in the balancing of objectives.

- Rate design offers opportunities to encourage customers to invest in efficiency where they find it to be cost-effective, and to participate in new programs that provide innovative technologies (e.g., smart meters) to help customers control their energy costs.

- Utility rates that are designed to promote sales or maximize stable revenues tend to lower the incentive for customers to adopt energy efficiency.

- Rate forms like declining block rates, or rates with large fixed charges reduce the savings that customers can attain from adopting energy efficiency.

- Appropriate rate designs should consider the unique characteristics of each customer class. Some general rate design options by customer class are listed below.

— *Residential.* Inclining tier block rates. These rates can be quickly implemented for all residential and small commercial and industrial electric and gas customers. At a minimum, eliminate declining tier block rates. As metering costs decline, also explore dynamic rate options for residential customers.

— *Small Commercial.* Time of use rates. While these rates might not lead to much change in annual usage, the price signals can encourage customers to consume less energy when energy is the most expensive to produce, procure, and deliver.

— *Large Commercial and Industrial.* Two-part rates. These rates provide bill stability and can be established so that the change in consumption through adoption of energy efficiency is priced at marginal cost. The complexity in establishing historical baseline quantities might limit the application of two-part rates to the larger customers on the system.

— *All Customer Classes.* Seasonal price differentials. Higher prices during the higher cost peak season encourage customer conservation during the peak and can reduce peak load growth. For example, higher winter rates can encourage the purchase of more efficient space heating equipment.

- Energy efficiency can be promoted through non-tariff mechanisms that reach customers through their utility bill. Such mechanisms include:

— *Benefit Sharing Programs.* Benefit sharing programs can resolve situations where normal customer bill savings are smaller than the cost of energy efficiency programs.

— *On-Bill Financing.* Financing support can help customers overcome the upfront costs of efficiency devices.

— *Energy Efficiency Rebate Programs.* Programs that offer discounts to customers who reduce their energy consumption, such as the 20/20 rebate program in California, offer clear incentives to customers to focus on reducing their energy use.

- More effort is needed to communicate the benefits and opportunities for energy efficiency to customers, regulators, and utility decision-makers.

Recommendations and Options

The National Action Plan for Energy Efficiency Leadership Group offers the following recommendations as ways to overcome many of the barriers to energy efficiency in rate design, and provides a number of options for consideration by utilities, regulators, and stakeholders *(as presented in the Executive Summary):*

Recommendation: Modify ratemaking practices to promote energy efficiency investments. Rate design offers opportunities to encourage customers to invest in efficiency where they find it to be cost-effective, and to participate in new programs that bring them innovative technologies (e.g., smart meters) to help them control their energy costs.

Options to Consider:

- Including the impact on adoption of energy efficiency as one of the goals of retail rate design, recognizing that it must be balanced with other objectives.
- Eliminating rate designs that discourage energy efficiency by not increasing costs as customers consume more electricity or natural gas.
- Adopting rate designs that encourage energy efficiency, considering the unique characteristics of each customer class, and including partnering tariffs with other mechanisms that encourage energy efficiency, such as benefit sharing programs and on-bill financing.

Recommendation: Broadly communicate the benefits of, and opportunities for, energy efficiency. Experience shows that energy efficiency programs help customers save money and contribute to lower cost energy systems. But these impacts are not fully documented nor recognized by customers, utilities, regulators and policymakers. More effort is needed to establish the business case for energy efficiency for all decision-makers, and to show how a well-designed approach to energy efficiency can benefit customers, utilities, and society by (1) reducing customers bills over time, (2) fostering financially healthy utilities (return on equity [ROE], earnings per share, debt coverage ratios unaffected), and (3) contributing to positive societal net benefits overall. Effort is also necessary to educate key stakeholders that, although energy efficiency can be an important low-cost resource to integrate into the energy mix, it does require funding just as a new power plant requires funding. Further, education is necessary on the impact that energy efficiency programs can have in concert with other energy efficiency policies such as building codes, appliance standards, and tax incentives.

Option to Consider:

- Communicating on the role of energy efficiency in lowering customer energy bills and system costs and risks over time.

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6: Energy Efficiency Program Best Practices

Energy efficiency programs have been operating successfully in some parts of the country since the late 1980s. From the experience of these successful programs, a number of best practice strategies have evolved for making energy efficiency a resource, developing a cost-effective portfolio of energy efficiency programs for all customer classes, designing and delivering energy efficiency programs that optimize budgets, and ensuring that programs deliver results.

Overview

Cost-effective energy efficiency programs have been delivered by large and small utilities and third-party program administrators in some parts of the country since the late 1980s. The rationale for utility investment in efficiency programming is that within certain existing markets for energy-efficient products and services, there are barriers that can be overcome to ensure that customers from all sectors of the economy choose more energy-efficient products and practices. Successful programs have developed strategies to overcome these barriers, in many cases partnering with industry and voluntary national and regional programs so that efficiency program spending is used not only to acquire demand-side resources, but also to accelerate market-based purchases by consumers.

Leadership Group Recommendations Applicable to Energy Efficiency Program Best Practices

- Recognize energy efficiency as a high priority energy resource.
- Make a strong, long-term commitment to cost-effective energy efficiency as a resource.
- Broadly communicate the benefits of, and opportunities for, energy efficiency.
- Provide sufficient and stable program funding to deliver energy efficiency where cost-effective.

A list of options for promoting best practice energy efficiency programs is provided at the end of this chapter.

Challenges that limit greater utility investment in energy efficiency include the following:

- The majority of utilities recover fixed operating costs and earn profits based on the volume of energy they sell. *Strategies for overcoming this throughput disincentive to greater investment in energy efficiency are discussed in Chapter 2: Utility Ratemaking & Revenue Requirements.*
- Lack of standard approaches on how to quantify and incorporate the benefits of energy efficiency into resource planning efforts, and institutional barriers at many utilities that stem from the historical business model of acquiring generation assets and building transmission and distribution systems. *Strategies for overcoming these challenges are addressed in Chapter 3: Incorporating Energy Efficiency in Resource Planning.*
- Rate designs that are counterproductive to energy efficiency might limit greater efficiency investment by large customer groups, where many of the most cost-effective opportunities for efficiency programming exist. *Strategies for encouraging rate designs that are compatible with energy efficiency are discussed in Chapter 5: Rate Design.*
- Efficiency programs need to address multiple customer needs and stakeholder perspectives while simultaneously addressing multiple system needs, in many cases while competing for internal resources. *This chapter focuses on strategies for making energy efficiency a resource, developing a cost-effective portfolio of energy efficiency programs for all customer classes, designing and delivering efficiency programs that optimize budgets, and ensuring that those programs deliver results are the focus of this chapter.*

Programs that have been operating over the past decade, and longer, have a history of proven savings in megawatts (MW), megawatt-hours (MWh), and therms, as well as on customer bills. These programs show that energy efficiency can compare very favorably to supply-side options.

This chapter summarizes key findings from a portfolio-level[1] review of many of the energy efficiency programs that have been operating successfully for a number of years. It provides an overview of best practices in the following areas:

- Political and human factors that have led to increased reliance on energy efficiency as a resource.
- Key considerations used in identifying target measures[2] for energy efficiency programming in the near- and long-term.
- Program design and delivery strategies that can maximize program impacts and increase cost-effectiveness.
- The role of monitoring and evaluation in ensuring that program dollars are optimized and that energy efficiency investments deliver results.

Background

Best practice strategies for program planning, design and implementation, and evaluation were derived from a review of energy efficiency programs at the portfolio level across a range of policy models (e.g., public benefit charge administration, integrated resource planning). The box on page 6-3 describes the policy models and Table 6-1 provides additional details and examples of programs operating under various policy models. This chapter is not intended as a comprehensive review of the energy efficiency programs operating around the country, but does highlight key factors that can help improve and accelerate energy efficiency program success. Organizations reviewed for this effort have a sustained history of successful energy efficiency program implementation (See Tables 6-2 and 6-3 for summaries of these programs) and share the following characteristics:

- Significant investment in energy efficiency as a resource within their policy context.
- Development of cost-effective programs that deliver results.
- Incorporation of program design strategies that work to remove near- and long-term market barriers to investment in energy efficiency.
- Willingness to devote the necessary resources to make programs successful.

Most of the organizations reviewed also have conducted full-scale impact evaluations of their portfolio of energy efficiency investments within the last few years.

The best practices gleaned from a review of these organizations can assist utilities, their commissions, state energy offices, and other stakeholders in overcoming barriers to significant energy efficiency programming, and begin tapping into energy efficiency as a valuable and clean resource to effectively meet future supply needs.

1 For the purpose of this chapter, *portfolio* refers to the collective set of energy efficiency programs offered by a utility or third-party energy efficiency program administrator.

2 *Measures* refer to the specific technologies (e.g., efficient lighting fixture) and practices (e.g., duct sealing) that are used to achieve energy savings.

Energy Efficiency Programs Are Delivered Within Many Policy Models

Systems Benefits Charge (SBC) Model

In this model, funding for programs comes from an SBC that is either determined by legislation or a regulatory process. The charge is usually a fixed amount per kilowatt-hour (kWh) or million British thermal units (MMBtu) and is set for a number of years. Once funds are collected by the distribution or integrated utility, programs can be administered by the utility, a state agency, or a third party. If the utility implements the programs, it usually receives current cost recovery and a shareholder incentive. Regardless of administrative structure, there is usually an opportunity for stakeholder input.

This model provides stable program design. In some cases, funding has become vulnerable to raids by state agencies. In areas aggressively pursuing energy efficiency as a resource, limits to additional funding have created a ceiling on the resource. While predominantly used in the electric sector, this model can, and is, being used to fund gas programs.

Integrated Resource Plan (IRP) Model

In this model, energy efficiency is part of the utility's IRP. Energy efficiency, along with other demand-side options, is treated on an equivalent basis with supply. Cost recovery can either be in base rates or through a separate charge. The utility might receive a shareholder incentive, recovery of lost revenue (from reduced sales volume), or both. Programs are driven more by the resource need than in the SBC models. This generally is an electric-only model. The regional planning model used by the Pacific Northwest is a variation on this model.

Request For Proposal (RFP) Model

In this case, a utility or an independent system operator (ISO) puts out a competitive solicitation RFP to acquire energy efficiency from a third-party provider to meet demand, particularly in areas where there are transmission and distribution bottlenecks or a generation need. Most examples of this model to date have been electric only. The focus of this type of program is typically on saving peak demand.

Portfolio Standard

In this model, the program adminstrator is subject to a portfolio standard expressed in terms of percentage of overall energy or demand. This model can include gas as well as electric, and can be used independently or in conjunction with an SBC or IRP requirement.

Municipal Utility/Electric Cooperative Model

In this model, programs are administered by a municipal utility or electric cooperative. If the utility/cooperative owns or is responsible for generation, the energy efficiency resource can be part of an IRP. Cost recovery is most likely in base rates. This model can include gas as well as electric.

Table 6-1. Overview of Energy Efficiency Programs

Policy Model/ Examples	Funding Type	Shareholder Incentive[1]	Lead Administrator	Role in Resource Acquisition	Scope of Programs	Political Context
SBC with utility implementation: • California • Rhode Island • Connecticut • Massachusetts	Separate charge	Usually	Utility	Depends on whether utility owns generation	Programs for all customer classes	Most programs of this type came out of a restructuring settlement in states where there was an existing infrastructure at the utilities
SBC with state or third-party implementation: • New York • Vermont • Wisconsin	Separate charge	No	State agency Third party	None or limited	Programs for all customer classes	Most programs of this type came out of a restructuring settlement
IRP or gas planning model: • Nevada • Arizona • Minnesota • Bonneville Power Administration (BPA) (regional planning model as well) • Vermont Gas • Keyspan	Varies: in rates, capitalized, or separate charge	In some cases	Utility	Integrated	Program type dictated by resource need	Part of IRP requirement; may be combined with other models
RFP model for full-scale programs and congestion relief	Varies	No	Utility buys from third party	Integrated – can be T&D only	Program type dictated by resource need	Connecticut and Con Edison going out to bid to reduce congestion
Portfolio standard model (can be combined with SBC or IRP): • Nevada • California • Connecticut • Texas	Varies	Varies	Utility may implement programs or buy to meet standard	Standard portfolio	Programs for all customer classes	Generally used in states with existing programs to increase program activity
Municipal utility & electric cooperative: • Sacramento Municipal Utility District (CA) • City of Austin (TX) • Great River Energy (MN)	In rates	No	Utility	Depends on whether utility owns generation	Programs for all customer classes	Based on customer and resource needs; can be similar to IRP model

[1] A shareholder incentive is a financial incentive to a utility (above those that would normally be recovered in a rate case) for achieving set goals for energy efficiency program performance.

Key Findings

Overviews of the energy efficiency programs reviewed for this chapter are provided in Table 6-2 and 6-3. Key findings drawn from these programs include:

- Energy efficiency resources are being acquired on average at about one-half the cost of the typical new power sources, and about one-third of the cost of natural gas supply in many cases—and contribute to an overall lower cost energy system for rate-payers (EIA, 2006).

- Many energy efficiency programs are being delivered at a total program cost of about $0.02 to $0.03 per lifetime kilowatt-hour (kWh) saved and $0.30 to $2.00 per lifetime million British thermal units (MMBtu) saved. These costs are less than the avoided costs seen in most regions of the country. Funding for the majority of programs reviewed ranges from about 1 to 3 percent of electric utility revenue and 0.5 to 1 percent of gas utility revenue.

- Even low energy cost states, such as those in the Pacific Northwest, have reason to invest in energy efficiency, as energy efficiency provides a low-cost, reliable resource that reduces customer utility bills. Energy efficiency also costs less than constructing new generation, and provides a hedge against market, fuel, and environmental risks (Northwest Power and Conservation Council, 2005).

- Well-designed programs provide opportunities for customers of all types to adopt energy savings measures and reduce their energy bills. These programs can help customers make sound energy use decisions, increase control over their energy bills, and empower them to manage their energy usage. Customers can experience significant savings depending on their own habits and the program offered.

- Consistently funded, well-designed efficiency programs are cutting electricity and natural gas load—providing annual savings for a given program year of 0.15 to 1 percent of energy sales. These savings typically will accrue at this level for 10 to 15 years. These programs are helping to offset 20 to 50 percent of expected energy growth in some regions without compromising end-user activity or economic well being.

- Research and development enables a continuing source of new technologies and methods for improving energy efficiency and helping customers control their energy bills.

- Many state and regional studies have found that pursuing economically attractive, but as yet untapped energy efficiency could yield more than 20 percent savings in total electricity demand nationwide by 2025. These savings could help cut load growth by half or more, compared to current forecasts. Savings in direct use of natural gas could similarly provide a 50 percent or greater reduction in natural gas demand growth. Potential varies by customer segment, but there are cost-effective opportunities for all customer classes.

- Energy efficiency programs are being operated successfully across many different contexts: regulated and unregulated markets; utility, state, or third-party administration; investor-owned, public, and cooperatives; and gas and electric utilities.

- Energy efficiency resources are being acquired through a variety of mechanisms including system benefits charges (SBCs), energy efficiency portfolio standards (EEPSs), and resource planning (or cost of service) efforts.

- Cost-effective energy efficiency programs for electricity and natural gas can be specifically targeted to reduce peak load.

- Effective models are available for delivering gas and electric energy efficiency programs to all customer classes. Models may vary based on whether a utility is in the initial stages of energy efficiency programming, or has been implementing programs for a number of years.

Table 6-2. Efficiency Measures of Natural Gas Savings Programs

Program Administrator	Keyspan (MA)	Vermont Gas (VT)	SoCal Gas (CA)
Policy Model	Gas	Gas	Gas
Period	2004	2004	2004
Program Funding			
Average Annual Budget ($MM)	12	1.1	21
% of Gas Revenue	1.00%	1.60%	0.53%
Benefits			
Annual MMBtu Saved [1] (000s MMBtu)	500	60	1,200
Lifetime MMBtu Saved [2] (000s MMBtu)	6,000	700	15,200
Cost-Effectiveness			
Cost of Energy Efficiency ($/lifetime MMBtu)	2	2	1
Retail Gas Prices ($/thousand cubic feet [Mcf])	11	9	8
Cost of Energy Efficiency (% Avoided Energy Cost)	19%	18%	18%
Total Avoided Cost (2005 $/MMBtu) [3]	12	11	7

[1] SWEEP, 2006; Southern California Gas Company, 2004.
[2] Lifetime MMBtu calculated as 12 times annual MMBtu saved where not reported (not reported for Keyspan or Vermont Gas).
[3] VT and MA avoided cost (therms) represents all residential (not wholesale) cost considerations (ICF Consulting, 2005).

- Energy efficiency programs, projects, and policies benefit from established and stable regulations, clear goals, and comprehensive evaluation.
- Energy efficiency programs benefit from committed program administrators and oversight authorities, as well as strong stakeholder support.
- Most large-scale programs have improved productivity, enabling job growth in the commercial and industrial sectors.
- Large-scale energy efficiency programs can reduce wholesale market prices.

Lessons learned from the energy efficiency programs operated since inception of utility programs in the late 1980s are presented as follows, and cover key aspects of energy efficiency program planning, design, implementation, and evaluation.

Summary of Best Practices

In this chapter, best practice strategies are organized and explained under four major groupings:

- Making Energy Efficiency a Resource
- Developing an Energy Efficiency Plan
- Designing and Delivering Energy Efficiency Programs
- Ensuring Energy Efficiency Investments Deliver Results

For the most part, the best practices are independent of the policy model in which the programs operate. Where policy context is important, it is discussed in relevant sections of this chapter.

Making Energy Efficiency a Resource

Energy efficiency is a resource that can be acquired to help utilities meet current and future energy demand. To realize this potential requires leadership at multiple levels, organizational alignment, and an understanding of the nature and extent of the energy efficiency resource.

- *Leadership* at multiple levels is needed to establish the business case for energy efficiency, educate key stakeholders, and enact policy changes that increase investment in energy efficiency as a resource. Sustained leadership is needed from:

— Key individuals in upper management at the utility who understand that energy efficiency is a resource alternative that can help manage risk, minimize long-term costs, and satisfy customers.

— State agencies, regulatory commissions, local governments and associated legislative bodies, and/or consumer advocates that expect to see energy efficiency considered as part of comprehensive utility management.

— Businesses that value energy efficiency as a way to improve operations, manage energy costs, and contribute to long-term energy price stability and availability, as well as trade associations and businesses, such as Energy Service Companies (ESCOs), that help members and customers achieve improved energy performance.

— Public interest groups that understand that in order to achieve energy efficiency and environmental objectives, they must help educate key stakeholders and find workable solutions to some of the financial challenges that limit acceptance and investment in energy efficiency by utilities.[3]

- *Organizational alignment.* With policies in place to support energy efficiency programming, organizations need to institutionalize policies to ensure that energy efficiency goals are realized. Factors contributing to success include:

— Strong support from upper management and one or more internal champions.

— A framework appropriate to the organization that supports large-scale implementation of energy efficiency programs.

— Clear, well-communicated program goals that are tied to organizational goals and possibly compensation.

— Adequate staff resources to get the job done.

— A commitment to continually improve business processes.

- *Understanding of the efficiency resource* is necessary to create a credible business case for energy efficiency. Best practices include the following:

— Conduct a "potential study" prior to starting programs to inform and shape program and portfolio design.

— Outline what can be accomplished at what costs.

— Review measures for all customer classes including those appropriate for hard-to-reach customers, such as low income and very small business customers.

Developing an Energy Efficiency Plan

An energy efficiency plan should reflect a long-term perspective that accounts for customer needs, program cost-effectiveness, the interaction of programs with other policies that increase energy efficiency, the opportunities for new technology, and the importance of addressing multiple system needs including peak load reduction and congestion relief. Best practices include the following:

- Offer programs for all key customer classes.
- Align goals with funding.

3 Public interest groups include environmental organizations such as the National Resources Defense Council (NRDC), Alliance to Save Energy (ASE), and American Council for an Energy Efficient Economy (ACEEE) and regional market transformation entities such as the Northeast Energy Efficiency Partnerships (NEEP), Southwest Energy Efficiency Project (SWEEP), and Midwest Energy Efficiency Alliance (MEEA).

Table 6-3. Efficiency Measures of Electric and Combination Programs

	NYSERDA (NY)	Efficiency Vermont (VT)	MA Utilities (MA)	WI Department of Administration[12]	CA Utilities (CA)
Policy Model	SBC w/State Admin	SBC w/3rd Party Admin	SBC w/Utility Admin	SBC w/State Admin	SBC w/Utility Admin & Portfolio Standard
Period	2005	2004	2002	2005	2004
Program Funding					
Spending on Electric Energy Efficiency ($MM) [1]	138	14	123	63	317
Budget as % of Electric Revenue [2]	1.3%	3.3%	3.0%	1.4%	1.5%
Avg Annual Budget Gas ($MM)	NR [10]	NA	3 [11]	NA	NA
% of Gas Revenue	NR [10]	NA	NA	NA	NA
Benefits					
Annual MWh Saved / MWh Sales [3,4]	0.2%	0.9%	0.4%	0.1%	1.0%
Lifetime MWh Saved [5] **(000s MWh)**	6,216	700	3,428	1,170	22,130
Annual MW Reduction	172	15	48	81	377
Lifetime MMBtu Saved [5] **(000s MMBtu)**	17,124	470	850	11,130	43,410
Annual MMBtu Saved (000s MMBtu)	1,427	40	70	930	3,620
Non-Energy Benefits	$79M bill reduction	37,200 CCF of water	$21M bill reduction 2,090 new jobs created	Value of non-energy benefits: Residential: $6M C/I: $36M	NR
Avoided Emissions (tons/yr for 1 program year) (could include benefits from load response, renewable, and DG programs)	NO_X: 470 SO_2: 850 CO_2: 400,000	Unspecified pollutants: 460,000 over lifetime	NO_X: 135 SO_2: 395 CO_2: 161,205	NO_X: 2,167 SO_2: 4,270 CO_2: 977,836 (annual savings from 5 program years)	NR
Cost-Effectiveness					
Cost of Energy Efficiency					
$/lifetime (kWh) [6]	0.02	0.02	0.03	0.05	0.01
$/lifetime (MMBtu)	NA	NA	0.32	NA	NA
Retail Electricity Prices ($/kWh)	0.13	0.11	0.11	0.07	0.13
Retail Gas Prices ($/mcf)	NA	NA	NR	NA	NA
Avoided Costs (2005$) [7,8]					
Energy ($/kWh)	0.03	0.07	0.07	0.02 to 0.06 [13]	0.06
Capacity ($/kW)[9]	28.20	3.62	6.64		
On-Peak Energy ($/kWh)			0.08		
Off-Peak Energy ($/kWh)			0.06		
Cost of Energy Efficiency as % Avoided Energy Cost	89%	29%	10%	90%	23%

C/I = Commercial and Industrial; CO_2 = Carbon Dioxide; $MM = Million Dollars; N/A = Not Applicable; NR = Not Reported; NO_X = Nitrogen Oxides; SO_2 = Sulfur Dioxide

1 NYSERDA 2005 spending derived from subtracting cumulative 2004 spending from cumulative 2005 spending; includes demand response and research and development (R&D).

2 ACEEE, 2004; Seattle City Light, 2005.

3 Annual MWh Saved averaged over program periods for Wisconsin and California Utilities. NYSERDA 2005 energy efficiency savings derived from subtracting cumulative 2004 savings from 2005 cumulative reported savings.

4 EIA, 2006; Austin Energy, 2004; Seattle City Light, 2005. Total sales for California Utilities in 2003 and SMUD in 2004 were derived based on growth in total California retail sales as reported by EIA.

5 Lifetime MWh savings based on 12 years effective life of installed equipment where not reported for NYSERDA, Wisconsin, Nevada, SMUD, BPA, and Minnesota. Lifetime MMBtu savings based on 12 years effective life of installed equipment.

Table 6-3. Efficiency Measures of Electric and Combination Programs (continued)

Nevada	CT Utilities (CT)	SMUD (CA)	Seattle City Light (WA)	Austin Energy	Bonneville Power Administration (ID, MT, OR, WA)	MN Electric and Gas Investor-Owned Utilities (MN)
IRP with Portfolio Standard	SBC w/Utility Admin & Portfolio Standard	Municipal Utility	Municipal Utility	Municipal Utility	Regional Planning	IRP and Conservation Improvement Program
2003	2005	2004	2004	2005	2004	2003
Program Funding						
11	65	30	20	25	78	52
0.5%	3.1%	1.5%	3.4%	1.9%	NR	NR
NA	NA	NA	NA	NA	NA	$14
NA	NA	NA	NA	NA	NA	0.50%
Benefits						
0.1%	1.0%	0.5%	0.7%	0.9%		0.5%
420	4,400	630	1,000	930	3,080	3,940
16	135	14	7	50	47.2	129
NA	NA	NA	NA	10,777	NA	22,010
NA	NA	NA	NA	1,268	NA	1,830
NR	lifetime savings of $550M on bills	NR	lifetime savings of $430M on bills created	Potentially over 900 jobs created Residential: $6M C/I: $36M	NR	NR
NR	NO_X: 334 SO_2: 123 CO_2: 198,586	NO_X: 18	CO_2: 353,100 (cummulative annual savings for 13 years)	NO_X: 640 SO_2: 104 CO_2: 680,000 over lifetime	NR	NR
Cost-Effectiveness						
0.03	0.01	0.03	0.02	0.03	0.03	0.01
NA	NA	NA	NA	2.32	NA	0.06
0.09	0.10	0.10	0.06	0.12	Wholesaler - NA	0.06
NA	NA	NA	NA	NA	NA	5.80
	0.07		NR	NR	Wholesaler - NA	NR
36.06	20.33					
		0.08				
		0.06				
Not calculated	21%	63%		Not calculated	Not calculated	Not calculated

6 Calculated for all cases except SMUD; SMUD data provided by J. Parks, Manager, Energy Efficiency and Customer R&D, Sacramento Municipal Utility District (personal communication, May 19, 2006).

7 Avoided cost reported as a consumption ($/kWh) not a demand (kW) figure.

8 Total NSTAR avoided cost for 2006.

9 Avoided capacity reported by NYSERDA as the three-year averaged hourly wholesale bid price per MWh.

10 NYSERDA does not separately track gas-related project budget, revenue, or benefits.

11 NSTAR Gas only.

12 Wisconsin has a portfolio that includes renewable distributed generation; some comparisons might not be appropriate.

13 Range based on credits given for renewable distributed generation.

- Use cost-effectiveness tests that are consistent with long-term planning.
- Consider building codes and appliance standards when designing programs.
- Plan to incorporate new technologies.
- Consider efficiency investments to alleviate transmission and distribution constraints.
- Create a roadmap of key program components, milestones, and explicit energy use reduction goals.

Designing and Delivering Energy Efficiency Programs

Program administrators can reduce the time to market and implement programs and increase cost-effectiveness by leveraging the wealth of knowledge and experience gained by other program administrators throughout the nation and working with industry to deliver energy efficiency to market. Best practices include the following:

- *Begin with the market in mind.*

— Conduct a market assessment.

— Solicit stakeholder input.

— Listen to customer and trade ally needs.

— Use utility channels and brands.

— Promote both energy and non-energy (e.g., improved comfort, improved air quality) benefits of energy efficient products and practices to customers.

— Coordinate with other utilities and third-party program administrators.

— Leverage the national ENERGY STAR program.

— Keep participation simple.

— Keep funding (and other program characteristics) as consistent as possible.

— Invest in education, training, and outreach.

— Leverage customer contact to sell additional efficiency and conservation.

- *Leverage private sector expertise, external funding, and financing.*

— Leverage manufacturer and retailer resources through cooperative promotions.

— Leverage state and federal tax credits and other tax incentives (e.g., accelerated depreciation, first-year expensing, sales tax holidays) where available.

— Build on ESCO and other financing program options.

— Consider outsourcing some programs to private and not-for-profit organizations that specialize in program design and implementation through a competitive bidding process.

- *Start with demonstrated program models—build infrastructure for the future.*

— Start with successful program approaches from other utilities and program administrators and adapt them to local conditions to accelerate program design and effective implementation.

— Determine the right incentives, and if incentives are financial, make sure that they are set at appropriate levels.

— Invest in educating and training the service industry (e.g., home performance contractors, heating and cooling technicians) to deliver increasingly sophisticated energy efficiency services.

— Evolve to more comprehensive programs.

— Change measures over time to adapt to changing markets and new technologies.

— Pilot test new program concepts.

Ensuring Energy Efficiency Investments Deliver Results

Program evaluation helps optimize program efficiency and ensure that energy efficiency programs deliver intended results. Best practices include the following:

- *Budget, plan and initiate* evaluation from the onset; formalize and document evaluation plans and processes.

- *Develop program and project tracking systems* that support evaluation and program implementation needs.

- *Conduct process evaluations* to ensure that programs are working efficiently.

- *Conduct impact evaluations* to ensure that mid- and long-term goals are being met.

- *Communicate evaluation results* to key stakeholders. Include case studies to make success more tangible.

Making Energy Efficiency a Resource

Energy efficiency programs are being successfully operated across many different contexts including electric and gas utilities; regulated and unregulated markets; utility, state, and third-party administrators; and investor-owned, public, and cooperatively owned utilities. These programs are reducing annual energy use by 0.15 to 1 percent at spending levels between 1 and 3 percent of electric, and 0.5 and 1.5 percent of gas revenues—and are poised to deliver substantially greater reductions over time. These organizations were able to make broader use of the energy efficiency resource in their portfolio by having:

- Leadership at multiple levels to enact policy change.

- Organizational alignment to ensure that efficiency goals are realized.

- A well-informed understanding of the efficiency resource including, the potential for savings and the technologies for achieving them.

Examples of leadership, organizational alignment, and the steps that organizations have taken to understand the nature and extent of the efficiency resource are provided in the next sections.

Leadership

Many energy efficiency programs reviewed in this chapter began in the integrated resource plan (IRP) era of the electric utilities of the 1980s. As restructuring started in the late 1990s, some programs were suspended or halted. In some cases (such as California, New York, Massachusetts, Connecticut, and Rhode Island), however, settlement agreements were reached that allowed restructuring legislation to move forward if energy efficiency programming was provided through the distribution utility or other third-party providers. In many cases, environmental advocates, energy service providers, and state agencies played active roles in the settlement process to ensure energy efficiency was part of the restructured electric utility industry. Other states (such as Minnesota, Wisconsin, and Vermont) developed legislation to address the need for stable energy efficiency programming without restructuring their state electricity markets. In addition, a few states (including California, Minnesota, New Jersey, Oregon, Vermont, and Wisconsin) enacted regulatory requirements for utilities or other parties to provide gas energy efficiency programs (Kushler, et al., 2003). Over the past few years, the mountain states have steadily ramped up energy efficiency programs.

In all cases, to establish energy efficiency as a resource required leadership at multiple levels:

- *Leadership* is needed to establish the business case for energy efficiency, educate key stakeholders, and enact policy changes that increase investment in energy efficiency as a resource. Sustained leadership is needed from:

— Key individuals in upper management at the utility who understand that energy efficiency is a resource alternative that can help manage risk, minimize long-term costs, and satisfy customers.

— State agencies, regulatory commissions, local governments and associated legislative bodies, and/or consumer advocates that expect to see energy efficiency considered as part of comprehensive utility management.

— Businesses that value energy efficiency as a way to improve operations, manage energy costs, and contribute to long-term energy price stability and availability, as well as trade associations and businesses, such as ESCOs, that help members and customers achieve improved energy performance.

– Public interest groups that understand that in order to achieve energy efficiency and environmental objectives, they must help educate key stakeholders and find workable solutions to some of the financial challenges that limit acceptance and investment in energy efficiency by utilities.

The following are examples of how leadership has resulted in increased investment in energy efficiency:

- In Massachusetts, energy efficiency was an early consideration as restructuring legislation was discussed. The Massachusetts Department of Public Utilities issued an order in D.P.U. 95-30 establishing principles to "establish the essential underpinnings of an electric industry structure and regulatory framework designed to minimize long-term costs to customers while maintaining safe and reliable electric service with minimum impact on the environment." Maintaining demand side management (DSM) programs was one of the major principles the department identified during the transition to a restructured electric industry. The Conservation Law Foundation, the Massachusetts Energy Efficiency Council, the National Consumer Law Center, the Division of Energy Resources, the Union of Concerned Scientists, and others took leadership roles in ensuring energy efficiency was part of a restructured industry (MDTE, 1995).

- Leadership at multiple levels led to significantly expanded programming of Nevada's energy efficiency program, from about $2 million in 2001 to an estimated $26 million to $33 million in 2006:

  "There are 'champions' for expanded energy efficiency efforts in Nevada, either in the state energy office or in the consumer advocate's office. Also, there have been very supportive individuals in key positions within the Nevada utilities. These individuals are committed to developing and implementing effective DSM programs, along with a supportive policy framework" (SWEEP, 2006).

  Public interest organizations, including SWEEP, also played an important role by promoting a supportive policy framework (see box on page 6-13, "Case Study: Nevada Efficiency Program Expansion" for additional information).

- Fort Collins City Council (Colorado) provides an example of local leadership. The council adopted the Electric Energy Supply Policy in March 2003. The Energy Policy includes specific goals for city-wide energy consumption reduction (10 percent per capita reduction by 2012) and peak demand reduction (15 percent per capita by 2012). Fort Collins Utilities introduced a variety of new demand-side management (DSM) programs and services in the last several years in pursuit of the energy policy objectives.

- Governor Huntsman's comprehensive policy on energy efficiency for the state of Utah, which was unveiled in April 2006, is one of the most recent examples of leadership. The policy sets a goal of increasing the state's energy efficiency by 20 percent by the year 2015. One key strategy of the policy is to collaborate with utilities, regulators, and the private sector to expand energy efficiency programs, working to identify and remove barriers, and assisting the utilities in ensuring that efficiency programs are effective, attainable, and feasible to implement.

Organizational Alignment

Once policies and processes are in place to spearhead increased investment in energy efficiency, organizations often institutionalize these policies to ensure that goals are realized. The most successful energy efficiency programs by utilities or third-party program administrators share a number of attributes. They include:

- Clear support from upper management and one or more internal champions.
- Clear, well-communicated program goals that are tied to organizational goals and, in some cases, compensation.
- A framework appropriate to the organization that supports large-scale implementation of energy efficiency programs.
- Adequate staff resources to get the job done.
- Strong regulatory support and policies.
- A commitment to continually improve business processes.

"Support of upper management is critical to program success" (Komor, 2005). In fact, it can make or break a program. If the CEO of a company or the lead of an agency is an internal champion for energy efficiency, it will be truly a part of how a utility or agency does business. Internal champions below the CEO or agency level are critical as well. These internal champions motivate their fellow employees and embody energy efficiency as part of the corporate culture.

Case Study: Nevada Efficiency Program Expansion

Nevada investor-owned utilities (IOUs), Nevada Power, and Sierra Pacific Power Company phased-out DSM programs in the mid-1990s. After 2001, when the legislature refined the state's retail electric restructuring law to permit only large customers (>1 megawatt [MW]) to purchase power competitively, utilities returned to a vertically integrated structure and DSM programs were restarted, but with a budget of only about $2 million that year.

As part of a 2001 IRP proceeding, a collaborative process was established for developing and analyzing a wider range of DSM program options. All parties reached an agreement to the IRP proceeding calling for $11.2 million per year in utility-funded DSM programs with an emphasis on peak load reduction but also significant energy savings. New programs were launched in March 2003.

In 2004, the Nevada public utilities commission also approved a new policy concerning DSM cost recovery, allowing the utilities to earn their approved rate of return plus 5 percent (e.g., a 15 percent return if the approved rate is 10 percent) on the equity-portion of their DSM program funding. This step gave the utilities a much greater financial incentive to expand their DSM programs.

In June 2005, legislation enacted in Nevada added energy savings from DSM programs to the state's Renewable Portfolio Standard. This innovative policy allows energy savings from utility DSM programs and efficiency measures acquired through contract to supply up to 25 percent of the requirements under the renamed clean energy portfolio standard. The clean energy standard is equal to 6 percent of electricity supply in 2005 and 2006 and increases to 9 percent in 2007 and 2008, 12 percent from 2009 to 2010, 15 percent in 2011 and 2012, 18 percent in 2013 and 2014, and 20 percent in 2015 and thereafter. At least half of the energy savings credits must come from electricity savings in the residential sector.

Within months of passage, the utilities proposed a large expansion of DSM programs for 2006. In addition to the existing estimated funding of $26 million, the Nevada utilities proposed adding another $7.5 million to 2006 DSM programs. If funding is approved, the Nevada utilities estimate the 2006 programs alone will yield gross energy savings of 153 gigawatt-hours/yr and 63 MW (Larry Holmes, personal communication, February 28, 2006).

Source: Geller, 2006.

Tying energy efficiency to overall corporate goals and compensation is important, particularly when the utility is the administrator of energy efficiency programs. Ties to corporate goals make energy efficiency an integral part of how the organization does business as exemplified below:

- Bonneville Power Administration (BPA) includes energy efficiency as a part of its overall corporate strategy, and its executive compensation is designed to reflect how well the organization meets its efficiency goals. BPA's strategy map states, "Development of all cost-effective energy efficiency in the loads BPA serves facilitates development of regional renewable resources, and adopts cost-effective non-construction alternatives to transmission expansion" (BPA, 2004).

- National Grid ties energy efficiency goals to staff and executive compensation (P. Arons, personnel communication, June 15, 2006).

- Sacramento Municipal Utility District (SMUD) ties energy efficiency to its reliability goal: "To ensure a reliable energy supply for customers in 2005, the 2005 budget includes sufficient capacity reserves for the peak summer season. We have funded all of the District's commercial and residential load management programs, and on-going efficiency programs in Public Good to continue to contribute to peak load reduction" (SMUD, 2004a).

- Nevada Power's Conservation Department had a "Performance Dashboard" that tracks costs, participating customers, kWh savings, kW savings, $/kWh, $/kW, customer contribution to savings, and total customer costs on a real time basis, both by program and overall.

- Austin Energy's Mission Statement is "to deliver clean, affordable, reliable energy and excellent customer services" (Austin Energy, 2004).

- Seattle City Light has actively pursued conservation as an alternative to new generation since 1977 and has tracked progress toward its goals (Seattle City Light, 2005). Its longstanding, resolute policy direction establishes energy conservation as the first choice resource. In more recent years, the utility has also been guided by the city's policy to meet of all the utility's future load growth with conservation and renewable resources (Steve Lush, personal communication, June 2006).

From Pacific Gas and Electric's (PG&E's) Second Annual Corporate Responsibility Report (2004):

"One of the areas on which PG&E puts a lot of emphasis is helping our customers use energy more efficiently."

"For example, we plan to invest more than $2 billion on energy efficiency initiatives over the next 10 years. What's exciting is that the most recent regulatory approval we received on this was the result of collaboration by a large and broad group of parties, including manufacturers, customer groups, environmental groups, and the state's utilities."

— Beverly Alexander, Vice President,
Customer Satisfaction, PG&E

Having an appropriate framework within the organization to ensure success is also important. In the case of the utility, this would include the regulatory framework that supports the programs, including cost recovery and potentially shareholder incentives and/or decoupling. For a third-party administrator, an appropriate framework might include a sound bidding process by a state agency to select the vendor or vendors and an appropriate regulatory arrangement with the utilities to manage the funding process.

Adequate resources also are critical to successful implementation of programs. Energy efficiency programs need to be understood and supported by departments outside those that are immediately responsible for program delivery. If information technology, legal, power supply, transmission, distribution, and other departments do not share and support the energy efficiency goals and programs, it is difficult for energy efficiency programs to succeed. When programs are initiated, the need for support from other departments is greatest. Support from other departments needs to be considered in planning and budgeting processes.

As noted in the Nevada case study, having a shareholder incentive makes it easier for a utility to integrate efficiency goals into its business because the incentive offsets some of the concerns related to financial treatment of program expenses and potential lost revenue from decreased sales. For third-party program administrators, goals might be built into the contract that governs the overall implementation of the programs. For example, Efficiency Vermont's contract with the Vermont Department of Public Service Board has specific performance targets. An added shareholder return will not motivate publicly and cooperatively owned utilities, though they might appreciate reduced risks from exposure to wholesale markets, and the value added in improved customer service. SMUD, for example, cites conservation programs as a way to help customers lower their utility bills (SMUD, 2004b). These companies, like IOUs, can link employee compensation to achieving energy efficiency targets.

Business processes for delivering energy efficiency programs and services to customers should be developed and treated like other business processes in an organization and reviewed on a regular basis. These processes should include documenting clear plans built on explicit assumptions, ongoing monitoring of results and plan inputs (assumptions), and regular reassessment to improve performance (using improved performance itself as a metric).

Understanding the Efficiency Resource

Energy efficiency potential studies provide the initial justification (the business case) for utilities embarking on or expanding energy efficiency programs, by providing information on (1) the overall potential for energy efficiency and (2) the technologies, practices, and sectors with the greatest or most cost-effective opportunities for achieving that potential. Potential studies illuminate the nature of energy efficiency resource, and can be used by legislators and regulators to inform efficiency policy and programs. Potential studies can usually be completed in three to eight months, depending on the level of detail, availability of data, and complexity. They range in cost from $100,000 to $300,000 (exclusive of primary data collection). Increasingly, many existing studies can be drawn from to limit the extent and cost of such an effort.

The majority of organizations reviewed in developing this chapter have conducted potential studies in the past five years. In addition, numerous other studies have been conducted in recent years by a variety of organizations interested in learning more about the efficiency resource in their state or region. Table 6-4 summarizes key findings for achievable potential (i.e., what can realistically be achieved from programs within identified funding parameters), by customer class, from a selection of these studies. It also illustrates that this potential is well represented across the residential, commercial, and industrial sectors. The achievable estimates presented are for a future time period, are based on realistic program scenarios, and represent potential program impacts above and beyond naturally occurring conservation. Energy efficiency potential studies are based on currently available technologies. New technologies such as those discussed in Table 6-9 will continuously and significantly increase potential over time.

The studies show that achievable potential for reducing overall energy consumption ranges from 7 to 32 percent for electricity and 5 to 19 percent for gas, and that demand for electricity and gas can be reduced by about 0.5 to 2 percent per year. For context, national electricity consumption is projected to grow by 1.6 percent per year, and gas consumption is growing 0.7 percent per year (EIA, 2006a).

The box on page 6-17, "Overview of a Well-Designed Potential Study" provides information on key elements of a potential study. Related best practices for efficiency programs administrators include:

- Conducting a "potential study" prior to starting programs.
- Outlining what can be accomplished at what cost.
- Reviewing measures appropriate to all customer classes including those appropriate for hard-to-reach customers, such as low income and very small business customers.

Table 6-4. Achievable Energy Efficiency Potential From Recent Studies

State/Region	Study Length (Years)	Achievable Demand Reduction (MW)			Achievable Gas Consumption Reduction (MMBtu)			Achievable GWh Reduction			Demand Savings as % of 2004 State Nameplate Capacity [10]	Annual % MW Savings	Electricity Savings as % of Total 2004 State Usage [11]	Annual % GWh Savings	Gas Savings as % of Total 2004 State Usage[12]	Annual % MMBtu Savings
		Residential	Commercial	Industrial	Residential	Commercial	Industrial	Residential	Commercial	Industrial	Electricity		Electricity		Gas	
U.S. (Clean Energy Future) [1]	20	n/a	n/a	n/a	500,000,000	300,000,000	1,400,000,000	392,732	281,360	292,076	n/a	n/a	24%	1.2%	10%	0.5%
Con Edison [2]	10	n/a	n/a	n/a	11,396,700	10,782,100	231,000	n/a	n/a	n/a	n/a	n/a	n/a	n/a	19%	1.9%
Pacific NW [3]	20	n/a	n/a	n/a	n/a	n/a	n/a	11,169	9,715	5,011	n/a	n/a	12.5%	0.6%	n/a	n/a
Puget Sound [4]	20	133	148	16	n/a	n/a	n/a	1,169	1,293	139	9.3%	0.5%	9.5%	0.5%	n/a	n/a
Connecticut [5]	8	240	575	93	n/a	n/a	n/a	1,655	2,088	723	12.5%	1.6%	13.4%	1.7%	n/a	n/a
California [6]	9	1,800	2,600	1,550	27,500,000	20,600,000	-	9,200	11,900	8,800	9.6%	1.1%	11.8%	1.3%	10%	1.1%
Southwest [7]	17	n/a	n/a	n/a	n/a	n/a	n/a	24,593	50,291	-	n/a	n/a	32.8%	1.9%	n/a	n/a
New York [8]	19	3,584	8,180	602	n/a	n/a	n/a	15,728	2,948	8,180	23.1%	1.2%	14.3%	0.8%	n/a	n/a
Illinois [9]	17	n/a	n/a	n/a	n/a	n/a	n/a	-	-	67,000	n/a	n/a	43.2%	2.5%	n/a	n/a
										AVERAGE:		**1.1%**		**1.3%**		**1.2%**

MW = Megawatt; MMBtu = Million British thermal units.

[1] ORNL, 2000.
[2] NYSERDA/OE, 2006.
[3] NPCC, 2005.
[4] Puget Sound Energy, 2003.
[5] GDS Associates and Quantum Consulting, 2004.
[6] KEMA, 2002; KEMA & XENERGY, 2003a; KEMA & XENERGY, 2003b.
[7] SWEEP, 2002.
[8] NYSERDA/OE, 2003.
[9] ACEEE, 1998.
[10] EIA, 2005a.
[11] EIA, 2005b.
[12] EIA, 2006b.

Overview of a Well-Designed Potential Study

Well-designed potential studies assess the following types of potential:

Technical potential assumes the complete penetration of all energy-conservation measures that are considered technically feasible from an engineering perspective.

Economic potential refers to the technical potential of those measures that are cost-effective, when compared to supply-side alternatives. The economic potential is very large because it is summing up the potential in existing equipment, without accounting for the time period during which the potential would be realized.

Maximum achievable potential describes the economic potential that could be achieved over a given time period under the most aggressive program scenario.

Achievable potential refers to energy saved as a result of specific program funding levels and incentives. These savings are above and **beyond those that would occur naturally** in the absence of any market intervention.

Naturally occurring potential refers to energy saved as a result of normal market forces, that is, in the absence of any utility or governmental intervention.

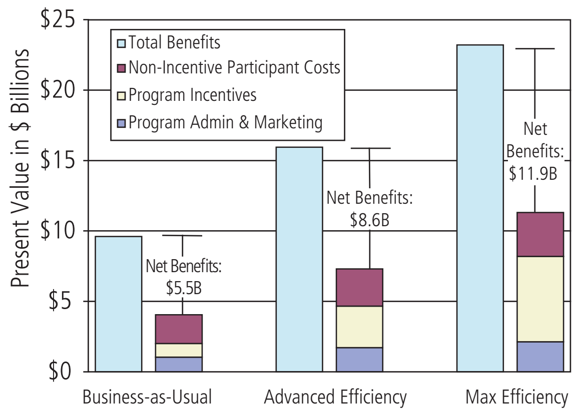
The output of technical and economic potential is the size of the energy efficiency resource in MW, MWh, MMBtu and other resources. The potential is built up from savings and cost data from hundreds of measures and is typically summarized by sector using detailed demographic information about the customer base and the base of appliances, building stock, and other characteristics of the relevant service area.

After technical and economic potential is calculated, typically the next phase of a well-designed potential study is to create program scenarios to estimate actual savings that could be generated by programs or other forms of intervention, such as changing building codes or appliance standards.

Program scenarios developed to calculate achievable potential are based on modeling example programs and using market models to estimate the penetration of the program. Program scenarios require making assumptions about rebate or incentive levels, program staffing, and marketing efforts.

Scenarios can also be developed for different price assumptions and load growth scenarios, as shown below in the figure of a sample benefit/cost output from a potential study conducted for the state of California.

Benefits and Costs of Electric Energy Efficiency Savings, 2002-2011



Source: KEMA, 2002

- Ensuring that potential state and federal codes and standards are modeled and included in evaluation scenarios
- Developing scenarios for relevant time periods.

In addition, an emerging best practice is to conduct uncertainty analysis on savings estimates, as well as other variables such as cost.

With study results in hand, program administrators are well positioned to develop energy efficiency goals, identify program measures and strategies, and determine funding requirements to deliver energy efficiency programs to all customers. Information from a detailed potential study can also be used as the basis for calculating program cost-effectiveness and determining measures for inclusion during the program planning and design phase. Detailed potential studies can provide information to help determine which technologies are replaced most frequently and are therefore candidates to deliver early returns (e.g., an efficient light bulb), and how long the savings from various technologies persist and therefore will continue to deliver energy savings. For example, an energy efficient light bulb might last six years, whereas an efficient residential boiler might last 20 years. (Additional information on measure savings and lifetimes can be found in *Resources and Expertise*, a forthcoming product of the Action Plan Leadership Group.)

Developing an Energy Efficiency Plan

The majority of organizations reviewed for this chapter are acquiring energy efficiency resources for about \$0.03/lifetime kWh for electric programs and about \$1.30 to \$2.00 per lifetime MMBtu for gas program (as shown previously in Tables 6-1 and 6-2). In many cases, energy efficiency is being delivered at a cost that is substantially less than the cost of new supply—on the order of half the cost of new supply. In addition, in all cases where information is available, the costs of saved energy are less than the avoided costs of energy. These organizations operate in diverse locations under different administrative and regulatory structures. They do, however, share many similar best practices when it comes to program planning, including one or more of the following:

- Provide programs for all key customer classes.
- Align goals with funding.
- Use cost-effectiveness tests that are consistent with long-term planning.
- Consider building codes and appliance standards when designing programs.
- Plan for developing and incorporating new technology.
- Consider efficiency investments to alleviate transmission and distribution constraints.
- Create a roadmap that documents key program components, milestones, and explicit energy reduction goals.

Provide Programs for All Customer Classes

One concern sometimes raised when funding energy efficiency programs is that all customers are required to contribute to energy efficiency programming, though not all customers will take advantage of programs once they are available, raising the issue that non-participants subsidize the efficiency upgrades of participants.

While it is true that program participants receive the direct benefits that accrue from energy efficiency upgrades, all customer classes benefit from well-managed energy efficiency programs, regardless of whether or not they participate directly. For example, an evaluation of the New York State Energy Research and Development Authority's (NYSERDA's) program portfolio concluded that: "total cost savings for all customers, including non participating customers [in the New York Energy $mart Programs] is estimated to be \$196 million for program activities through year-end 2003, increasing to \$420 to \$435 million at full implementation" (NYSERDA, 2004).

In addition, particularly for programs that aim to accelerate market adoption of energy efficiency products or services, there is often program "spillover" to non-program participants. For example, an evaluation of National Grid's Energy Initiative, Design 2000plus, and other small commercial and industrial programs found energy efficient measures were installed by non-participants due to program influences on design professionals and vendors. The analysis indicated that "non-participant spillover from the programs amounted to 12,323,174 kWh in the 2001 program year, which is approximately 9.2 percent of the total savings produced in 2001 by the Design 2000plus and Energy Initiative programs combined" (National Grid, 2002).

Furthermore, energy efficiency programming can help contribute to an overall lower cost system for all customers over the longer term by helping avoid the need to purchase energy, or the need to build new infrastructure such as generation, transmission and distribution lines. For example:

- The Northwest Power Planning and Conservation Council found in its Portfolio Analysis that strategies that included more conservation had the least cost and the least risk (measured in dollars) relative to strategies that included less conservation. The most aggressive conservation case had an expected system cost of $1.8 billion lower and a risk factor of $2.5 billion less than the strategy with the least conservation (NPPC, 2005).

- In its 2005 analysis of energy efficiency and renewable energy on natural gas consumption and price, ACEEE states, "It is important to note that while the direct benefits of energy efficiency investment flow to participating customers, the benefits of falling prices accrue to all customers." Based on their national scenario of cost-effective energy efficiency opportunities, ACEEE found that total costs for energy efficiency would be $8 billion, and would result in consumer benefits of $32 billion in 2010 (Elliot & Shipley, 2005).

- Through cost-effective energy efficiency investments in 2004, Vermonters reduced their annual electricity use by 58 million kWh. These savings, which are expected to continue each year for an average of 14 years, met 44 percent of the growth in the state's energy needs in 2004 while costing ratepayers just 2.8 cents per kWh. That cost is only 37 percent of the cost of generating, transmitting, and distributing power to Vermont's homes and businesses (Efficiency Vermont, 2004).

- The Massachusetts Division of Energy noted that cumulative impact on demand from energy efficiency measures installed from 1998 to 2002 (excluding reductions from one-time interruptible programs) was significant—reducing demand by 264 megawatt (MW). During the summer of 2002, a reduction of this magnitude meant avoiding the need to purchase $19.4 million worth of electricity from the spot market (Massachusetts, 2004).

Despite evidence that both program participants and non-participants can benefit from energy efficiency programming, it is a best practice to provide program opportunities for all customer classes and income levels. This approach is a best practice because, in most cases, funding for efficiency programs comes from all customer classes, and as mentioned above, program participants will receive both the indirect benefits of system-wide savings and reliability enhancements and the direct benefits of program participation.

All program portfolios reviewed for this chapter include programs for all customer classes. Program administrators usually strive to align program funding with spending based on customer class contributions to funds. It is not uncommon, however, to have limited cross-subsidization for (1) low-income, agricultural, and other hard-to-reach customers; (2) situations where budgets limit achievable potential, and the most cost-effective energy efficiency savings are not aligned with customer class contributions to energy efficiency funding; and (3) situations where energy efficiency savings are targeted geographically based on system needs—for example, air conditioner turn-ins or greater new construction incentives that are targeted to curtail load growth in an area with a supply or transmission and distribution need. For programs targeting low-income or other hard-to-reach customers, it is not uncommon for them to be implemented with a lower benefit-cost threshold, as long as the overall energy efficiency program portfolio for each customer class (i.e., residential, commercial, and industrial) meets cost-effectiveness criteria.

NYSERDA's program portfolio is a good example of programs for all customer classes and segments (see Table 6-5).

Table 6-5. NYSERDA 2004 Portfolio

Sector	Program	% of Sector Budget
Residential	Small Homes	23%
	Keep Cool	19%
	ENERGY STAR Products	20%
	Program Marketing	16%
	Multifamily	10%
	Awareness/Other	12%
Low Income	Assisted Multifamily	59%
	Assisted Home Performance	17%
	Direct Install	8%
	All Other	16%
Business	Performance Contracting	36%
	Peak Load Reduction	12%
	Efficient Products	9%
	New Construction	23%
	Technical Assistance	10%
	All Other	10%

Nevada Power/Sierra Pacific Power Company's portfolio provides another example with notable expansion of program investments in efficient air conditioning, ENERGY STAR appliances, refrigerator collection, and renewable energy investments within a one-year timeframe (see Table 6-6).

Align Goals With Funding

Regardless of program administrative structure and policy context, it is a best practice for organizations to align funding to explicit goals for energy efficiency over the near-term and long-term. How quickly an organization is able to ramp up programs to capture achievable potential can vary based on organizational history of running DSM programs, and the sophistication of the marketplace in which a utility operates (e.g., whether there is a network of home energy raters, ESCOs, or certified heating, ventilation, and air conditioning [HVAC] contractors).

Utilities or third-party administrators should set long-term goals for energy efficiency designed to capture a significant percentage of the achievable potential energy savings identified through an energy efficiency potential study. Setting long-term goals is a best practice for administrators of energy efficiency program portfolios, regardless of policy models and whether they are an investor-owned or a municipal or cooperative utility, or a third-party program administrator. Examples of how long-term goals are set are provided as follows:

- In states where the utility is responsible for integrated resource planning (the IRP Model), energy efficiency must be incorporated into the IRP. This process generally requires a long-term forecast of both spending and savings for energy efficiency at an aggregated level that is consistent with the time horizon of the IRP—generally at least 10 years. Five- and ten-year goals can then be developed based on the resource need. In states without an SBC, the budget for energy efficiency is usually a revenue requirement expense item, but can be a capital investment or a combination of the two. (As discussed in Chapter 2: Utility Ratemaking & Revenue Requirements, capitalizing efficiency program investments rather than expensing them can reduce short-term rate impacts.)

- Municipal or cooperative utilities that own generation typically set efficiency goals as part of a resource planning process. The budget for energy efficiency is usually a revenue requirement expense item, a capital expenditure, or a combination of the two.

Table 6-6. Nevada Resource Planning Programs

	2005 Budget	2006 Budget
Air Conditioning Load Management	$3,450,000	$3,600,000
High-Efficiency Air Conditioning	2,600,000	15,625,000
Commercial Incentives	2,300,000	2,800,000
Low-Income Support	1,361,000	1,216,000
Energy Education	1,205,000	1,243,000
ENERGY STAR Appliances	1,200,000	2,050,000
School Support	850,000	850,000
Refrigerator Collection	700,000	1,915,000
Commercial New Construction	600,000	600,000
Other – Miscellaneous & Technology	225,000	725,000
Total Nevada Resource Planning Programs	$14,491,000	$30,624,000
SolarGenerations	1,780,075	7,220,000
Company Renewable – PV	1,000,000	1,750,000
California Program	370,000	563,000
Sierra Natural Gas Programs	—	820,000
Total All Programs	$17,641,075	$40,977,000

- A resource portfolio standard is typically set at a percentage of overall energy or demand, with program plans and budgets developed to achieve goals at the portfolio level. The original standard can be developed based on achievable potential from a potential study, or as a percentage of growth from a base year.

- In most SBC models, the funding is determined by a small volumetric charge on each customer's utility bill. This charge is then used as a basis for determining the overall budget for energy efficiency programming—contributions by each customer class are used to inform the proportion of funds that should be targeted to each customer class. Annual goals are then based on these budgets and a given program portfolio. Over time, the goal of the program should be to capture a large percentage of achievable potential.

- In most gas programs, funding can be treated as an expense, in a capital budget, or a combination (as is the case in some of the electric examples shown previously). Goals are based on the budget developed for the time period of the plan.

Once actual program implementation starts, program experience is usually the best basis for developing future budgets and goals for individual program years.

Use Cost-Effectiveness Tests That Are Consistent With Long-Term Planning

All of the organizations reviewed for this chapter use cost-effectiveness tests to ensure that measures and programs are consistent with valuing the benefits and costs of their efficiency investments relative to long-term supply options. Most of the organizations reviewed use either the total resource cost (TRC), societal, or program administrator test (utility test) to screen measures. None of the organizations reviewed for this chapter used the rate impact measure (RIM) test as a primary decision-making test.[5] The key cost-effectiveness tests are described as follows, per Swisher, et al. (1997), with key benefits and costs further illustrated in Table 6-7.

- *Total Resource Cost (TRC) Test.* Compares the total costs and benefits of a program, including costs and benefits to the utility and the participant and the avoided costs of energy supply.

- *Societal Test.* Similar to the TRC Test, but includes the effects of other societal benefits and costs such as environmental impacts, water savings, and national security.

- *Utility/Program Administrator Test.* Assesses benefits and costs from the program administrator's perspective (e.g., benefits of avoided fuel and operating capacity costs compared to rebates and administrative costs).

- *Participant Test.* Assesses benefits and costs from a participant's perspective (e.g., the reduction in customers' bills, incentives paid by the utility, and tax credits received as compared to out-of-pocket expenses such as costs of equipment purchase, operation, and maintenance).

- *Rate Impact Measure (RIM).* Assesses the effect of changes in revenues and operating costs caused by a program on customers' bills and rates.

Another metric used for assessing cost-effectiveness is the cost of conserved energy, which is calculated in cents per kWh or dollars per thousand cubic feet (Mcf). This measure does not depend on a future projection of energy prices and is easy to calculate; however, it does not fully capture the future market price of energy.

An overall energy efficiency portfolio should pass the cost-effectiveness test(s) of the jurisdiction. In an IRP situation, energy efficiency resources are compared to new supply-side options–essentially the program administrator or utility test. In cases where utilities have divested generation, a calculated avoided cost or a wholesale market price projection is used to represent the generation benefits. Cost-effectiveness tests are appropriate to screen out poor program design, and to identify programs in markets that have been transformed and might need to be redesigned to continue. Cost-effectiveness analysis is important but must be supplemented by other aspects of the planning process.

If the TRC or societal tests are used, "other resource benefits" can include environmental benefits, water savings, and other fuel savings. Costs include all program costs (administrative, marketing, incentives, and evaluation) as well as customer costs. Future benefits from emissions trading (or other regulatory approaches that provide payment for emission credits) could be treated as additional benefits in any of these models. Other benefits of programs can include job impacts, sales generated, gross state product added, impacts from wholesale price reductions, and personal income (Wisconsin, 2006; Massachusetts, 2004).

Example of Other Benefits

The Massachusetts Division of Energy Resources estimates that its 2002 DSM programs produced 2,093 jobs, increased disposable income by $79 million, and provided savings to all customers of $19.4 million due to lower wholesale energy clearing prices (Massachusetts, 2004).

At a minimum, regulators require programs to be cost-effective at the sector level (residential, commercial, and industrial) and typically at the program level as well. Many program administrators bundle measures under a single program umbrella when, in reality, measures are delivered to customers through different strategies and marketing channels. This process allows program admin-

5 The RIM test is viewed as less certain than the other tests because it is sensitive to the difference between long-term projections of marginal or market costs and long-term projections of rates (CEC, 2001).

Table 6-7. Overview of Cost-Effectiveness Tests

	Benefits					Costs			
Test	**Externalities**	**Energy Benefits G, T&D**	**Demand Benefits G, T&D**	**Non-Energy Benefits**	**Other Resource Benefits**	**Impact On Rates**	**Program Implementation Costs**	**Program Evaluation Costs**	**Customer Costs**
Total Resource Cost Test		X	X		X		X	X	X
Societal Test	X	X	X	X	X		X	X	X
Utility Test/ Administrator Test		X	X				X	X	
Rate Impact Test		X	X			X	X	X	
Participant Test		X	X	X					X

G, T&D = Generation, Transmission, and Distribution

istrators to adjust to market realities during program implementation. For example, within a customer class or segment, if a high-performing and well-subscribed program or measure is out-performing a program or measure that is not meeting program targets, the program administrator can redirect resources without seeking additional regulatory approval.

Individual programs should be screened on a regular basis, consistent with the regulatory schedule—typically, once a year. Individual programs in some customer segments, such as low income, are not always required to be cost-effective, as they provide other benefits to society that might not all be quantified in the cost-effectiveness tests. The same is true of education-only programs that have hard-to-quantify benefits in terms of energy impacts. (See section on conducting impact evaluations for information related to evaluating energy education programs.)

Existing measures should be screened by the program administrator at least every two years, and new measures should be screened annually to ensure they are performing as anticipated. Programs should be reevaluated and updated from time to time to reflect new methods, technologies, and systems. For example, many programs today include measures such as T-5 lighting that did not exist five to ten years ago.

Consider Building Codes and Appliance Standards When Designing Programs

Enacting state and federal codes and standards for new products and buildings is often a cost-effective opportunity for energy savings. Changes to building codes and appliance standards are often considered an intervention that could be deployed in a cost-effective way to achieve results. Adoption of state codes and standards in many states requires an act of legislation beyond the scope of utility programming, but utilities and other third-party program administrators can and do interact with state and federal codes and standards in several ways:

- In the case of building codes, code compliance and actual building performance can lag behind enactment of legislation. Some energy efficiency program administrators design programs with a central goal of improving code compliance. Efficiency Vermont's ENERGY STAR Homes program (described in the box on page 6-24) includes increasing compliance with Vermont Building Code as a specific program objective.

The California investor owned utilities also are working with the national ENERGY STAR program to ensure availability of ENERGY STAR/Title 24 Building Code-compliant residential lighting fixtures and to ensure overall compliance with their new residential building code through their ENERGY STAR Homes program.

- Some efficiency programs fund activities to advance codes and standards. For example, the California IOUs are funding a long-term initiative to contribute expertise, research, analysis, and other kinds of support to help the California Energy Commission (CEC) develop and adopt energy efficiency standards. One rationale for utility investment in advancing codes and standards is that utilities can lock in a baseline of energy savings and free up program funds to work on efficiency opportunities that could not otherwise be realized. In California's case, the IOUs also developed a method for estimating savings associated with their codes and standards work. The method was accepted by the California Public Utilities Commission, and is formalized in the California Energy Efficiency Evaluation Protocols: Technical, Methodological, and Reporting Require-ments for Evaluation Professionals (CPUC, 2006).

Regardless of whether they are a component of an energy efficiency program, organizations have found that it is essential to coordinate across multiple states and regions when pursuing state codes and standards, to ensure that retailers and manufacturers can respond appropriately in delivering products to market.

Program administrators must be aware of codes and standards. Changes in codes and standards affect the baseline against which future program impacts are measured. Codes and standards should be explicitly considered in planning to prevent double counting. The Northwest Power and Conservation Council (NWPCC) explicitly models both state codes and federal standards in its long-term plan (NWPCC, 2005).

Plan for Developing and Incorporating New Technology

Many of the organizations reviewed have a history of providing programs that change over time to accommodate changes in the market and the introduction of new technologies. The new technologies are covered using one or more of the following approaches:

- They are included in research and development (R&D) budgets that do not need to pass cost-effectiveness tests, as they are, by definition, addressing new or experimental technologies. Sometimes R&D funding

Efficiency Vermont ENERGY STAR Homes Program

In the residential new construction segment, Efficiency Vermont partners with the national ENERGY STAR program to deliver whole house performance to its customers and meet both resource acquisition and market transformation goals. Specific objectives of Efficiency Vermont's program are to:

- Increase market recognition of superior construction
- Increase compliance with the Vermont Building Code
- Increase penetration of cost-effective energy efficiency measures
- Improve occupant comfort, health, and safety (including improved indoor air quality)
- Institutionalize Home Energy Rating Systems (HERS)

Participating homebuilders agree to build to the program's energy efficiency standards and allow homes to be inspected by an HERS rater. The home must score 86+ on the HERS inspection and include four energy efficient light fixtures, power-vented or sealed combustion equipment, and an efficient mechanical ventilation system with automatic controls. When a home passes, builders receive a rebate check, program certificate, an ENERGY STAR Homes certificate, and gifts. **Efficiency Vermont ENERGY STAR Homes Program saved more than 700 MWh with program spending of $1.4 million in 2004.**

Source: Efficiency Vermont, 2005

comes from sources other than the utility or state agency. Table 6-8 summarizes R&D activities of several organizations reviewed.

- They are included in pilot programs that are funded as part of an overall program portfolio and are not individually subject to cost-effectiveness tests.

- They are tested in limited quantities under existing programs (such as commercial and industrial custom rebate programs).

Technology innovation in electricity use has been the cornerstone of global economic progress for more than 50 years. In the future, advanced industrial processes, heating and cooling, and metering systems will play very important roles in supporting customers' needs for efficient use of energy. Continued development of new, more efficient technologies is critical for future industrial and commercial processes. Furthermore, technology innovation that targets improved energy efficiency and energy management will enable society to advance and sustain energy efficiency in the absence of government-sponsored or regulatory-mandated programs. Robust and competitive consumer-driven markets are needed for energy efficient devices and energy efficiency service.

The Electric Power Research Institute (EPRI)/U.S. Department of Energy (DOE) Gridwise collaborative and the Southern California Edison (SCE) Lighting Energy Efficiency Demand Response Program are two examples of research and development activities:

- *The EPRI IntelliGrid Consortium* is an industry-wide initiative and public/private partnership to develop the technical foundation and implementation tools to evolve the power delivery grid into an integrated energy and communications system on a continental scale. A key development by this consortium is the IntelliGrid Architecture, an open-standards-based architecture

Table 6-8. Research & Development (R&D) Activities of Select Organizations

Program Administrator	R&D Funding Mechanism(s)	R&D as % of Energy Efficiency Budget	Examples of R&D Technologies/ Initiatives Funded
PG&E	CEC Public Interest Energy Research (PIER) performs research from California SBC funding (PG&E does not have access to their bills' SBC funds); other corporate funds support the California Clean Energy Fund	**1%**[a,b]	California Clean Energy Fund - New technologies and demonstration projects
NYSERDA	SBC funding	**13%**[c,d]	Product development, demonstration and evaluation, university research, technology market opportunities studies
BPA	In rates	**6%**[e,f]	PNL / DOE GridWise Collaborative, Northwest Energy Efficiency Alliance, university research
SCE	CEC Public Interest Energy Research (PIER) performs research from California SBC funding (SCE does not have access to their bills' SBC funds). Procurement proceedings and other corporate funds support Emerging Technologies and Innovative Design for Energy Efficiency programs.	**5%**[g,h,i]	Introduction of emerging technologies (second D of RD&D)

[a] [Numerator] $4 million in 2005 for Californial Clean Energy Fund (CCEF, 2005).

[b] [Denominator] $867 million to be spent 2006-2008 on energy efficiency projects not including evaluation, measurement, and validation (CPUC, 2005). 1/3 of full budget used for single year budget ($289 million).

[c] [Numerator] $17 million for annual energy efficiency R&D budget consists of "residential ($8 M), industrial ($6 M), and transportation ($3 M)" (G. Walmet, NYSERDA, personal communication, May 23, 2006).

[d] [Denominator] $134 M for New York Energy $mart from 3/2004-3/2005 (NYSERDA, 2005b).

[e] [Numerator] BPA funded the Northwest Energy Efficiency Alliance with $10 million in 2003. [Denominator] The total BPA energy efficiency allocation was $138 million (Blumstein, et al., 2005).

[f] [Note] BPA overall budgetting for energy efficiency increased in subsequent years (e.g., $170 million in 2004 with higher commitments going to an average of $245 million from 2006-2012) (Alliance to Save Energy, 2004).

[g] Funding for the statewide Emerging Technologies program will increase in 2006 to $10 million [Numerator] out of a total budget of $581 million [Denominator] for utility energy-efficiency programs (Mills and Livingston, 2005).

[h] [Note] Data from Mills and Livingston (2005) differs from $675 million 3-yr figure from CPUC (2005).

[i] Additional 3% is spent on Innovative Design for Energy Efficiency (InDEE) (D. Arambula, SCE, personal communication, June 8, 2006).

for integrating the data communication networks and smart equipment on the grid and on consumer premises. Another key development is the consumer portal—essentially, a two-way communication link between utilities and their customers to facilitate information exchange (EPRI, 2006). Several efficiency program administrators are pilot testing GridWise/Intelligrid as presented in the box below.

- *The Lighting Energy Efficiency Demand Response Program* is a program proposed by SCE. It will use Westinghouse's two–way wireless dimmable energy efficiency T-5 fluorescent lighting as a retrofit for existing T-12 lamps. SCE will be able to dispatch these lighting systems using wireless technology. The technology will be piloted in small commercial buildings, the educational sector, office buildings, and industrial facilities and could give SCE the ability to reduce load by 50 percent on those installations. This is an excellent example of combining energy efficiency and direct load control technologies.

Both EPRI and ESource (a for-profit, membership-based energy information service) are exploring opportunities to expand their efforts in these areas. ESource is also considering developing a database of new energy efficiency and load response technologies. Leveraging R&D resources through regional and national partnering efforts has been successful in the past with energy efficiency technologies. Examples include compact fluorescent lighting, high-efficiency ballasts and new washing machine technologies. Regional and national efforts send a consistent signal to manufacturers, which can be critical to increasing R&D activities.

Programs must be able to incorporate new technologies over time. As new technologies are considered, the programs must develop strategies to overcome the barriers specific to these technologies to increase their acceptance. Table 6-9 provides some examples of new technologies, challenges, and possible strategies for overcoming these challenges. A cross-cutting challenge for many of these technologies is that average rate designs do not send a price signal during periods of peak demand. A strategy for overcoming this barrier would be to investigate time-sensitive rates (see Chapter 5: Rate Design for additional information).

Pilot Tests of GridWise/Intelligrid

GridWise Pacific Northwest Demonstration Projects

These projects are designed to demonstrate how advanced, information-based technologies can be used to increase power grid efficiency, flexibility, and reliability while reducing the need to build additional transmission and distribution infrastructure. These pilots are funded by DOE's Office of Electricity Delivery and Energy Reliability.

Olympic Peninsula Distributed Resources Demonstration

This project will integrate demand response and distributed resources to reduce congestion on the grid, including demand response with automated control technology, smart appliances, a virtual real-time market, Internet-based communications, contract options for customers, and the use of distributed generation.

Grid-Friendly Appliance Demonstration

In this project, appliance controllers will be used in both clothes dryers and water heaters to detect fluctuations in frequency that indicate there is stress in the grid, and will respond by reducing the load on that appliance.

These pilots include: Pacific Northwest National Laboratory, Bonneville Power Administration, PacificCorp, Portland General Electric, Mason County PUD #3, Clallam County PUD, and the city of Port Angeles.

Table 6-9. Emerging Technologies for Programs

Technology/ Program	Description	Availability	Key Challenges	Key Strategies	Examples
Smart Grid/ GridWise technologies	Smart grid technologies include both customer-side and grid-side technologies that allow for more efficient operation of the grid.	Available in pilot situations	Cost Customer Acceptance Communication Protocols	Pilot programs R&D programs	GridWise pilot in Pacific NW
Smart appliances/ Smart Homes	Homes with gateways that would allow for control of appliances and other end-uses via the Internet.	Available	Cost Customer Acceptance Communication Protocols	Pilot programs Customer education	GridWise pilot in Pacific NW
Load control of A/C via smart thermostat	A/C controlled via smart thermostat. Communication can be via wireless, power line carrier (PLC) or Internet.	Widely available	Cost Customer acceptance	Used to control loads in congested situation Pilot and full-scale programs Customer education	Long Island Power Authority (LIPA), Austin Energy, Utah Power and Light, ISO New England
Dynamic pricing/critical peak pricing/ thermostat control with enhanced metering	Providing customers with either real time or critical peak pricing via a communication technology. Communication can be via wireless, PLC, or Internet. Customers can also be provided with educational materials.	Available	Cost Customer acceptance Split incentives in deregulated markets Regulatory barriers	Pilot and full-scale Programs Used in congested areas Customer education	Georgia (large users) Niagara Mohawk, California Peak Pricing Experiment, Gulf Power
Control of lighting via wireless, power line carrier or other communication technologies	Using direct control to control commercial lighting during high price periods.	Recently available	Cost Customer acceptance Contractor acceptance	R&D programs Pilot programs	SCE pilot using wireless NYSERDA pilot with power line carrier control
T-5s	Relatively new lighting technology for certain applications.	Widely available	Cost Customer acceptance Contractor acceptance	Add to existing programs as a new measure	Included in most large-scale programs
New generation tankless water heaters	Tankless water heaters do not have storage tanks and do not have standby losses. They can save energy relative to conventional water heaters in some applications. Peak demand implications are not yet known.	Widely available	Cost Customer acceptance Contractor acceptance	Add to existing programs as a new measure	More common in the EU

Some load control technologies will require more than R&D activities to become widespread. To fully capture and utilize some of these technologies, the following four building blocks are needed:

- *Interactive communications.* Interactive communications that allow for two-way flow of price information and decisions would add new functionality to the electricity system.

- *Innovative rates and regulation.* Regulations are needed to provide adequate incentives for energy efficiency investments to both suppliers and customers.

- *Innovative markets.* Market design must ensure that energy efficiency and load response measures that are advanced by regulation become self-sustaining in the marketplace.

- *Smart end-use devices.* Smart devices are needed to respond to price signals and facilitate the management of the energy use of individual and networked appliances.

In addition, the use of open architecture systems is the only long-term way to take existing non-communicating equipment into an energy-efficient future that can use two-way communications to monitor and diagnose appliances and equipment.

Consider Efficiency Investments to Alleviate Transmission and Distribution Constraints

Energy efficiency has a history of providing value by reducing generation investments. It should also be considered with other demand-side resources, such as demand response, as a potential resource to defer or avoid investments in transmission and distribution systems. Pacific Gas and Electric's (PG&E) Model Energy Communities Project (the Delta Project) provides one of the first examples of this approach. This project was conceived to test whether demand resources could be used as a least cost resource to defer the capital expansion of the transmission and distribution system in a constrained area. In this case, efforts were focused on the constrained area, and customers were offered versions of existing programs and additional measures to achieve a significant reduction in the constrained area (PG&E, 1993). A recently approved settlement at the Federal Energy Regulatory Commission (FERC) allows energy efficiency along with load response and distributed generation to participate in the Independent System Operator New England (ISO-NE) Forward Capacity Market (FERC, 2006; FERC, 2005). In addition, Consolidated Edison has successfully used a Request For Proposals (RFP) approach to defer distribution upgrades in four substation areas with contracts totaling 45 MW. Con Ed is currently in a second round of solicitations for 150 MW (NAESCO, 2005). Recent pilots using demand response, energy efficiency, and intelligent grid are proving promising as shown in the BPA example in the box on page 6-29.

To evaluate strategies for deferring transmission and distribution investments, the benefits and costs of energy efficiency and other demand resources are compared to the cost of deferring or avoiding a distribution or transmission upgrade (such as a substation upgrade) in a constrained area. This cost balance is influenced by location-specific transmission and distribution costs, which can vary greatly.

Create a Roadmap of Key Program Components, Milestones, and Explicit Energy Use Reduction Goals

Decisions regarding the key considerations discussed throughout this section are used to inform the development of an energy efficiency plan, which serves as a roadmap with key program components, milestones, and explicit energy reduction goals.

A well-designed plan includes many of the elements discussed in this section including:

- Budgets (see section titled "Leverage Private-Sector Expertise, External Funding, and Financing" for information on the budgeting processes for the most common policy models)

— Overall

— By program

- Kilowatt , kWh, and Mcf savings goals overall and by program

— Annual savings

— Lifetime savings

- Benefits and costs overall and by program

- Description of any shareholder incentive mechanisms

Bonneville Power Administration (BPA) Transmission Planning

BPA has embarked on a new era in transmission planning. As plans take shape to address load growth, constraints, and congestion on the transmission system, BPA is considering measures other than building new lines, while maintaining its commitment to provide reliable transmission service. The agency, along with others in the region, is exploring "non-wires solutions" as a way to defer large construction projects.

BPA defines non-wires solutions as the broad array of alternatives including, but not limited to, demand response, distributed generation, conservation measures, generation siting, and pricing strategies that individually, or in combination, delay or eliminate the need for upgrades to the transmission system. The industry also refers to non-wires solutions as non-construction alternatives or options.

BPA has reconfigured its transmission planning process to include an initial screening of projects to assess their potential for a non-wires solution. BPA is now committed to using non-wires solutions screening criteria for all capital transmission projects greater than $2 million, so that it becomes an institutionalized part of planning. BPA is currently sponsoring a number of pilot projects to test technologies, resolve institutional barriers, and build confidence in using non-wires solution.

For each program, the plan should include the following:

- Program design description
- Objectives
- Target market
- Eligible measures
- Marketing plan
- Implementation strategy
- Incentive strategy
- Evaluation plan
- Benefit/cost outputs
- Metrics for program success
- Milestones

The plan serves as a road-map for programs. Most program plans, however, are modified over time based on changing conditions (e.g., utility supply or market changes) and program experience. Changes from the original roadmap should be both documented and justified. A plan that includes all of these elements is an appropriate starting point for a regulatory filing. A well-documented plan is also a good communications vehicle for informing and educating stakeholders. The plan should also include a description of any pilot programs and R&D activities.

Energy Efficiency Program Design and Delivery

The organizations reviewed for this chapter have learned that program success is built over time by understanding the markets in which efficient products and services are delivered, by addressing the wants and needs of their customers, by establishing relationships with customers and suppliers, and by designing and delivering programs accordingly.

- They have learned that it is essential to program success to coordinate with private market actors and other influential stakeholders, to ensure that they are well informed about program offerings and share this information with their customers/constituents.

- Many of the organizations reviewed go well beyond merely informing businesses and organizations, by actually partnering with them in the design and delivery of one or more of their efficiency programs.

- Recognizing that markets are not defined by utility service territory, many utilities and other third-party program administrators actively cooperate with one another and with national programs, such as ENERGY STAR, in the design and delivery of their programs.

This section discusses key best practices that emerge from a decade or more of experience designing and implementing energy efficiency programs.

Begin With the Market in Mind

Energy efficiency programs should complement, rather than compete with, private and other existing markets for energy efficient products and services. The rationale for utility or third-party investment in efficiency programming is usually based on the concept that within these markets, there are barriers that need to be overcome to ensure that an efficient product or service is chosen over a less efficient product or standard practice. Barriers might include higher initial cost to the consumer, lack of knowledge on the part of the supplier or the customer, split incentives between the tenant who pays the utility bills and the landlord who owns the building, lack of supply for a product or service, or lack of time (e.g., to research efficient options, seek multiple bids—particularly during emergency replacements).

Conduct a Market Assessment

Understanding how markets function is a key to successful program implementation, regardless of whether a program is designed for resource acquisition, market transformation, or a hybrid approach. A market assessment can be a valuable investment to inform program design and implementation. It helps establish who is part of the market (e.g., manufacturers, distributors, retailers, consumers), what the key barriers are to greater energy efficiency from the producer or consumer perspectives, who are the key trend-setters in the business and the key influencers in consumer decision-making, and what approaches might work best to overcome barriers to greater supply and investment in energy efficient options, and/or uptake of a program. A critical part of completing a market assessment is a baseline measurement of the goods and services involved and the practices, attitudes, behaviors, factors, and conditions of the marketplace (Feldman, 1994). In addition to informing program design and implementation, the baseline assessment also helps inform program evaluation metrics, and serves as a basis for which future program impacts are measured. As such, market assessments are usually conducted by independent third-party evaluation professionals. The extent and needs of a market assessment can vary greatly. For well-established program models, market assessments are somewhat less involved, and can rely on existing program experience and literature, with the goal of understanding local differences and establishing the local or regional baseline for the targeted energy efficiency product or service.

Table 6-10 illustrates some of the key stakeholders, barriers to energy efficiency, and program strategies that are explored in a market assessment, and are useful for considering when designing programs.

Solicit Stakeholder Input

Convening stakeholder advisory groups from the onset as part of the design process is valuable for obtaining multiple perspectives on the need and nature of planned programs. This process also serves to improve the program design, and provides a base of program support within the community.

Once programs have been operational for a while, stakeholder groups should be reconvened to provide program feedback. Stakeholders that have had an ongoing relationship with one or more of the programs can provide insight on how the programs are operating and perceived in the community, and can recommend program modifications. They are also useful resources for tapping into extended networks beyond those easily accessible to the program providers. For example, contractors, building owners, and building operators can be helpful in providing access to their specific trade or business organizations.

Table 6-10. Key Stakeholders, Barriers, and Program Strategies by Customer Segment

Customer Segment	Key Stakeholders	Key Program Barriers	Key Program Strategies
Large Commercial & Industrial Retrofit	• Contractors • Building owners and operators • Distributors: lighting, HVAC, motors, other • Product manufacturers • Engineers • Energy services companies	• Access to capital • Competing priorities • Lack of information • Short-term payback (<2 yr) mentality	• Financial incentives (rebates) • Performance contracting • Performance benchmarking • Partnership with ENERGY STAR • Low interest financing • Information from unbiased sources • Technical assistance • Operations and maintenance training
Small Commercial	• Distributors: lighting, HVAC, other • Building owners • Business owners • Local independent trades	• Access to capital • Competing priorities • Lack of information	• Financial incentives (rebates) • Information from unbiased sources • Direct installation • Partnership with ENERGY STAR
Commercial & Industrial New Construction	• Architects • Engineers • Building and energy code officials • Building owners • Potential occupants	• Project/program timing • Competing priorities • Split incentives (for rental property) • Lack of information • Higher initial cost	• Early intervention (ID requests for hook-up) • Design assistance • Performance targeting/benchmarking • Partnership with ENERGY STAR • Training of architects and engineers • Visible and ongoing presence in design community • Education on life cycle costs
Residential Existing Homes	• Distributors: appliances, HVAC, lighting • Retailers: appliance, lighting, windows • Contractors: HVAC, insulation, remodeling • Homeowners	• Higher initial cost • Lack of information • Competing priorities • Inexperience or prior negative experience w/technology (e.g., early compact florescent lighting) • Emergency replacements	• Financial incentives • Partnership with ENERGY STAR • Information on utility Web sites, bill inserts, and at retailers • Coordination with retailers and contractors
Residential New Homes	• Contractors: general and HVAC • Architects • Code officials • Builders • Home buyers • Real estate agents • Financial institutions	• Higher initial cost • Split incentives: builder is not the occupant	• Partnership with ENERGY STAR • Linking efficiency to quality • Working with builders • Building code education & compliance • Energy efficient mortgages
Multifamily	• Owners and operators • Contractors • Code officials • Tenants	• Split incentives • Lack of awareness	• Financial incentives • Marketing through owner and operator associations
Low Income	• Service providers: Weatherization Assistance Program (WAP), Low-Income Home Energy Assistance Program (LIHEAP) • Social service providers: state and local agencies • NGOs and advocacy groups • Credit counseling organizations • Tenants	• Program funding • Program awareness • Bureaucratic challenges	• Consistent eligibility requirements with existing programs • Direct installation • Leveraging existing customer channels for promotion and delivery • Fuel blind approach

To be successful, stakeholder groups should focus on the big picture, be well organized, and be representative. Stakeholder groups usually provide input on budgets, allocation of budgets, sectors to address, program design, evaluation, and incentives.

Listen to Customer and Trade Ally Needs

Successful energy efficiency programs do not exist without customer and trade ally participation and acceptance of these technologies. Program designs should be tested with customer market research before finalizing offerings. Customer research could include surveys, focus groups,

Best Practice: Solicit Stakeholder Input

Minnesota's Energy Efficiency Stakeholder Process exemplifies the best practice of engaging stakeholders in program design. The Minnesota Public Utility Commission hosted a roundtable with the commission, utilities, and other stakeholders to review programs. Rate implications and changes to the programs are worked out through this collaborative and drive program design (MPUC, 2005).

Successful stakeholder processes generally have the following attributes:

- Neutral facilitation of meetings.
- Clear objectives for the group overall and for each meeting.
- Explicit definition of stakeholder group's role in program planning (usually advisory only).
- Explicit and fair processes for providing input.
- A timeline for the stakeholder process.

forums, and in-depth interviews. Testing of incentive levels and existing market conditions by surveying trade allies is critical for good program design.

Use Utility Channels and Brand

Utilities have existing channels for providing information and service offerings to their customers. These include Web sites, call centers, bill stuffers, targeted newsletters, as well as public media. Using these channels takes advantage of existing infrastructure and expertise, and provides customers with energy information in the way that they are accustomed to obtaining it. These methods reduce the time and expense of bringing information to customers. In cases where efficiency programming is delivered by a third party, gaining access to customer data and leveraging existing utility channels has been highly valuable for program design and implementation. In cases such as Vermont (where the utilities are not responsible for running programs), it has been helpful to have linkages from the utility Web sites to Efficiency Vermont's programs, and to establish Efficiency Vermont as a brand that the utilities leverage to deliver information about efficiency to their customers.

Promote the Other Benefits of Energy Efficiency and Energy Efficient Equipment

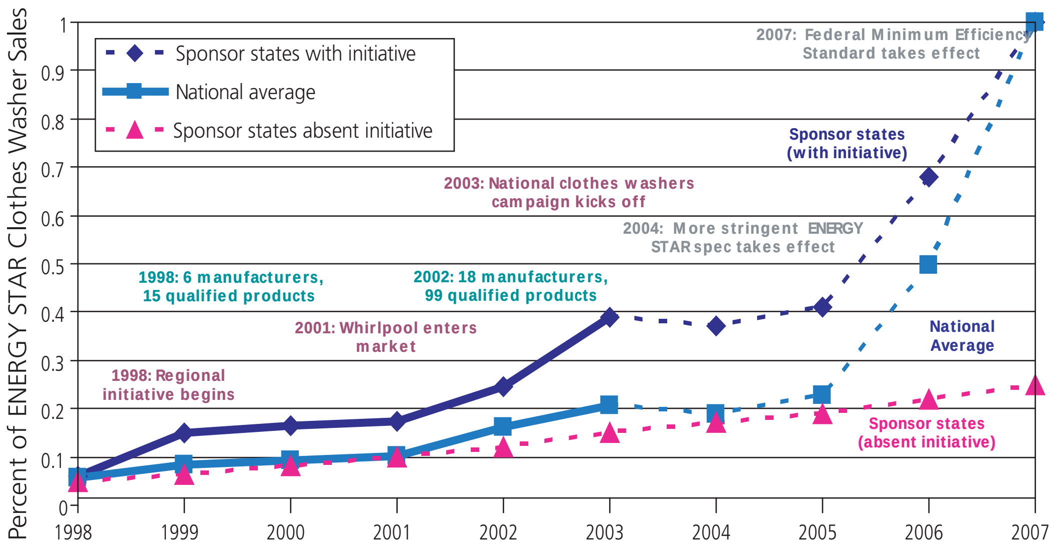
Most customers are interested in reducing energy consumption to save money. Many, however, have other motivations for replacing equipment or renovating space that are consistent with energy efficiency improvements. For example, homeowners might replace their heating system to improve the comfort of their home. A furnace with a variable speed drive fan will further increase comfort (while saving energy) by providing better distribution of both heating and cooling throughout the home and reducing fan motor noise. It is a best practice for program administrators to highlight these features where non-energy claims can be substantiated.

Coordinate With Other Utilities and Third-Party Program Administrators

Coordination with other utilities and third-party program administrators is also important. Both program allies and customers prefer programs that are consistent across states and regions. This approach reduces transaction costs for customers and trade allies and provides consistent messages that avoid confusing the market. Some programs can be coordinated at the regional level by entities such as Northeast Energy Efficiency Partnership (NEEP), the Northwest Energy Efficiency Alliance, and the Midwest Energy Efficiency Alliance. Figure 6-1 illustrates the significant impact that initiative sponsors of the Northeast Lighting and Appliance Initiative (coordinated regionally by NEEP) have been able to have on the market for energy-efficient clothes washers by working in coordination over a long time period. **NEEP estimates the program is saving an estimated 36 million kWh per year, equivalent to the annual electricity needs of 5,000 homes** (*NEEP, undated*).

Similarly, low-income programs benefit from coordination with and use of the same eligibility criteria as the federal Low-Income Home Energy Assistance Program (LIHEAP) or Weatherization Assistance Program (WAP). These programs have existing delivery channels that can

Figure 6-1. Impacts of the Northeast Lighting and Appliance Initiative



be used to keep program costs down while providing substantial benefit to customers. On average, weatherization reduces heating bills by 31 percent and overall energy bills by $274 per year for an average cost per home of $2,672 per year. Since 1999, DOE has been encouraging the network of weatherization providers to adopt a whole-house approach whereby they approach residential energy efficiency as a system rather than as a collection of unrelated pieces of equipment (DOE, 2006). The Long Island Power Authority's (LIPA) program shown at right provides an example.

Leverage the National ENERGY STAR Program

Nationally, ENERGY STAR provides a platform for program implementation across customer classes and defines voluntary efficiency levels for homes, buildings, and products. ENERGY STAR is a voluntary, public-private partnership designed to reduce energy use and related greenhouse gas emissions. The program, administered by the U.S. Environmental Protection Agency (EPA) and the DOE, has an extensive network of partners including equipment manufacturers, retailers, builders, ESCOs, private businesses, and public sector organizations.

Since the late 1990s, EPA and DOE have worked with utilities, state energy offices, and regional nonprofit organizations to help leverage ENERGY STAR messaging, tools, and strategies to enhance local energy efficiency programs. Today more than 450 utilities (and other efficiency program administrators), servicing 65 percent of U.S. households, participate in the ENERGY STAR program. (See box on page 6-34 for additional information.) New Jersey and Minnesota provide examples of states that have leveraged ENERGY STAR.

Long Island Power Authority (LIPA): Residential Energy Affordability Partnership Program (REAP)

This program provides installation of comprehensive electric energy efficiency measures and energy education and counseling. The program targets customers who qualify for DOE's Low-Income Weatherization Assistance Program (WAP), as well as electric space heating and cooling customers who do not qualify for WAP and have an income of no more than 60 percent of the median household income level. **LIPA's REAP program has saved 2.5 MW and 21,520 MWh 1999 to 2004 with spending of $12.4 million.**

Source: LIPA, 2004

- *New Jersey's Clean Energy Program.* The New Jersey Board of Public Utilities, Office of Clean Energy has incorporated ENERGY STAR tools and strategies since the inception of its residential products and Warm Advantage (gas) programs. Both programs encourage customers to purchase qualified lighting, appliances, windows, programmable thermostats, furnaces, and boilers. The New Jersey Clean Energy Program also educates consumers, retailers, builders, contractors, and manufacturers about ENERGY STAR. **In 2005, New Jersey's Clean Energy Program saved an estimated 60 million kWh of electricity, 1.6 million therms of gas, and 45,000 tons of carbon dioxide (CO_2).**

ENERGY STAR Program Investments

In support of the ENERGY STAR program, EPA and DOE invest in a portfolio of energy efficiency efforts that utilities and third-party program administrators can leverage to further their local programs including:

- *Education and Awareness Building.* ENERGY STAR sponsors broad-based public campaigns to educate consumers on the link between energy use and air emissions, and to raise awareness about how products and services carrying the ENERGY STAR label can protect the environment while saving money.

- *Establishing Performance Specifications and Performing Outreach on Efficient Products.* More than 40 product categories include ENERGY STAR-qualifying models, which ENERGY STAR promotes through education campaigns, information exchanges on utility-retailer program models, and extensive online resources. Online resources include qualifying product lists, a store locator, and information on product features.

- *Establishing Energy Efficiency Delivery Models to Existing Homes.* ENERGY STAR assistance includes an emphasis on home diagnostics and evaluation, improvements by trained technicians/building professionals, and sales training. It features online consumer tools including the Home Energy Yardstick and Home Energy Advisor.

- *Establishing Performance Specifications and Performing Outreach for New Homes.* ENERGY STAR offers builder recruitment materials, sales toolkits, consumer messaging, and outreach that help support builder training, consumer education, and verification of home performance.

- *Improving the Performance of New and Existing Commercial Buildings.* EPA has designed an Energy Performance Rating System to measure the energy performance at the whole-building level, to help go beyond a component-by-component approach that misses impacts of design, sizing, installation, controls, operation, and maintenance. EPA uses this tool and other guidance to help building owners and utility programs maximize energy savings.

Additional information on strategies, tools, and resources by customer segment is provided in the fact sheet "ENERGY STAR—A Powerful Resource for Saving Energy," which can be downloaded from *www.epa.gov/cleanenergy/pdf/napee_energystar-factsheet.pdf.*

- *Great River Energy, Minnesota.* In 2005, Great River Energy emphasized cost-effective energy conservation by offering appliance rebates to cooperative members who purchase ENERGY STAR qualifying refrigerators, clothes washers, and dishwashers. Great River provided its member cooperatives with nearly $2 million for energy conservation rebates and grants, including the ENERGY STAR rebates, as a low-cost resource alternative to building new peaking generation. In addition to several off-peak programs, Great River Energy's residential DSM/conservation program consists of:

— Cycled air conditioning

— Interruptible commercial load response/management

— Interruptible irrigation

— Air and ground source heat pumps

— ENERGY STAR high-efficiency air conditioning rebate

— ENERGY STAR appliance rebates

— ENERGY STAR compact fluorescent lamp rebate

— Low-income air conditioning tune-ups

— Residential and commercial energy audits

A Seattle City Light Example of a Simple Program

Seattle City Light's $mart Business program offers a "per-fixture" rebate for specific fixtures in existing small businesses. Customers can use their own licensed electrical contractor or select from a pre-approved contractor list. Seattle City Light provides the rebate to either the installer or participating customer upon completion of the work. Completed work is subject to onsite verification.

Since 1986, Seattle City Light's $mart Business program has cumulative savings (for all measures) of 70,382 MWh and 2.124 MW.

Source: Seattle City Light, 2005

Keep Participation Simple

Successful programs keep participation simple for both customers and trade allies. Onerous or confusing participation rules, procedures, and paperwork can be a major deterrent to participation from trade allies and customers. Applications and other forms should be clear and require the minimum information (equipment and customer) to confirm eligibility and track participation by customer for measurement and verification (M&V) purposes. Given that most energy efficiency improvements are made at the time of either equipment failure or retrofit, timing can be critical. A program that potentially delays equipment installation or requires customer or contractor time for participation will have fewer participants (and less support from trade allies). Seattle City Light's program shown above has two paths for easy participation.

Keep Funding (and Other Program Characteristics) as Consistent as Possible

Over time, both customers and trade allies become increasingly aware and comfortable with programs. Disruptions to program funding frustrate trade allies who cannot stock appropriately or are uncomfortable making promises to customers regarding program offerings for fear that efficiency program administrators will be unable to deliver on services or financial incentives.

Invest in Education, Training, and Outreach

Some of the key barriers to investment in energy efficiency are informational. Education, outreach, and training should be provided to trade allies as well as customers. Some programs are information-only programs; some programs have educational components integrated into the program design and budget; and in some cases, education is budgeted and delivered somewhat independently of specific programs. In general, stand-alone education programs do not comprise more than

10 percent of the overall energy efficiency budget, but information, training, and outreach might comprise a larger portion of some programs that are designed to affect long-term markets, when such activities are tied to explicit uptake of efficiency measures and practices. This approach might be particularly applicable in the early years of implementation, when information and training are most critical for building supply and demand for products and services over the longer term. KeySpan and Flex Your Power are examples of coordinating education, training, and outreach activities with programs.

Leverage Customer Contact to Sell Additional Efficiency and Conservation Measures

Program providers can take advantage of program contact with customers to provide information on other program offerings, as well as on no or low-cost opportunities to reduce energy costs. Information might include proper use or maintenance of newly purchased or installed equipment or general practices around the home or workplace for efficiency improvements. Education is often included in low-income programs, which generally include direct installation of equipment, and thus already include in-home interaction between the program provider and customer. The box below provides some additional considerations for low-income programs.

Leverage Private-Sector Expertise, External Funding, and Financing

Well-designed energy efficiency programs leverage external funding and financing to stretch available dollars and to take advantage of transactions as they occur in

KeySpan Example

KeySpan uses training and certification as critical parts of its energy efficiency programs. KeySpan provides building operator certification training, provides training on the Massachusetts state building code, and trains more than 1,000 trade allies per year.

Source: Johnson, 2006

California: Flex Your Power Campaign

The California Flex Your Power Campaign was initiated in 2001 in the wake of California's rolling black-outs. While initially focused on immediate conservation measures, the campaign has transitioned to promoting energy efficiency and long-term behavior change. The program coordinates with the national ENERGY STAR program as well as the California investor-owned utilities to ensure that consumers are aware of energy efficiency options and the incentives available to them through their utilities.

Low-Income Programs

Most utilities offer energy efficiency programs targeted to low-income customers for multiple reasons:

- Low-income customers are less likely to take advantage of rebate and other programs, because they are less likely to be purchasing appliances or making home improvements.
- The "energy burden" (percent of income spent on energy) is substantially higher for low-income customers, making it more difficult to pay bills. Programs that help reduce energy costs reduce the burden, making it easier to maintain regular payments.
- Energy efficiency improvements often increase the comfort and safety of these homes.
- Utilities have the opportunity to leverage federal programs, such as LIHEAP and WAP, to provide comprehensive services to customers.
- Low-income customers often live in less efficient housing and have older, less efficient appliances.
- Low-income customers often comprise a substantial percentage (up to one-third) of utility residential customers and represent a large potential for efficiency and demand reduction.
- Using efficiency education and incentives in conjunction with credit counseling can be very effective in this sector.

the marketplace. This approach offers greater financial incentives to the consumer without substantially increasing program costs. It also has some of the best practice attributes discussed previously, including use of existing channels and infrastructure to reach customers. The following are a few opportunities for leveraging external funding and financing:

- *Leverage Manufacturer and Retailer Resources Through Cooperative Promotions.* For example, for mass market lighting and appliance promotions, many program administrators issue RFPs to retailers and manufacturers asking them to submit promotional ideas. These RFPs usually require cost sharing or in-kind advertising and promotion, as well as requirements that sales data be provided as a condition of the contract. This approach allows competitors to differentiate themselves and market energy efficiency in a way that is compatible with their business model.

- *Leverage State and Federal Tax Credits Where Available.* Many energy efficiency program administrators are now pointing consumers and businesses to the new federal tax credits and incorporating them in their programs. In addition, program administrators can educate their customers on existing tax strategies, such as accelerated depreciation and investment tax strategies, to help them recoup the costs of their investments faster. Some states offer additional tax credits, and/or offer sales tax "holidays," where sales tax is waived at point of sale for a specified period of time ranging from one day to a year. The North Carolina Solar Center maintains a database of efficiency incentives, including state and local tax incentives, at *www.dsireusa.org*.

- *Build on ESCO and Other Financing Program Options.* This is especially useful for large commercial and industrial projects.

The NYSERDA and California programs presented at right and on the following page are both good examples of leveraging the energy services market and increasing ESCO presence in the state.

New York Energy $mart Commercial/ Industrial Performance Program

The New York Energy $mart Commercial/Industrial Performance Program, which is administered by NYSERDA, is designed to promote energy savings and demand reduction through capital improvement projects and to support growth of the energy service industry in New York state. Through the program, ESCOs and other energy service providers receive cash incentives for completion of capital projects yielding verifiable energy and demand savings. By providing $111 million in performance-based financial incentives, this nationally recognized program has leveraged more than $550 million in private capital investments. M&V ensures that electrical energy savings are achieved. **Since January 1999, more than 860 projects were completed in New York with an estimated savings of 790 million kWh/yr.**

Sources: Thorne-Amann and Mendelsohn, 2005; AESP, 2006

- *Leverage Organizations and Outside Education and Training Opportunities.* Many organizations provide education and training to their members, sometimes on energy efficiency. Working with these organizations provides access to their members, and the opportunity to leverage funding or marketing opportunities provided by these organizations.

In addition, the energy efficiency contracting industry has matured to the level that many proven programs have been "commoditized." A number of private firms and not-for-profit entities deliver energy efficiency programs throughout the United States or in specific regions of the country. "The energy efficiency industry is now a $5 billion to $25 billion industry (depending on how expansive one's definition) with a 30-year history of developing and implementing all types of programs for

California Non-Residential Standard Performance Contract (NSPC) Program

The California NSPC program is targeted at customer efficiency projects and is managed on a statewide basis by PG&E, SCE, and San Diego Gas & Electric. Program administrators offer fixed-price incentives (by end use) to project sponsors for measured kilowatt-hour energy savings achieved by the installation of energy efficiency measures. The fixed price per kWh, performance measurement protocols, payment terms, and other operating rules of the program are specified in a standard contract. This program has helped to stimulate the energy services market in the state. **In program year 2003, the California NSPC served 540 customers and saved 336 gigawatt-hours and 6.54 million therms.**

Source: Quantum Consulting Inc., 2004

utilities and projects for all types of customers across the country" (NAESCO, 2005). These firms can quickly get a program up and running, as they have the expertise, processes, and infrastructure to handle program activities. New program administrators can contract with these organizations to deliver energy efficiency program design, delivery, and/or implementation support in their service territory.

Fort Collins Utilities was able to achieve early returns for its Lighting with a Twist program (discussed on page 6-39) by hiring an experienced implementation contractor through a competitive solicitation process and negotiating cooperative marketing agreements with national retail chains and manufacturers, as well as local hardware stores.

The Building Owners & Managers Association (BOMA) Energy Efficiency Program

The BOMA Foundation, in partnership with the ENERGY STAR program, has created an innovative operational excellence program to teach property owners and managers how to reduce energy consumption and costs with proven no- and low-cost strategies for optimizing equipment, people and practices. The BOMA Energy Efficiency Program consists of six Web-assisted audio seminars (as well as live offerings at the BOMA International Convention). The courses are taught primarily by real estate professionals who speak in business vernacular about the process of improving performance. The courses are as follows:

- Introduction to Energy Performance
- How to Benchmark Energy Performance
- Energy-Efficient Audit Concepts & Economic Benefits
- No- and Low-Cost Operational Adjustments to Improve Energy Performance
- Valuing Energy Enhancement Projects & Financial Returns
- Building an Energy Awareness Program

The commercial real estate industry spends approximately $24 billion annually on energy and contributes 18 percent of the U.S. CO_2 emissions. According to EPA and ENERGY STAR Partner observations, a 30 percent reduction is readily achievable simply by improving operating standards.

Fort Collins Utilities Lighting With a Twist

Fort Collins Utilities estimates annual savings of 2,023 MWh of electricity with significant winter peak demand savings of 1,850 kW at a total resource cost of $0.018/kWh from its Lighting with a Twist program, which uses ENERGY STAR as a platform. The program was able to get off to quick and successful start by hiring an experienced implementation contractor and negotiating cooperative marketing agreements with retailers and manufacturers—facilitating the sale of 78,000 compact fluorescent light bulbs through six retail outlets from October to December 2005 (Fort Collins Utilities, et al., 2005).

Start Simply With Demonstrated Program Models: Build Infrastructure for the Future

Utilities starting out or expanding programs should look to other programs in their region and throughout the country to leverage existing and emerging best programs. After more than a decade of experience running energy efficiency programs, many successful program models have emerged and are constantly being refined to achieve even more cost-effective results.

While programs must be adapted to local realities, utilities and state utility commissions can dramatically reduce their learning curve by taking advantage of the wealth of data and experience from other organizations around the country. The energy efficiency and services community has numerous resources and venues for sharing information and formally recognizing best practice programs. The Association of Energy Service Professionals (*www.aesp.org*), the Association of Energy Engineers (*www.aeecenter.org*), and the American Council for an Energy Efficient Economy (*www.aceee.org*) are a few of these resources. Opportunities for education and information sharing are also provided via national federal programs such as ENERGY STAR (*www.energystar.gov*) and the Federal Energy Management Program (*www.eere.energy.gov/femp*). Additional resources will be provided in *Energy Efficiency Best Practices Resources and Expertise* (a forthcoming product of the Leadership Group). Leveraging these resources will reduce the time and expense of going to market with new efficiency programs. This will also increase the quality and value of the programs implemented.

Start With Demonstrated Program Approaches That Can Easily Be Adapted to New Localities

Particularly for organizations that are new to energy efficiency programming or have not had substantial energy efficiency programming for many years, it is best to start with tried and true programs that can easily be transferred to new localities, and be up and running quickly to achieve near term results. ENERGY STAR lighting and appliance programs that are coordinated and delivered through retail sales channels are a good example of this approach on the residential side. On the commercial side, prescriptive incentives for technologies such as lighting, packaged unitary heating and cooling equipment, commercial food service equipment, and motors are good early targets. While issues related to installation can emerge, such as design issues for lighting, and proper sizing issues for packaged unitary heating and cooling equipment, these technologies can deliver savings independent from how well the building's overall energy system is managed and controlled. In the early phase of a program, offering prescriptive rebates is simple and can garner supplier interest in programs, but as programs progress, rebates might need to be reduced or transitioned to other types of incentives (e.g., cooperative marketing approaches, customer referrals) or to more comprehensive approaches to achieving energy savings. If the utility or state is in a tight supply situation, it might make sense to start with proven larger scale programs that address critical load growth drivers such as increased air conditioning load from both increased central air conditioning in new construction and increased use of room air conditioners.

Determine the Right Incentives and Levels

There are many types of incentives that can be used to spur increased investment in energy-efficient products and services. With the exception of education and

Table 6-11. Types of Financial Incentives

Financial Incentives	Description
Prescriptive Rebate	Usually a predetermined incentive payment per item or per kW or kWh saved. Can be provided to the customer or a trade ally.
Custom Rebate	A rebate that is customized by the type of measures installed. Can be tied to a specific payback criteria or energy savings. Typically given to the customer.
Performance Contracting Incentive	A program administrator provides an incentive to reduce the risk premium to the ESCO installing the measures.
Low Interest Financing	A reduced interest rate loan for efficiency projects. Typically provided to the customer.
Cooperative Advertising	Involves providing co-funding for advertising or promoting a program or product. Often involves a written agreement.
Retailer Buy Down	A payment to the retailer per item that reduces the price of the product.
MW Auction	A program administrator pays a third party per MW and/or per MWh for savings.

training programs, most programs offer some type of financial incentive. Table 6-11 shows some of the most commonly used financial incentives. Getting incentives right, and at the right levels, ensures program success and efficient use of resources by ensuring that programs do not "overpay" to achieve results. The market assessment and stakeholder input process can help inform initial incentives and levels. Ongoing process and impact evaluation (discussed below) and reassessment of cost-effectiveness can help inform when incentives need to be changed, reduced, or eliminated.

Invest in the Service Industry Infrastructure

Ultimately, energy efficiency is implemented by people—home performance contractors, plumbers, electricians, architects, ESCOs, product manufacturers, and others—who know how to plan for, and deliver, energy efficiency to market.

While it is a best practice to incorporate whole house and building performance into programs, these programs cannot occur unless the program administrator has a skilled, supportive community of energy service professionals to call upon to deliver these services to market. In areas of the country lacking these talents, development of these markets is a key goal and critical part of the program design.

In many markets—even those with well established efficiency programs—it is often this lack of infrastructure or supply of qualified workers that prevents wider deployment of otherwise cost-effective energy efficiency programs. Energy efficiency program administrators often try to address this lack of infrastructure through various program strategies, including pilot testing programs that foster demand for these services and help create the business case for private sector infrastructure development, and vocational training and outreach to universities, with incentives or business referrals to spur technician training and certification.

Examples of programs that have leveraged the ESCO industry were provided previously. One program with an explicit goal of encouraging technical training for the residential marketplace is Home Performance with ENERGY STAR, which is an emerging program model being implemented in a number of states including Wisconsin, New York, and Texas (see box on page 6-41 for an example). The program can be applied in the gas or electric context, and is effective at reducing peak load, because the program captures improvements in heating and cooling performance.

Austin Energy: Home Performance with ENERGY STAR

In Texas, Austin Energy's Home Performance with ENERGY STAR program focuses on educating customers, and providing advanced technical training for professional home performance contractors to identify energy efficiency opportunities, with an emphasis on safety, customer comfort, and energy savings. Participating Home Performance contractors are given the opportunity to receive technical accreditation through the Building Performance Institute.

Qualified contractors perform a top-to-bottom energy inspection of the home and make customized recommendations for improvements. These improvements might include measures such as air-sealing, duct sealing, adding insulation, installing energy efficient lighting, and installing new HVAC equipment or windows, if needed. In 2005, Austin Energy served more than 1,400 homeowners, with an average savings per customer of $290 per year. **Collectively, Austin Energy customers saved an estimated $410,000 and more than 3 MW through the Home Performance with ENERGY STAR program.**

Source: Austin Energy, 2006

Evolve to More Comprehensive Programs

A sample of how program approaches might evolve over time is presented in Table 6-12. As this table illustrates, programs typically start with proven models and often simpler approaches, such as providing prescriptive rebates for multiple technologies in commercial/industrial existing building programs. In addition, early program options are offered for all customer classes, and all of the programs deliver capacity benefits in addition to energy efficiency. Ultimately, the initial approach taken by a program administrator will depend on how quickly the program needs to ramp up, and on the availability of service industry professionals who know how to plan for, and deliver, energy efficiency to market.

As program administrators gain internal experience and a greater understanding of local market conditions, and regulators and stakeholders gain greater confidence in the value of the energy efficiency programs being offered, program administrators can add complexity to the programs provided and technologies addressed. The early and simpler programs will help establish internal relationships (across utility or program provider departments) and external relationships (between program providers, trade allies and other stakeholders). Both the program provider and trade allies will better understand roles and relationships, and trade allies will develop familiarity with program processes and develop trust in the programs. Additional complexity can include alternative financing approaches (e.g., performance contracting), the inclusion of custom measures, bidding programs, whole buildings and whole home approaches, or additional cutting edge technologies. In addition, once programs are proven within one subsector, they can often be offered with slight modification to other sectors; for example, some proven residential program offerings might be appropriate for multi-family or low-income customers, and some large commercial and industrial offerings might be appropriate for smaller customers or multifamily applications. Many of the current ENERGY STAR market-based lighting and appliance programs that exist in many parts of the country evolved from customer-based lighting rebates with some in-store promotion. Many of the more complex commercial and industrial programs, such at NSTAR and National Grid's Energy Initiative program evolved from lighting, HVAC, and motor rebate programs.

The Wisconsin and Xcel Energy programs discussed on page 6-43 are also good examples of programs that have become more complex over time.

Change Measures Over Time

Program success, changing market conditions, changes in codes, and changes in technology require reassessing the measures included in a program. High saturations in the market, lower incremental costs, more rigid codes, or

Table 6-12. Sample Progression of Program Designs

Sector	Program Ramp Up			Energy & Environmental Co-Benefits (In Addition to kWh)			
	Early (6 Months -2 YRS)	Midterm (2-3 YRS)	Longer Term (3 To 7 YRS)	Other Fuels	Peak (S = Summer, W = Winter)	Water Savings	Other
Residential: Existing Homes	Market-based lighting & appliance program			X	S, W	X	Bill savings and reduced emissions
	Home performance with ENERGY STAR pilot	Home performance with ENERGY STAR		X	S, W		
		HVAC rebate	Add HVAC practices	X	S		
Residential: New Construction	ENERGY STAR Homes pilot (in areas without existing infrastructure)	ENERGY STAR Homes		X	S, W	X	Bill savings and reduced emissions
			Add ENERGY STAR Advanced Lighting Package		S, W		
Low-Income	Education and coordination with weatherization programs			X	W		Bill savings and reduced emissions
		Direct install		X	S, W	X	Improved bill payment
			Add home repair				Improved comfort
Multifamily	Lighting, audits				S, W		Bill savings and reduced emissions
		Direct install		X	S, W		
Commercial: Existing Buildings	Lighting, motors, HVAC, pumps, refrigeration, food service equipment prescriptive rebates				S, W		Bill savings and reduced emissions
		Custom measures			S, W	X	
	ESCO-type program		Comprehensive approach				
Commercial: New Construction	Lighting, motors, HVAC, pumps, refrigeration, food service equipment prescriptive rebates				S, W		Bill savings and reduced emissions
		Custom measures and design assistance			S, W	X	
Small Business	Lighting and HVAC rebates				S, W		Bill savings and reduced emissions
		Direct install			S, W		

the availability of newer, more efficient technologies are all reasons to reassess what measures are included in a program. Changes can be incremental, such as limiting incentives for a specific measure to specific markets or specific applications. As barriers hindering customer investment in a measure are reduced, it might be appropriate to lower or eliminate financial incentives altogether. It is not uncommon, however, for programs to continue

Wisconsin Focus on Energy: Comprehensive Commercial Retrofit Program

Wisconsin Focus on Energy's Feasibility Study Grants and Custom Incentive Program encourages commercial customers to implement comprehensive, multi-measure retrofit projects resulting in the long-term, in-depth energy savings. Customers implementing multi-measure projects designed to improve the whole building might be eligible for an additional 30 percent payment as a comprehensive bonus incentive. **The Comprehensive Commercial Retrofit Program saved 70,414,701 kWh, 16.4 MW, and 2 million therms from 2001 through 2005.**

Sources: Thorne-Amann and Mendelsohn, 2005; Wisconsin, 2006.

Xcel Energy Design Assistance

Energy Design Assistance offered by Xcel, targets new construction and major renovation projects. The program goal is to improve the energy efficiency of new construction projects by encouraging the design team to implement an integrated package of energy efficient strategies. The target markets for the program are commercial customers and small business customers, along with architectural and engineering firms. The program targets primarily big box retail, public government facilities, grocery stores, healthcare, education, and institutional customers. The program offers three levels of support depending on project size. For projects greater than 50,000 square feet, the program offers custom consulting. For projects between 24,000 and 50,000 square feet, the program offers plan review. Smaller projects get a standard offering. The program covers multiple HVAC, lighting, and building envelope measures. The program also addresses industrial process motors and variable speed drives. **Statewide, the Energy Design Assistance program saved 54.3 GWh and 15.3 MW at a cost of $5.3 million in 2003.**

Source: Minnesota Office of Legislative Auditor, 2005; Quantum Consulting Inc., 2004

monitoring product and measure uptake after programs have ceased or to support other activities, such as continued education, to ensure that market share for products and services are not adversely affected once financial incentives are eliminated.

Pilot New Program Concepts

New program ideas and delivery approaches should be initially offered on a pilot basis. Pilot programs are often very limited in duration, geographic area, sector or technology, depending upon what is being tested. There should be a specific set of questions and objectives that the pilot program is designed to address. After the pilot period, a quick assessment of the program should be conducted to determine successful aspects of the program and any problem areas for improvement, which can then be addressed in a more full-scale program. The NSTAR program shown below is a recent example of an emerging program type that was originally started as a pilot.

Table 6-13 provides a summary of the examples provided in this section.

NSTAR Electric's ENERGY STAR Benchmarking Initiative

NSTAR is using the ENERGY STAR benchmarking and portfolio manager to help its commercial customers identify and prioritize energy efficiency upgrades. NSTAR staff assist the customer in using the ENERGY STAR tools to rate their building relative to other buildings of the same type, and identify energy efficiency upgrades. Additional support is provided through walk-through energy audits and assistance in applying for NSTAR financial incentive programs to implement efficiency measures.

Ongoing support is available as participants monitor the impact of the energy efficiency improvements on the building's performance.

Table 6-13. Program Examples for Key Customer Segments

Customer Segment	Program	Program Administrator	Program Description/ Strategies	Program Model		Key Best Practices
				Proven	Emerging	
All	Training and certification components	KeySpan	KeySpan's programs include a significant certification and training component. This includes building operator certification, building code training and training for HVAC installers. Strategies include training and certification.		X	Don't underinvest in education, training, and outreach. Solicit stakeholder input. Use utilities channels and brand.
Commercial, Industrial	Non-residential performance contracting program	California Utilities	This program uses a standard contract approach to provide incentives for measured energy savings. The key strategy is the provision of financial incentives.	X		Build upon ESCO and other financing program options. Add program complexity over time. Keep participation simple.
Commercial, Industrial, New Construction	Energy design assistance	XCEL	This program targets new construction and major renovation projects. Key strategies are incentives and design assistance for electric saving end uses.	X		Keep participation simple. Add complexity over time.
Commercial, Industrial	Custom incentive program	Wisconsin Focus on Energy	This program allows commercial and industrial customers to implement a wide array of measures. Strategies include financial assistance and technical assistance.	X		Keep participation simple. Add complexity over time.
Large Commercial, Industrial	NY Performance Contracting Program	NYSERDA	Comprehensive Performance Contracting Program provides incentives for measures and leverages the energy services sector. The predominant strategies are providing incentives and using the existing energy services infrastructure.	X	Does allow for technologies to be added over time	Leverage customer contact to sell additional measures. Add program complexity over time. Keep participation simple. Build upon ESCO and other financing options.
Large Commercial, Industrial	ENERGY STAR Benchmarking	NSTAR	NSTAR uses EPA's ENERGY STAR benchmarking and Portfolio Manager to assist customers in rating their buildings.	X		Coordinate with other programs. Keep participation simple. Use utility channels and brand. Leverage ENERGY STAR.
Small Commercial	Smart business	Seattle City Light	This program has per unit incentives for fixtures and is simple to participate in. It also provides a list of pre-qualified contractors.	X		Use utility channels and brand. Leverage customer contact to sell additional measures. Keep funding consistent.
Residential	Flex Your Power	California IOU's	This is an example of the CA utilities working together on a coordinated campaign to promote ENERGY STAR products. Lighting and appliances were among the measures promoted. Strategies include incentives and advertising.	X		Don't underinvest in education, training, and outreach. Solicit stakeholder input. Use utilities channels and brand. Coordinate with other programs. Leverage manufacturer and retailer resources. Keep participation simple. Leverage ENERGY STAR.
Residential - Low Income	Residential affordability program	LIPA	Comprehensive low-income program that installs energy saving measures and also provides education. Strategies are incentives and education.	X		Coordinate with other programs. Keep participation simple. Leverage customer contact to sell additional measures.

Table 6-13. Program Examples for Key Customer Segments (continued)

Customer Segment	Program	Program Administrator	Program Description/ Strategies	Program Model		Key Best Practices
				Proven	Emerging	
Residential Existing Homes	Home Performance with ENERGY STAR	Austin Energy	Whole house approach to existing homes. Measures include: air sealing, insulation, lighting, duct-sealing, and replacing HVAC.		X	Start with proven models. Use utilities channels and brand. Coordinate with other programs.
Residential New Construction	ENERGY STAR Homes	Efficiency Vermont	Comprehensive new construction program based on a HERS rating system. Measures include HVAC, insulation lighting, windows, and appliances.	X		Don't underinvest in education, training, and outreach. Solicit stakeholder input. Leverage state and federal tax credits. Leverage ENERGY STAR.
Residential Existing Homes	Residential program	Great River Coop	Provides rebates to qualifying appliances and technologies. Also provides training and education to customers and trade allies. Is a true dual-fuel program.	X		Start with proven models. Use utilities channels and brand. Coordinate with other programs.
Residential Existing Homes	New Jersey Clean Energy Program	New Jersey BPU	Provides rebates to qualifying appliances and technologies. Also provides training and education to customers and trade allies. Is a true dual-fuel program.	X		Start with proven models. Coordinate with other programs.
Commercial Existing	Education and training	BOMA	Designed to teach members how to reduce energy consumption and costs through no- and low-cost strategies.		X	Leverage organizations and outside education and training opportunities. Leverage ENERGY STAR.

Ensuring Energy Efficiency Investments Deliver Results

Program evaluation informs ongoing decision-making, improves program delivery, verifies energy savings claims, and justifies future investment in energy efficiency as a reliable energy resource. Engaging in evaluation during the early stages of program development can save time and money by identifying program inefficiencies, and suggesting how program funding can be optimized. It also helps ensure that critical data are not lost.

The majority of organizations reviewed for this paper have formal evaluation plans that address both program processes and impacts. The evaluation plans, in general, are developed consistent with the evaluation budget cycle and allocate evaluation dollars to specific programs and activities. Process and impact evaluations are performed for each program early in program cycles. As programs and portfolios mature, process evaluations are less frequent than impact evaluations. Over the maturation period, impact evaluations tend to focus on larger programs (or program components), and address more complex impact issues.

Most programs have an evaluation reporting cycle that is consistent with the program funding (or budgeting) cycle. In general, savings are reported individually by sector and totaled for the portfolio. Organizations use evaluation results from both process and impact evaluations to improve programs moving forward, and adjust their portfolio of energy efficiency offerings based on evaluation findings and other factors. Several organizations have adopted the International Performance Measurement and Verification Protocol (IPMVP) to provide guidelines for evaluation approaches. California has its own set of formal protocols that address specific program types. Key methods used by organizations vary based on program type and can include billing analysis, engineering analysis, metering, sales data tracking, and market effects studies.

Table 6-14 summarizes the evaluation practices of a subset of the organizations reviewed for this study.

Table 6-14. Evaluation Approaches

	NYSERDA (NY)	Efficiency Vermont (VT)	Electric Utilities NSTAR (MA)	WI Department of Administration (WI)	CA Utilities (CA)	MN Electric and Gas Investor-Owned Utilities (MN)	Bonneville Power Administration (ID, MT, OR , WA)
Policy Model	SBC w/state administration	SBC w/3rd party administration	SBC w/utility administration	SBC w/state administration	SBC w/utility administration	IRP and Conservation Improvement Program	Regional Planning Model
Program Funding Source	Annual appropriation. 8-year renewable portfolio standard program. 5-year public benefit programs.	Not available	SBC	SBC – electric ratepayers	Not available	Utilities, by order of state legislature, to spend a percent of revenues on efficiency programs.	Not available
Program Budgeting Cycle	Annual	3 years	Annual from SBC	Annual	Current funding cycle is 3 years. Previous periods were only 2 years.	Currently a 2-year cycle, but a 4-year cycle is recommended. Natural gas submits plans 1 year; electricity the next.	Dependent upon rate case, can be every 2 to 5 years. Generally amortized annually.
Evaluation Funding Cycle	Annual	Not available	Annual; evaluation is a line item in budgeting process.	Annual	Ongoing, every year. Upcoming contracts will be 3 year evaluation with annual reporting.	Funded as needed	Evaluation funded periodically when necessary. Starting to do more frequent evaluations than in previous years.
Evaluation Reporting Cycle	Quarterly and annually	Annually and as needed	Annually but not every program every year	Twice per year	Annual	Annual status reports	Not available
Role of Deemed Savings (i.e., pre-determined savings)	Estimate savings. Program planning and goals.	Estimate savings.	DOER for report to legislature. Program planning and design.	Estimate savings. Program planning and goals.	Planning. Inputs for TRC analysis. Adjusted regularly based on evaluation results.	Not available	Determine payment schedule for efficiency measures with established savings records.
Report Gross Savings (usually kWh, kW)	No	No	Yes	Yes	Yes	Not available	Yes. Gross savings forms basis for regional power plans.
Report Net Savings (usually kWh, kW)	Yes	Yes	Yes	Yes	Yes	Not available	Yes. Used to evaluate the efficiency of measures and fine-tune programs. Savings netted out depends upon program.
Net Savings Components							
Installation Verification	Yes		Yes	Yes	Yes		Not available
Engineering Review	Yes		Yes	Yes	Yes		Not available
Free Ridership	Yes	Yes	Yes	Yes	Yes	Yes	Not available
Spillover or Market Effects	Yes	Yes	Yes	Yes	Yes		Not available
Retention	Yes	Yes	Yes	Yes			Not available
Non-Energy Benefits	Yes					Yes	Not available
Other Not Specified						Yes	

Table 6-14. Evaluation Approaches (continued)

	NYSERDA (NY)	Efficiency Vermont (VT)	Electric Utilities NSTAR (MA)	WI Department of Administration (WI)	CA Utilities (CA)	MN Electric and Gas Investor-Owned Utilities (MN)	Bonneville Power Administration (ID, MT, OR , WA)
Education and Training in EE Budget	Yes	Not available	Yes	Not available	Yes	Not available	Yes
Education and Training Evaluated	Yes	Not available	Depends on program	Initial years only	Yes	Not available	No
Evaluation Funding as Percent of Program Budget	Not available	<1%	2%	8% increase from 4.25%	No more than 3% of minimum efficiency spending requirement.	<1%	
Evaluation Budget	Not available	Not available	Varies annually dependent upon project portfolio and other demands.	Not Available	$160MM over 3 years.	Not available	$1MM
Financial Evaluation	Internal State Comptroller CPA	CPA	Internal CPA	CPA	Not avaiable	Internal. Reviewed by Department of Commerce. Reviewed by Legislature.	Internal
Cost-Effectiveness Analysis	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Timing	Annually	Triennially	Varies annually dependent upon project portfolio and other demands.	Periodically (less frequent than funding cycle)	Not available	2 years	Periodically
Test Used (RIM, TRC, Utility, Other)	TRC; Other	Utility Cost Test and Societal Cost-Benefit Test	TRC	Societal; also includes economic impacts	TRCPAC (program administrator test)	Societal; Utility; Participant; Ratepayer	TRC
Who Evaluates	Independent evaluators	Independent experts under contract to DPS	Utilities manage independent evaluators through RFP process	One independent team of evaluators	Independent evaluators hired for each program via RFP process	Department of Commerce Legislature Audit Commission, if deemed necessary	Independent evaluators
Oversight of evaluation	NYSERDA provides ongoing oversight. Public Utilities Commission final audience.	Department of Public Service	Evaluations are reviewed in collaborative and filed with the Massachusetts Department of Telecommunications and Energy	WI Department of Administration	California Public Utilities Commission and CEC	Department of Commerce	Power Council
Protocols	IPMVP	Not available	Not available	None	Has had statewide protocols for many years. New protocols were recently adopted.	Not available	IPMVP as reference

Best practices for program evaluation that emerge from review of these organizations include the following:

- Budget, plan, and initiate evaluation from the onset.
- Formalize and document evaluation plans.
- Develop program tracking systems that are compatible with needs identified in evaluation plans.
- Conduct process evaluations to ensure that programs are working efficiently.
- Conduct impact evaluations to ensure that mid- and long-term goals are being met.
- Communicate evaluation results.

Budget, Plan, and Initiate Evaluation From the Onset

A well-designed evaluation plan addresses program process and impact issues. *Process evaluations* address issues associated with program delivery such as marketing, staffing, paperwork flow, and customer interactions, to understand how they can be improved to better meet program objectives. *Impact evaluations* are designed to determine the energy or peak savings from the program. Sometimes evaluations address other program benefits such as non-energy benefits to consumers, water savings, economic impacts, or emission reductions. Market research is often included in evaluation budgets to assist in assessing program delivery options, and for establishing baselines. An evaluation budget of 3 to 6 percent of program budget is a reasonable spending range. Often evaluation spending is higher in the second or third year of a program. Certain evaluation activities such as establishing baselines are critical to undertake from the onset to ensure that valuable data are not lost.

> "We should measure the performance of DSM programs in much the same way and with the same competence and diligence that we monitor the performance of power plants."
>
> **—Eric Hirst (1990), Independent Consultant and Former Corporate Fellow, Oak Ridge National Laboratory**

Develop Program and Project Tracking Systems That Support Evaluation Needs

A well-designed tracking system should collect sufficiently detailed information needed for program evaluation and implementation. Data collection can vary by program type, technologies addressed, and customer segment; however, all program tracking systems should include:

- *Participating customer information.* At a minimum, create an unique customer identifier that can be linked to the utility's Customer Information System (CIS). Other customer or site specific information might be valuable.
- *Measure specific information.* Record equipment type, equipment size or quantity, efficiency level and estimated savings.
- *Program tracking information.* Track rebates or other program services provided (for each participant) and key program dates.
- *All program cost information.* Include internal staffing and marketing costs, subcontractor and vendor costs, and program incentives.

Efficiency Vermont's tracking system incorporates all of these features in a comprehensive, easy-to-use relational database that includes all program contacts including, program allies and customers, tracks all project savings and costs, shows the underlying engineering estimates for all measures, and includes billing data from all of the Vermont utilities.

Conduct Process Evaluations to Ensure Programs Are Working Efficiently

Process evaluations are a tool to improve the design and delivery of the program and are especially important for newer programs. Often they can identify improvements to program delivery that reduce program costs, expedite program delivery, improve customer satisfaction, and better focus program objectives. Process evaluation can also address what technologies get rebates or determine rebate levels. Process evaluations use a variety of qualitative and quantitative approaches including review of program documents, in-depth interviews, focus groups, and surveys. Customer research in general, such as regular customer and vendor surveys, provides program administrators with continual feedback on how the program is working and being received by the market.

Conduct Impact Evaluations to Ensure Goals Are Being Met

Impact evaluations measure the change in energy usage (kWh, kW, and therms) attributable to the program. They use a variety of approaches to quantify energy savings including statistical comparisons, engineering estimation, modeling, metering, and billing analysis. The impact evaluation approach used is a function of the budget available, the technology(ies) addressed, the certainty of the original program estimates, and the level of estimated savings. The appliance recycling example shown at right is an example of how process and impact evaluations have improved a program over time.

Measurement and Verification (M&V)

The term "measurement and verification" is often used in regard to evaluating energy efficiency programs. Sometimes this term refers to ongoing M&V that is incorporated into program operations, such as telephone confirmation of installations by third-party installers or measurement of savings for selected projects. Other times, it refers to external (program operations) evaluations to document savings.

California Residential Appliance Recycling Program (RARP)

The California RARP was initially designed to remove older, inefficient second refrigerators from participant households. As the program matured, evaluations showed that the potential for removing old second refrigerators from households had decreased substantially as a result of the program. The program now focuses on pick-up of older refrigerators that are being replaced, to keep these refrigerators out of the secondary refrigerator market.

Organizations are beginning to explore the use of the EPA Energy Performance Rating System to measure the energy performance at the whole-building level, complement traditional M&V measures, and go beyond component-by-component approaches that miss the interactive impacts of design, sizing, installation, controls, and operation and maintenance.

While most energy professionals see inherent value in providing energy education and training (lack of information is often identified as a barrier to customer and market actor adoption of energy efficiency products and practices), few programs estimate savings directly as a result of education efforts. Until 2004, California assigned a savings estimate to the Statewide Education and Training Services program based on expenditures.

Capturing the energy impacts of energy education programs has proven to be a challenge for evaluators for several reasons. First, education and training efforts are often integral to specific program offerings. For example, training of HVAC contractors on sizing air conditioners might be integrated into a residential appliance rebate program. Second, education and training are often a small part of a program in terms of budget and estimated savings. Third, impact evaluation efforts might be expensive compared to the education and training budget and anticipated savings. Fourth, education and training efforts are not always designed to achieve direct benefits. They are often designed to inform participants or market actors of program opportunities, simply to familiarize them with energy efficiency options. Most evaluations of

Best Practices in Evaluation

- Incorporating an overall evaluation plan and budget into the program plan.
- Adopting a more in-depth evaluation plan each program year.
- Prioritizing evaluation resources where the risks are highest. This includes focusing impact evaluation activities on the most uncertain outcomes and highest potential savings. New and pilot programs have the most uncertain outcomes, as do newer technologies.
- Allowing evaluation criteria to vary across some program types to allow for education, outreach, and innovation.
- Conducting ongoing verification as part of the program process.
- Establishing a program tracking system that includes necessary information for evaluation.
- Matching evaluation techniques to the situation in regards to the costs to evaluate, the level of precision required, and feasibility.
- Maintaining separate staff for evaluation and for program implementation. Having outside review of evaluations (e.g., state utility commission), especially if conducted by internal utility staff.
- Evaluating regularly to refine programs as needed (changing market conditions often require program changes).

energy education and training initiatives have focused on process issues. Recently, there have been impact evaluations of training programs, especially those designed to produce direct energy savings, such as Building Operator Certification.

In the future, energy efficiency will be part of emissions trading initiatives (such as the Regional Greenhouse Gas Initiative [RGGI]) and is likely to be eligible for payments for reducing congestion and providing capacity value such as in the ISO-NE capacity market settlement. These emerging opportunities will require that evaluation methods become more consistent across states and regions, which might necessitate adopting consistent protocols for project-level verification for large projects, and standardizing sampling approaches for residential measures such as compact fluorescent lighting. This is an emerging need and should be a future area of collaboration across states.

Communicate Evaluation Results to Key Stakeholders

Communicating the evaluation results to program administrators and stakeholders is essential to enhancing program effectiveness. Program administrators need to understand evaluation approaches, findings, and especially recommendations to improve program processes and increase (or maintain) program savings levels. Stakeholders need to see that savings from energy efficiency programs are realized and have been verified independently.

Evaluation reports need to be geared toward the audiences reviewing them. Program staff and regulators often prefer reports that clearly describe methodologies, limitations, and findings on a detailed and program level. Outside stakeholders are more likely to read shorter evaluation reports that highlight key findings at the customer segment or portfolio level. These reports must be written in a less technical manner and highlight the impacts of the program beyond energy or demand savings. For example, summary reports of the Wisconsin Focus on Energy programs highlight energy, demand, and therm savings by sector, but also discuss the environmental benefits of the program and the impacts of energy savings on the Wisconsin economy. Because the public benefits budget goes through the state legislature, the summary reports include maps of Wisconsin showing where Focus on Energy projects were completed. Examples of particularly successful investments, with the customer's permission, should be part of the evaluation. These case studies can be used to make the success more tangible to stakeholders.

Recommendations and Options

The National Action Plan for Energy Efficiency Leadership Group offers the following recommendations as ways to promote best practice energy efficiency programs, and provides a number of options for consideration by utilities, regulators, and stakeholders.

Recommendation: Recognize energy efficiency as a high-priority energy resource. Energy efficiency has not been consistently viewed as a meaningful or dependable resource compared to new supply options, regardless of its demonstrated contributions to meeting load growth. Recognizing energy efficiency as a high priority energy resource is an important step in efforts to capture the benefits it offers and lower the overall cost of energy services to customers. Based on jurisdictional objectives, energy efficiency can be incorporated into resource plans to account for the long-term benefits from energy savings, capacity savings, potential reductions of air pollutants and greenhouse gases, as well as other benefits. The explicit integration of energy efficiency resources into the formalized resource planning processes that exist at regional, state, and utility levels can help establish the rationale for energy efficiency funding levels and for properly valuing and balancing the benefits. In some jurisdictions, existing planning processes might need to be adapted or new planning processes might need to be created to meaningfully incorporate energy efficiency resources into resource planning. Some states have recognized energy efficiency as the resource of first priority due to its broad benefits.

Option to Consider:

- Quantifying and establishing the value of energy efficiency, considering energy savings, capacity savings, and environmental benefits, as appropriate.

Recommendation: Make a strong, long-term commitment to cost-effective energy efficiency as a resource. Energy efficiency programs are most successful and provide the greatest benefits to stakeholders when appropriate policies are established and maintained over the long-term. Confidence in long-term stability of the program will help maintain energy efficiency as a dependable resource compared to supply-side resources, deferring or even avoiding the need for other infrastructure investments, and maintains customer awareness and support. Some steps might include assessing the long-term potential for cost-effective energy efficiency within a region (i.e., the energy efficiency that can be delivered cost-effectively through proven programs for each customer class within a planning horizon); examining the role for cutting-edge initiatives and technologies; establishing the cost of supply-side options versus energy efficiency; establishing robust M&V procedures; and providing for routine updates to information on energy efficiency potential and key costs.

Options to Consider:

- Establishing appropriate cost-effectiveness tests for a portfolio of programs to reflect the long-term benefits of energy efficiency.
- Establishing the potential for long-term, cost-effective energy efficiency savings by customer class through proven programs, innovative initiatives, and cutting-edge technologies.
- Establishing funding requirements for delivering long-term, cost-effective energy efficiency.
- Developing long-term energy saving goals as part of energy planning processes.
- Developing robust M&V procedures.
- Designating which organization(s) is responsible for administering the energy efficiency programs.
- Providing for frequent updates to energy resource plans to accommodate new information and technology.

Recommendation: Broadly communicate the benefits of, and opportunities for, energy efficiency. Experience shows that energy efficiency programs help customers save money and contribute to lower cost energy systems. But these impacts are not fully documented nor recognized by customers, utilities, regulators, and policy-makers. More effort is needed to establish the business case for energy efficiency for all decision-makers, and to show how a well-designed approach to energy efficiency can benefit customers, utilities, and society by (1) reducing customers bills over time, (2) fostering financially healthy utilities (return on equity [ROE], earnings per share, debt coverage ratios), and (3) contributing to positive societal net benefits overall. Effort is also necessary to educate key stakeholders that, although energy efficiency can be an important low-cost resource to integrate into the energy mix, it does require funding, just as a new power plan requires funding. Further, education is necessary on the impact that energy efficiency programs can have in concert with other energy efficiency policies such as building codes, appliance standards, and tax incentives.

Options to Consider:

- Communicating the role of energy efficiency in lowering customer energy bills and system costs and risks over time.

- Communicating the role of building codes, appliance standards, tax and other incentives.

Recommendation: Provide sufficient and stable program funding to deliver energy efficiency where cost-effective. Energy efficiency programs require consistent and long-term funding to effectively compete with energy supply options. Efforts are necessary to establish this consistent long-term funding. A variety of mechanisms have been, and can be, used based on state, utility, and other stakeholder interests. It is important to ensure that the efficiency programs providers have sufficient program funding to recover energy efficiency program costs and implement the energy efficiency that has been demonstrated to be available and cost-effective. A number of states are now linking program funding to the achievement of energy savings.

Option to Consider:

- Establishing funding for multi-year periods.

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7: Report Summary

This report presents a variety of policy, planning, and program approaches that can be used to help natural gas and electric utilities, utility regulators, and partner organizations pursue the National Action Plan for Energy Efficiency recommendations and meet their commitments to energy efficiency. This chapter summarizes these recommendations and the energy efficiency key findings discussed in this report.

Overview

This National Action Plan for Energy Efficiency (Action Plan) is a call to action to bring diverse stakeholders together at the national, regional, state, or utility level, as appropriate, to foster the discussions, decision-making, and commitments necessary to take investment in energy efficiency to a new level. The overall goal is to create a sustainable, aggressive national commitment to energy efficiency through gas and electric utilities, utility regulators, and partner organizations.

Based on the policies, practices, and efforts of many organizations previously discussed in this report, the Leadership Group offers five recommendations as ways to overcome many of the barriers that have limited greater investment in programs to deliver energy efficiency to customers of electric and gas utilities (Figure 7-1). These recommendations may be pursued through a number of different options, depending on state and utility circumstances.

As part of the Action Plan, leading organizations are committing to aggressively pursue energy efficiency opportunities in their organizations and to assist others who want to increase the use of energy efficiency in their regions. The commitments pursued under the Action Plan have the potential to save Americans many billions of dollars on energy bills over the next 10 to 15 years, contribute to energy security, and improve the environment.

Recommendations and Options to Consider

The Action Plan Report provides information on the barriers that limit greater investment in programs to deliver energy efficiency to customers of electric and gas utilities. Figure 7-2 illustrates the key barriers and how they relate to policy structure, utility resource planning, and program implementation.

Figure 7-1. National Action Plan for Energy Efficiency Recommendations

- **Recognize energy efficiency as a high-priority energy resource.**
- **Make a strong, long-term commitment to implement cost-effective energy efficiency as a resource.**
- **Broadly communicate the benefits of and opportunities for energy efficiency.**
- **Promote sufficient, timely, and stable program funding to deliver energy efficiency where cost-effective**.
- **Modify policies to align utility incentives with the delivery of cost-effective energy efficiency and modify ratemaking practices to promote energy efficiency investments.**

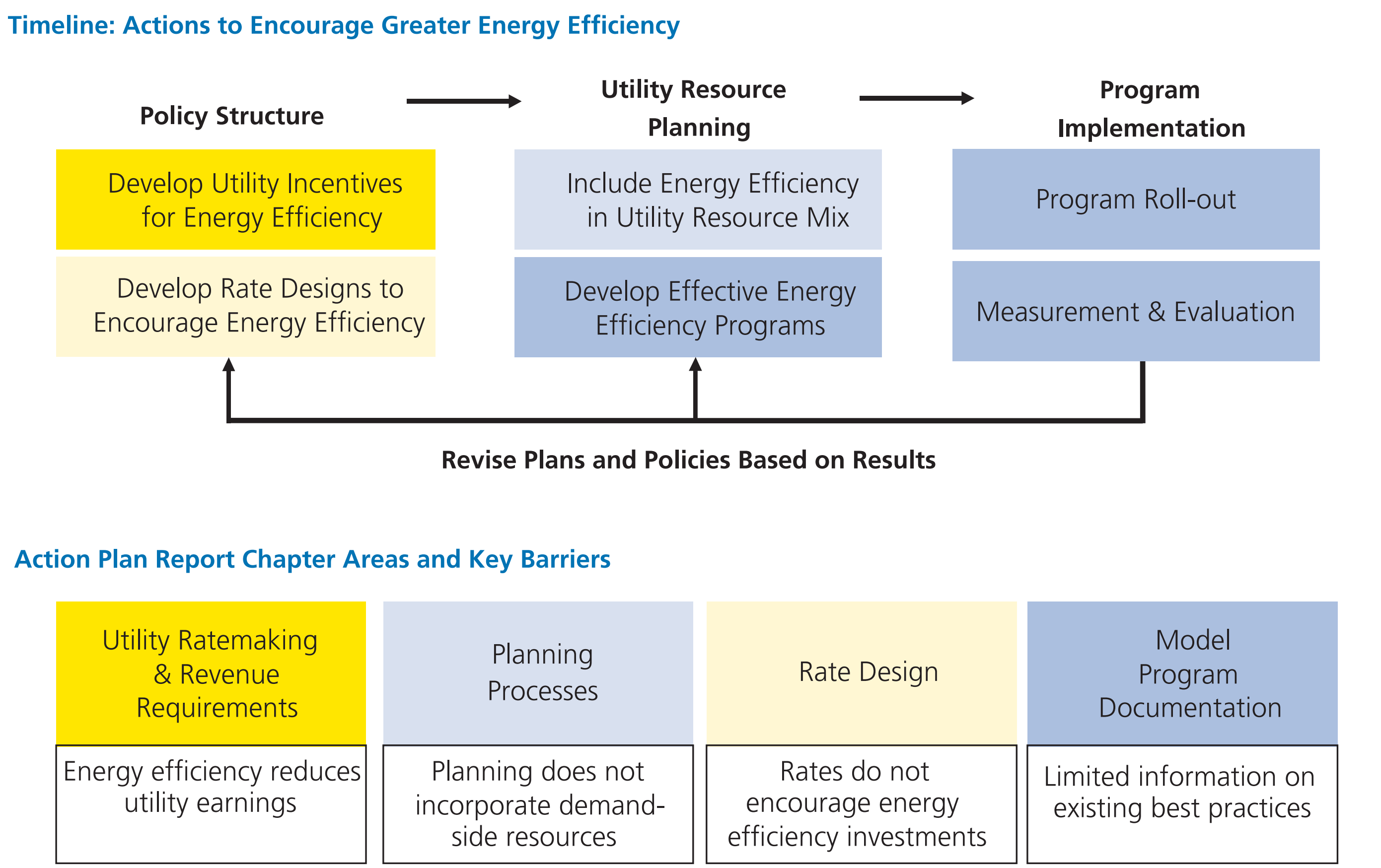
Several options exist for utilities, regulators, and partner organizations to overcome these barriers and pursue the Action Plan recommendations. Different state and utility circumstances affect which options are pursued. Table 7-1 provides a list of the Leadership Group recommendations along with sample options to consider. The table also provides a cross reference to supporting discussions in Chapters 2 through 6 of this report.

Key Findings

The key finding of the Action Plan Report is that energy efficiency can be a cost-effective resource and can provide multiple benefits to utilities, customers, and society. These benefits, also discussed in more detail in Chapter 1: Introduction and Background,[1] include:

- Lower energy bills, greater customer control, and greater customer satisfaction.
- Lower cost than only supplying new generation from new power plants.
- Advantages from being modular and quick to deploy.
- Significant energy savings.
- Environmental benefits.
- Economic development opportunities.
- Energy security.

Figure 7-2: National Action Plan for Energy Efficiency Report Addresses Actions to Encourage Greater Energy Efficiency



[1] Chapter 6: Energy Efficiency Program Best Practices also provides more information on these benefits.

Table 7-1. Leadership Group Recommendations and Options to Consider, by Chapter

Leadership Group Recommendations (With Options To Consider)	Chapter 2: Utility Ratemaking & Revenue Requirements	Chapter 3: Energy Resource Planning Processes	Chapter 4: Business Case for Energy Efficiency	Chapter 5: Rate Design	Chapter 6: Energy Efficiency Program Best Practices
Recognize energy efficiency as a high priority energy resource.		**X**			**X**
Establishing policies to establish energy efficiency as a priority resource.		X			
Integrating energy efficiency into utility, state, and regional resource planning activities.		X			
Quantifying and establishing the value of energy efficiency, considering energy savings, capacity savings, and environmental benefits, as appropriate.		X			X
Make a strong, long-term commitment to cost effective energy efficiency as a resource.	**X**	**X**			**X**
Establishing appropriate cost-effectiveness tests for a portfolio of programs to reflect the long-term benefits of energy efficiency.		X			X
Establishing the potential for long-term, cost effective energy efficiency savings by customer class through proven programs, innovative initiatives, and cutting-edge technologies.		X			X
Establishing funding requirements for delivering long-term, cost-effective energy efficiency.	X	X			X
Developing long-term energy saving goals as part of energy planning processes.		X			X
Developing robust measurement and verification (M&V) procedures.		X			X
Designating which organization(s) is responsible for administering the energy efficiency programs.	X	X			X
Providing for frequent updates to energy resource plans to accommodate new information and technology.		X			X
Broadly communicate the benefits of, and opportunities for, energy efficiency.	**X**	**X**	**X**	**X**	**X**
Establishing and educating stakeholders on the business case for energy efficiency at the state, utility, and other appropriate level addressing relevant customer, utility, and societal perspectives.	X	X	X		
Communicating the role of energy efficiency in lowering customer energy bills and system costs and risks over time.	X	X	X	X	X
Communicating the role of building codes, appliance standards, and tax and other incentives.					X

Table 7-1. Leadership Group Recommendations and Options to Consider, by Chapter (continued)

Leadership Group Recommendations (With Options To Consider)	**Chapter 2: Utility Ratemaking & Revenue Requirements**	**Chapter 3: Energy Resource Planning Processes**	**Chapter 4: Business Case for Energy Efficiency**	**Chapter 5: Rate Design**	**Chapter 6: Energy Efficiency Program Best Practices**
Provide sufficient, timely, and stable program funding to deliver energy efficiency where cost-effective.	**X**	**X**			**X**
Deciding on and committing to a consistent way for program administrators to recover energy efficiency costs in a timely manner.	X	X			
Establishing funding mechanisms for energy efficiency from among the available options such as revenue requirement or resource procurement funding, system benefits charges, rate-basing, shared-savings, incentive mechanisms, etc.	X	X			
Establishing funding for multi-year periods.	X	X			X
Modify policies to align utility incentives with the delivery of cost-effective energy efficiency and modify ratemaking practices to promote energy efficiency investments.	**X**			**X**	
Addressing the typical utility throughput incentive and removing other regulatory and management disincentives to energy efficiency.	X				
Providing utility incentives for the successful management of energy efficiency programs.	X				
Including the impact on adoption of energy efficiency as one of the goals of retail rate design, recognizing that it must be balanced with other objectives.				X	
Eliminating rate designs that discourage energy efficiency by not increasing costs as customers consume more electricity or natural gas.				X	
Adopting rate designs that encourage energy efficiency by considering the unique characteristics of each customer class and including partnering tariffs with other mechanisms that encourage energy efficiency, such as benefit sharing programs and on-bill financing.				X	

As discussed in Chapter 2: Utility Ratemaking & Revenue Requirements, financial disincentives exist that hinder utilities from pursuing energy efficiency, even when cost-effective. Many states have experience in addressing utility financial disincentives in the following areas:

- Overcoming the throughput incentive.
- Providing reliable means for utilities to recover energy efficiency costs.
- Providing a return on investment for efficiency programs that is competitive with the return utilities earn on new generation.
- Addressing the risk of program costs being disallowed, along with other risks.
- Recognizing the full value of energy efficiency to the utility system.

Chapter 3: Energy Resource Planning Processes found that there are many approaches to navigate and overcome the barriers to incorporating energy efficiency in planning processes. Common themes across approaches include:

- Cost and savings data for energy efficiency measures are readily available.
- Energy, capacity, and non-energy benefits can justify robust energy efficiency programs.
- A clear path to funding is needed to establish a budget for energy efficiency resources.
- Parties should integrate energy efficiency early in the resource planning process.

Based on the eight cases examined using the Energy Efficiency Benefits Calculator in Chapter 4: Business Case for Energy Efficiency, energy efficiency investments were found to provide consistently lower costs over time for both utilities and customers, while providing positive net benefits to society. Key findings include:

- Ratemaking policies to address utility financial barriers to energy efficiency maintain utility health while comprehensive, cost-effective energy efficiency programs are implemented.
- The costs of energy efficiency and the reduction in utility sales volume initially raise gas or electricity bills due to slightly higher rates, but efficiency gains will reduce average customer bills by 2 to 9 percent over a 10-year period.
- Energy efficiency investments yielded net societal benefits on the order of hundreds of millions of dollars for each of the eight small- to medium-sized utility cases examined.

Chapter 5: Rate Design found that recognizing the promotion of energy efficiency is an important factor to balance along with the numerous regulatory and legislative goals addressed during the complex rate design process. Additional key findings include:

- Several rate design options exist to encourage customers to invest in efficiency and to participate in new programs that provide innovative technologies (e.g., smart meters).
- Utility rates that are designed to promote sales or maximize stable revenues tend to lower customer incentives to adopt energy efficiency.
- Some rate forms, like declining block rates or rates with large fixed charges, reduce the savings that customers can attain from adopting energy efficiency.
- Appropriate rate designs should consider the unique characteristics of each customer class.
- Energy efficiency can be promoted through non-tariff mechanisms that reach customers through their utility bill.
- More effort is needed to communicate the benefits and opportunities for energy efficiency to customers, regulators, and utility decision-makers.

Chapter 6: Energy Efficiency Program Best Practices provided a summary of best practices, as well as general program key findings. The best practice strategies for program planning, design, implementation, and evaluation are found to be independent of the policy model in which the program operates. These best practices, organized by four major groupings, are provided below:

- Making Energy Efficiency A Resource

— Require leadership at multiple levels.

— Align organizational goals.

— Understand the efficiency resource.

- Developing An Energy Efficiency Plan

— Offer programs for all key customer classes.

— Align goals with funding.

— Use cost-effectiveness tests that are consistent with long-term planning.

— Consider building codes and appliance standards when designing programs.

— Plan to incorporate new technologies.

— Consider efficiency investments to alleviate transmission and distribution constraints.

— Create a roadmap of key program components, milestones, and explicit energy use reduction goals.

- Designing and Delivering Energy Efficiency Programs

— Begin with the market in mind.

— Leverage private sector expertise, external funding, and financing.

— Start with demonstrated program models—build infrastructure for the future.

- Ensuring Energy Efficiency Investments Deliver Results

— Budget, plan, and initiate evaluation.

— Develop program and project tracking systems.

— Conduct process evaluations.

— Conduct impact evaluations.

— Communicate evaluation results to key stakeholders.

The key program findings in Chapter 6 are drawn from the programs reviewed for this report.[2] These findings include:

- Energy efficiency resources are being acquired on average at about one-half the cost of typical new power sources and about one-third of the cost of natural gas supply in many cases—contributing to an overall lower-cost energy system for rate-payers (EIA, 2006).

- Many energy efficiency programs are being delivered at a total program cost of about $0.02 to $0.03 per lifetime kilowatt-hour (kWh) saved and $1.30 to $2.00 per lifetime million British thermal units (MMBtu) saved. These costs are less than the avoided costs seen in most regions of the country. Funding for the majority of programs reviewed ranges from about 1 to 3 percent of electric utility revenue and 0.5 to 1 percent of gas utility revenue.

- Even low energy cost states, such as those in the Pacific Northwest, have reason to invest in energy efficiency because energy efficiency provides a low-cost, reliable resource that reduces customer utility bills. Energy efficiency also costs less than constructing new generation and provides a hedge against market, fuel, and environmental risks (NWPCC, 2005).

- Well-designed energy efficiency programs provide opportunities for customers of all types to adopt energy saving measures and reduce their energy bills. These programs can help customers make sound energy-use decisions, increase control over their energy bills, and empower them to manage their energy usage. Customers can experience significant savings depending on their own habits and the program offered.

- Consistently funded, well-designed efficiency programs are cutting electricity and natural gas load—providing annual savings for a given program year of 0.15 to 1 percent of energy sales. These savings typically will

[2] See Chapter 6: Energy Efficiency Program Best Practices, Tables 6-2 and 6-3, for more information on energy efficiency programs reviewed.

accrue at this level for 10 to 15 years. These programs are helping to offset 20 to 50 percent of expected energy growth in some regions without compromising end-user activity or economic well being.

- Research and development enables a continuing source of new technologies and methods for improving energy efficiency and helping customers control their energy bills.

- Many state and regional studies have found that pursuing economically attractive, but as yet untapped, energy efficiency could yield more than 20 percent savings in total electricity demand nationwide by 2025. These savings could help cut load growth by half or more compared to current forecasts. Savings in direct use of natural gas could similarly provide a 50 percent or greater reduction in natural gas demand growth. Energy savings potential varies by customer segment, but there are cost-effective opportunities for all customer classes.

- Energy efficiency programs are being operated successfully across many different contexts: regulated and unregulated markets; utility, state, or third-party administration; investor-, publicly-, and cooperatively-owned utilities; and gas and electric utilities.

- Energy efficiency resources are being acquired through a variety of mechanisms including system benefits charges (SBC), energy efficiency portfolio standards (EEPS), and resource planning (or cost-of-service) efforts.

- Cost-effective energy efficiency programs exist for electricity and natural gas, including programs that can be specifically targeted to reduce peak load.

- Effective models exist for delivering gas and electric energy efficiency programs to all customer classes. Models might vary for some programs based on whether a utility is in the initial stages of energy efficiency programming or has been implementing programs for years.

- Energy efficiency programs, projects, and policies benefit from established and stable regulations, clear goals, and comprehensive evaluation.

- Energy efficiency programs benefit from committed program administrators and oversight authorities, as well as strong stakeholder support.

- Most large-scale energy efficiency programs have improved productivity, enabling job growth in the commercial and industrial sectors.

- Large-scale energy efficiency programs can reduce wholesale market prices.

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Appendix A: Additional Guidance on Removing the Throughput Incentive

The National Action Plan for Energy Efficiency provides policy recommendations and options to support a strong commitment to cost-effective energy efficiency in the United States. One policy that receives a great deal of attention is reducing or eliminating the financial incentive for a utility to sell more energy—the throughput incentive. Options exist to address the throughput incentive, as discussed in more detail in this appendix.

Overview

In order to eliminate the conflict between the public service objectives of least-cost service on the one hand, and a utility's profitability objectives on the other hand, it is necessary to remove the throughput incentive. Some options for removing the throughput incentive are generally called decoupling because these options "decouple" profits from sales volume. In its simplest form, decoupling is accomplished by periodically adjusting tariff prices so that the utility's revenues (and hence its profits) are, on a total company basis, held relatively constant in the face of changes in customer consumption.

This appendix explains options to address the throughput incentive by changing regulations and the way utilities make money, to ensure that utility net income and coverage of fixed costs are not affected solely by sales volume.

Types of Decoupling

Utilities and regulators have implemented a variety of different approaches to remove the throughput incentive. Regardless of which approach is used, a frame of reference is created, and used to compare with actual results. Periodic tariff price adjustments true up actual results to the expected results and are critical to the decoupling approach.

- *Average revenue-per-customer.* This approach is often considered for utilities, where their underlying costs during the period between rate adjustments do not vary with consumption. Such can be the case for a wires-only distribution company, where the majority of investments are in the wires and transformers used to deliver the commodity.

- *Forecast revenues over a period of time and use a balancing account.* This approach is often considered for utilities where a significant portion of the costs (primarily fuel) vary with consumption. For these cases, it might be best to use a price-based decoupling mechanism for the commodity portion of electric service (which gives the utility the incentive to reduce fuel and other variable costs), while using a revenue-per-customer approach for the "wires" costs. Alternatively, regulators can use traditional tariffs for the commodity portion and apply decoupling only to the wires portion of the business.

Sample Approach to Removing the Throughput Incentive[1]

Implementing decoupling normally begins with a traditional revenue requirement rate case. Decoupling can also be overlaid on existing tariffs where there is a high confidence that those tariffs continue to represent the utility's underlying revenue requirements.

Under traditional rate of return regulation:

Price (Rates) = Revenue Requirement/Sales
(test year or forecasted)

[1] In this section, the revenue per customer approach is discussed, but can be easily adapted to a revenue forecast approach.

The revenue requirement as found in the rate case will not change again until the next rate case. Note that the revenue requirement contains an allowance for profit and debt coverage. Despite all the effort in the rate case to calculate the revenue requirement, what really matters after the rate case is the price the consumer pays for electricity.

After the rate case:

$$\text{Actual revenues} = \text{Price} * \text{Actual Sales}$$

And

$$\text{Actual Profit} = \text{Actual Revenue} - \text{Actual Costs}$$

Based on the rate case "test year" data, an average revenue-per-customer value can then be calculated for each rate class.

$$\text{Revenue Requirement } t_0 \text{ /number of customers } t_0 = \text{revenue per customer (RPC)}$$

Thus, at time "zero"(t_0), the company's revenues equal its number of customers multiplied by the revenues per customer, while the prices paid by customers equal the revenues to be collected divided by customers' consumption units (usually expressed as $/kW for metered demand and $/kWh for metered energy). Looking forward, as the number of customers changes, the revenue to be collected changes.

$$\text{Revenue Requirement } t_n = \text{RPC} * \text{number of customers } t_n$$

For each future period (t_1, t_2…, t_n), the new revenue to be collected is then divided by the expected consumption to periodically derive a new price, the true-up.

$$\text{Price (Rates) } t_n = \text{Revenue Requirement } t_n \text{ / Sales } t_n$$

$$\text{True up} = \text{Price } t_n - \text{Price } t_0$$

Prices can also be trued-up based on deviations between revenue and cost forecasts and actual results, where a forecast approach is used. Note that no redesign of rates is necessary as part of decoupling. Rate redesign might be desirable for other reasons (for more information on changes that promote energy efficiency, see Chapter 5: Rate Design), and decoupling does not interfere with those reasons.

The process can be augmented by various features that, for example, explicitly factor in utility productivity, exogenous events (events of financial significance, out of control of the utility), or factors that might change RPC over time.

Timing of Adjustments

Rates can be adjusted monthly, quarterly, or annually (magnitude of any t_n). By making the adjustments more often, the magnitude of any price change is minimized. However, frequent adjustments will impose some additional administrative expense. A plan that distinguishes commodity cost from other costs could have more frequent adjustments for more volatile commodities (if these are not already being dealt with by an adjustment clause). Because the inputs used for these adjustments are relatively straight-forward, coming directly from the utility's billing information, each filing should be largely administrative and not subject to a significant controversy or litigation. This process can be further streamlined through the use of "deadbands," which allow for small changes in either direction in revenue or profits with no adjustment in rates.

Changes to Utility Incentives

With decoupling in place, a prudently managed utility will receive revenue from customers that will cover its fixed costs, including profits. If routine costs go up, the utility will absorb those costs. A reduction in costs produces the opportunity for additional earnings. The primary driver for profitability growth, however, will be the addition of new customers, and the greatest contribution to profits will be from customers who are more efficient—that is, whose incremental costs are the lowest.

An effective decoupling plan should lower utility risk to some degree. Reduced risk should be reflected in the cost of capital and, for investor-owned utilities, can be realized through either an increase in the debt/equity ratio, or a decrease in the return on equity investment. For all utilities, these changes will flow through to debt ratings and credit requirements.

In addition, decoupling can be combined with performance indicators to ensure that service quality is maintained, and that cost reductions are the result of gains in efficiency and not a decline in the level of service. Other exogenous factors, such as inflation, taxes, and economic conditions, can also be combined with decoupling; however, these factors do not address the primary purpose of removing the disincentive to efficiency. Also, if there is a distinct productivity for the electric utility as compared with the general economy, a factor accounting for it can be woven into the revenue per customer calculations over time.

Allocation of Weather Risk

One specific factor that is implicit in any regulatory approach (whether it be traditional regulation or decoupling) is the allocation of weather risk between utilities and their customers. Depending on the policy position of the regulatory agency, the risk of weather changes can be allocated to either customers or the utility. This decision is inherent to the rate structure, even if the regulatory body makes no cognizant choice.

Under traditional regulation, weather risk is usually largely borne by the utility, which means that the utility can suffer shortfalls if the weather is milder than normal. At the same time, it can enjoy windfalls if the weather is more extreme than normal. These scenarios result because, while revenues will change with weather, the underlying cost structure typically does not. These situations translate directly into greater earnings variability, which implies a higher required cost of capital. In order to allocate the weather risk to the utility, the "test year" information used to compute the base revenue-per-customer values should be weather normalized. Thereafter, with each adjustment to prices, the consumption data would weather normalize as well.

Potential Triggers and Special Considerations in Decoupling Mechanisms

Because decoupling is a different way of doing business for regulators and utilities, it is prudent to consider off-ramps or triggers that can avoid unpleasant surprises. The following are some of the approaches that might be appropriate to consider:

- *Banding of rate adjustments.* To minimize the magnitude of adjustments, the decoupling mechanism could be premised on a "dead band" within which no adjustment would be made. The effect would be to reduce the number of tariff changes and possibly, but not necessarily, the associated periodic filings.

  The plan can also cap the amount of any single rate adjustment. To the extent it is based on reasonable costs otherwise recoverable under the plan, the excess could be set aside in a regulatory account for later recovery.

- *Banding of earnings.* To control the profit level of the regulated entity within some bounds, earnings greater and/or less than certain limits can be shared with customers. For example, consider a scenario in which the earnings band is 1 percent on return on equity (either way) compared to the allowed return found in the most recent rate case. If the plan would share results outside the band 50-50, then if the utility earns +1.5 percent of the target, an amount equal to 0.25 percent of earnings (half the excess) is returned to consumers through a price adjustment. If the utility earns -1.3 percent of the target, however, an amount equal 0.15 percent of earnings (half the deficiency) is added to the price. Designing this band should leave the utility with ample incentive to make and benefit from process engineering improvements during the plan, recognizing that a subsequent rate case might result in the benefits accruing in the long run to consumers. While the illustration is "symmetrical," in practice, the band can be asymmetrical in size and sharing proportion to assure the proper balance between consumer and utility interests.

- *Course corrections for customer count changes, major changes for unique major customers, and large changes in revenues-per-customer.* Industrial consumers might experience more volatility in average use per customer calculations because there are typically a small number of these customers and they can be quite varied. For example, the addition or deletion of one large customer (or of a work shift for a large customer) might make a significant difference in the revenue per customer values for that class, or result in appropriate shifting of revenues among customers. To address this problem, some trigger or off-ramp might be appropriate to review such unexpected and significant changes, and to modify the decoupling calculation to account for them. In some cases, a new rate case might be warranted from such a change.

- *Accounting for utilities whose marginal revenues per customer are significantly different than their embedded average revenue per customer.* If a utility's revenue per customer has been changing rapidly over time, imposition of a revenue-per-customer decoupling mechanism will have the effect of changing its profit growth path. For example, if incremental revenues per customer are growing rapidly, decoupling will have the effect of lowering future earnings, although not necessarily below the company's allowed rate of return. On the other hand, if incremental revenues per customer are declining, decoupling will have the effect of increasing future earnings. Where these trends are strong and there is a desire to make decoupling "earnings neutral," vis-à-vis the status quo earning path, the revenue-per-customer value can be tied to an upward or downward growth rate. This type of adjustment is more oriented toward maintaining neutrality than reflecting any underlying economic principle. Care should be taken to exclude recent growth in revenues per customer that are driven by inefficient consumption (usually tied to the utility having a pro-consumption marketing program).

Appendix B: Business Case Details

To help natural gas and electric utilities, utility regulators, and partner organizations communicate the business case for energy efficiency, the National Action Plan for Energy Efficiency provides an Energy Efficiency Benefits Calculator (Calculator available at *www.epa.gov/cleanenergy/eeactionplan.htm*). This Calculator examines the financial impact of energy efficiency on major stakeholders, and was used to develop the eight cases discussed in Chapter 4: Business Case for Energy Efficiency. Additional details on these eight cases are described in this appendix.

Overview

A business case is an analysis that shows the benefits of energy efficiency to the utility, customers, and society within an approach that can lead to actions by utilities, regulators, and other stakeholders. Making the business case for energy efficiency programs requires a different type of analysis than that required for traditional supply-side resources. Because adoption of energy efficiency reduces utility sales and utility size, traditional metrics such as impact on rates and total earnings do not measure the benefits of energy efficiency. However, by examining other metrics, such as customer bills and utility earnings per share, the benefits to all stakeholders of adopting energy efficiency can be demonstrated. These benefits include reduced customer bills, decreased cost per unit of energy provided, increased net resource savings, decreased emissions, and decreased reliance on energy supplies.

This appendix provides more detailed summary and interpretation of results for the eight cases discussed in Chapter 4: Business Case for Energy Efficiency. All results are from the Energy Efficiency Benefits Calculator's interpretation tab.

Case 1: Low-Growth Electric and Gas Utility

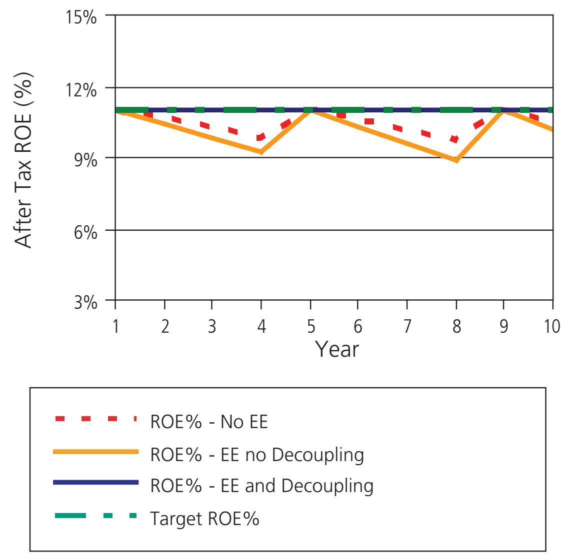
Utility Perspective

Utility Financial Health – Small Changes

The change in utility financial health depends on whether or not there are decoupling mechanisms in place, if there are shareholder incentives in place (for investor-owned utilities), the frequency of rate adjustments, and other factors. Depending on the type of utility, the measure of financial health changes. Investor-owned utility health is measured by return on equity (ROE), while publicly or cooperatively owned utility health is measured by cash position or debt coverage ratio.

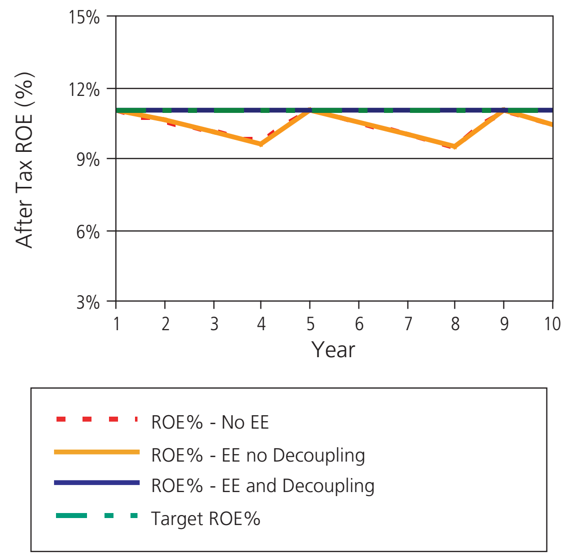
Electric

Investor-Owned Utility Comparison of Return on Equity



Gas

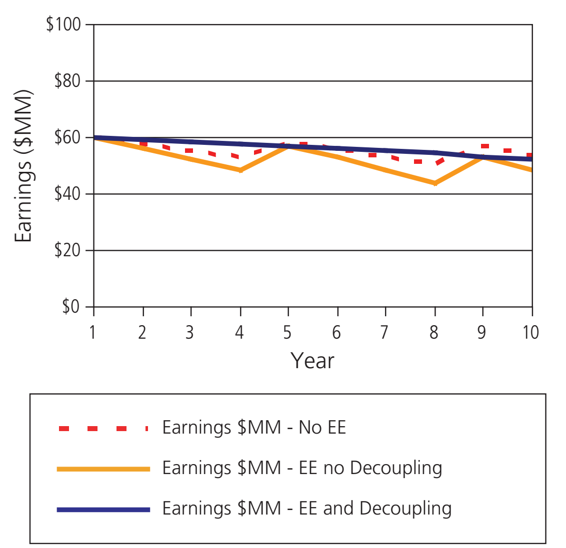
Investor-Owned Utility Comparison of Return on Equity



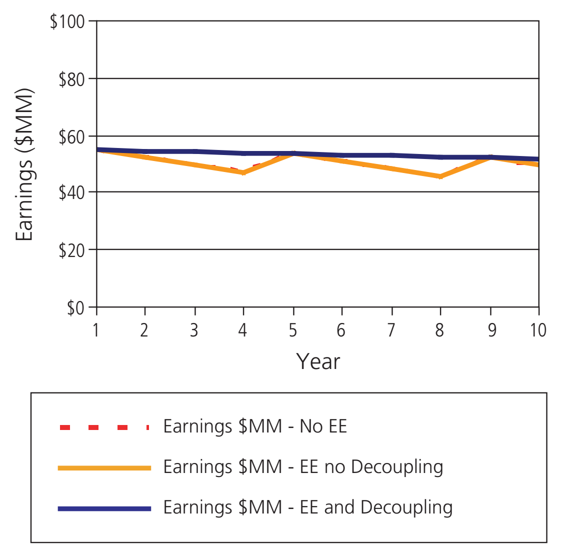
Utility Earnings – Results Vary

Utility earnings depend on growth rate, capital investment, frequency of rate adjustments, and other factors. If energy efficient (EE) reduces capital investment, the earnings will be lower in the EE case, unless shareholder incentives for EE are introduced. However, utility return (ROE or earnings per share) may not be affected.

Utility Earnings



Utility Earnings

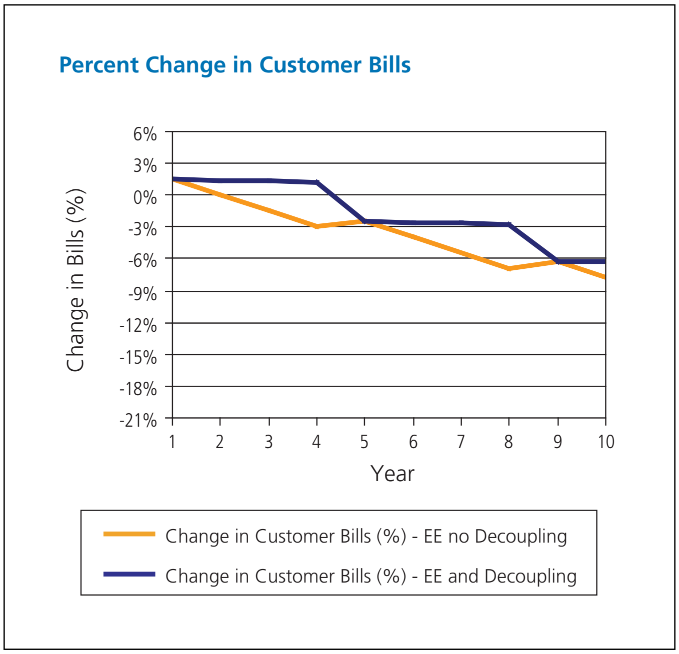


Customer Perspective

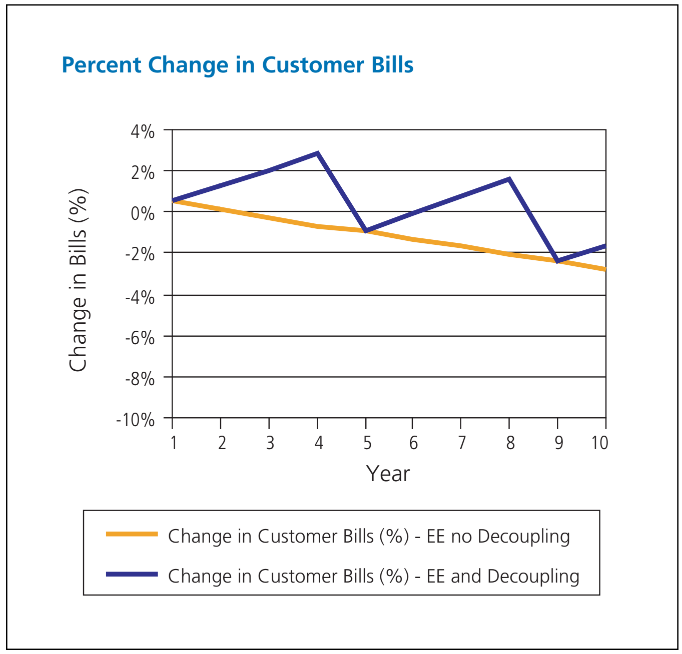
Customer Bills – Decrease

In the first year, customer utility bills increase because the cost of the EE program has not yet produced savings. Total customer bills decline over time, usually within the first three years, indicating customer savings resulting from lower energy consumption.

Electric

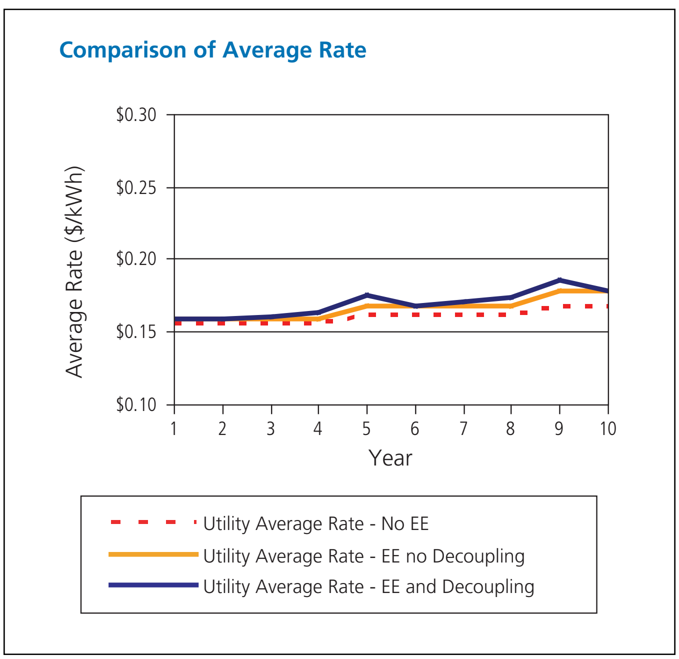


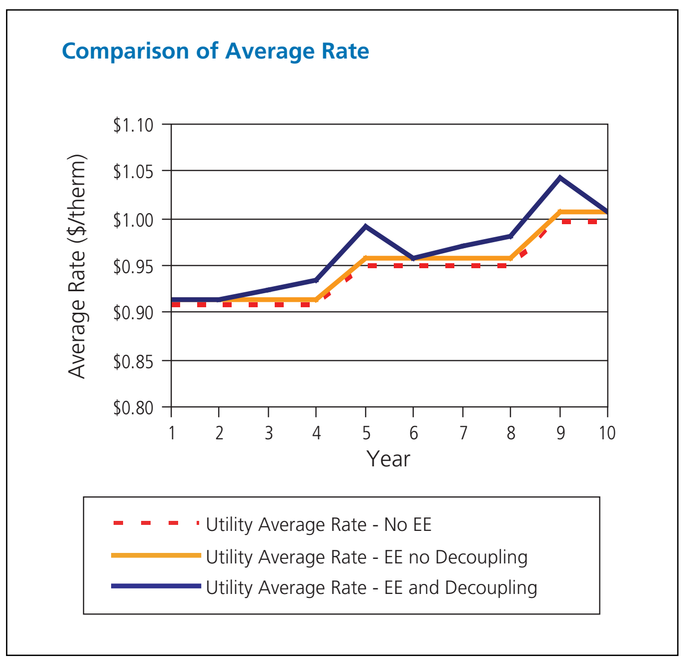
Gas



Utility Rates – Mild Increase

The rates customers pay ($/kWh, $/therm) increase when avoided costs are less than retail rates, which is typically the case for most EE programs. Rates increase because revenue requirements increase more quickly than sales.



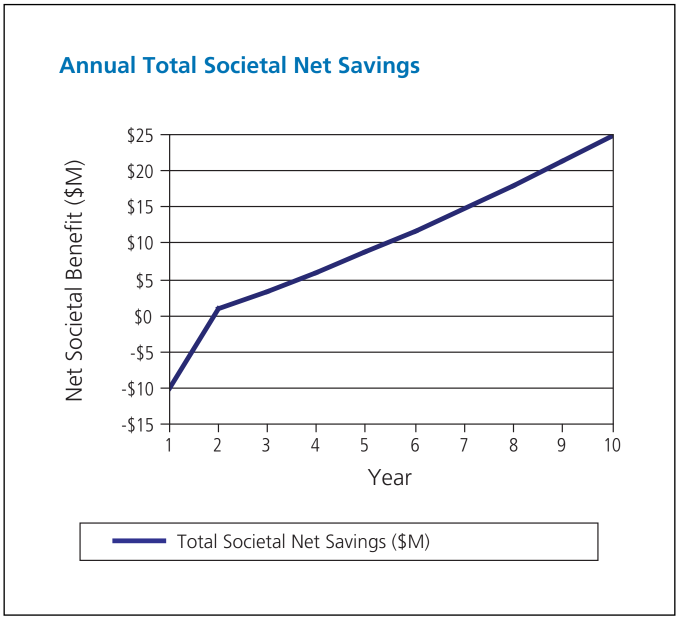


Societal Perspective

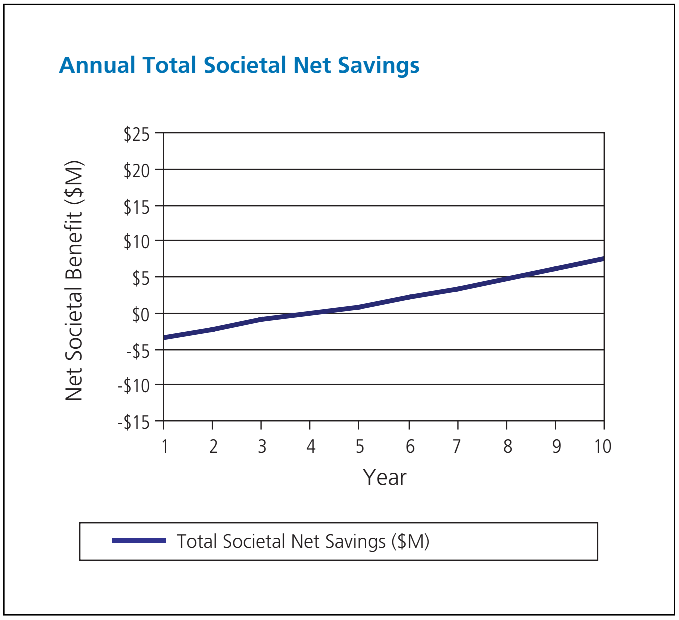
Societal Net Savings – Increase

The net savings are the difference of total utility costs, including EE program costs, with EE and without EE. In the first year, the cost of the EE program is a cost to society. Over time, cumulative EE savings lead to a utility production cost savings that is greater than the EE program cost. The graph shape is therefore upward sloping. Total Societal Net Savings is the same with and without decoupling; therefore, only one line is shown.

Electric

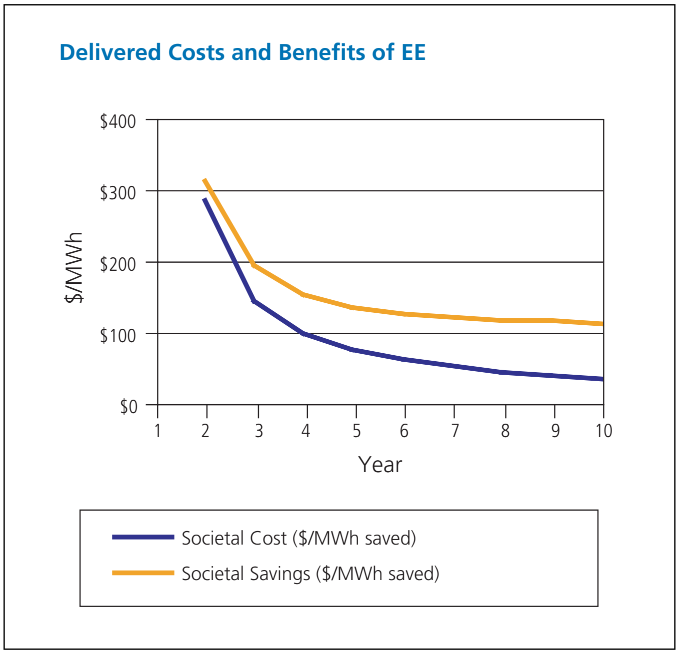


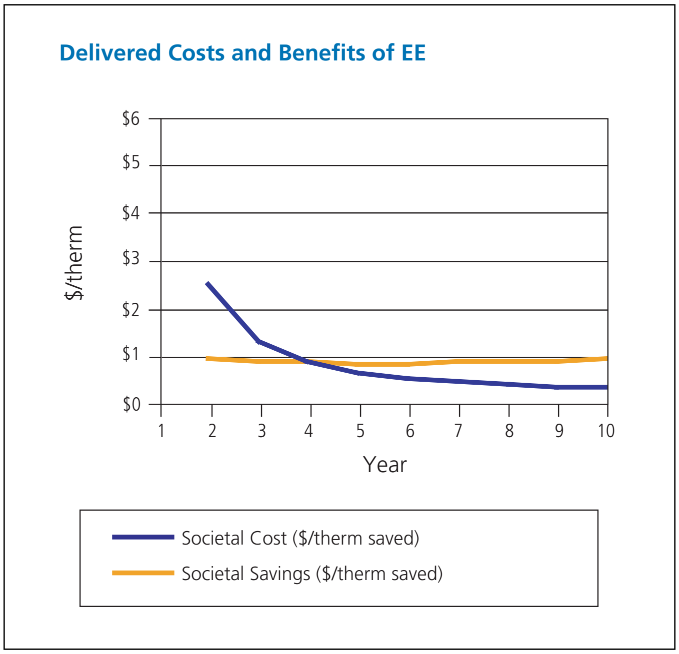
Gas



Total Societal Cost Per Unit – Declines

Total cost of providing each unit of energy (MWh, therm) declines over time because of the impacts of energy savings, decreased peak load requirements, and decreased costs during peak periods. Well-designed EE programs can deliver energy at an average cost less than that of new power sources. When the two lines cross, the annual cost of EE equals the annual savings resulting from EE. The Societal Cost and Societal Savings are the same with and without decoupling.

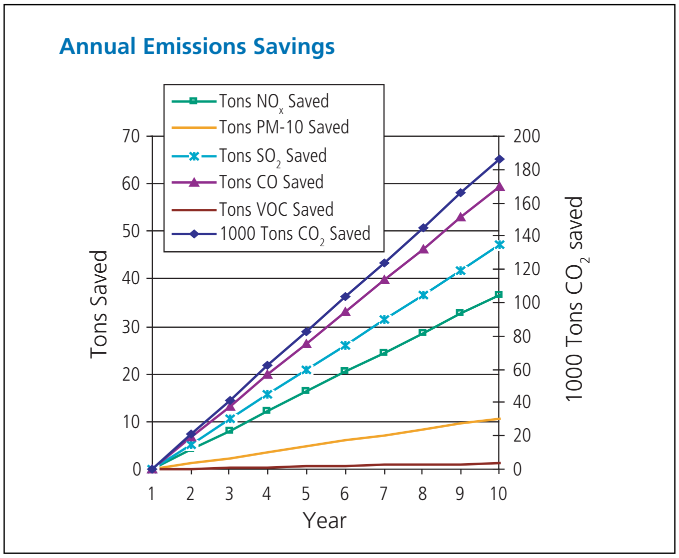




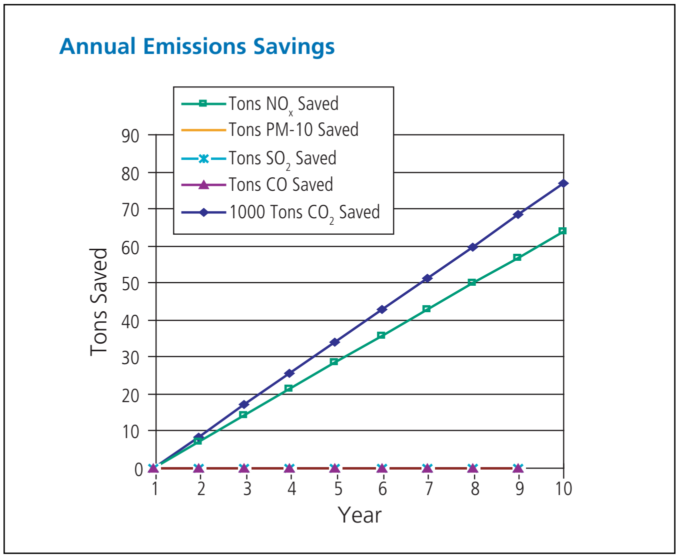
Emissions and Cost Savings – Increase

Annual tons of emissions saved increases. Emissions cost savings increases when emissions cost is monetized. Emissions costs and savings are the same with and without decoupling.

Electric

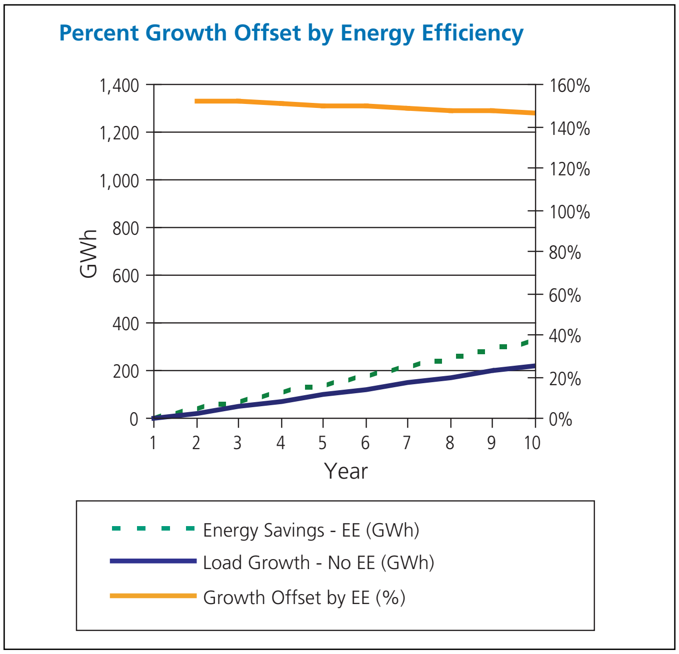


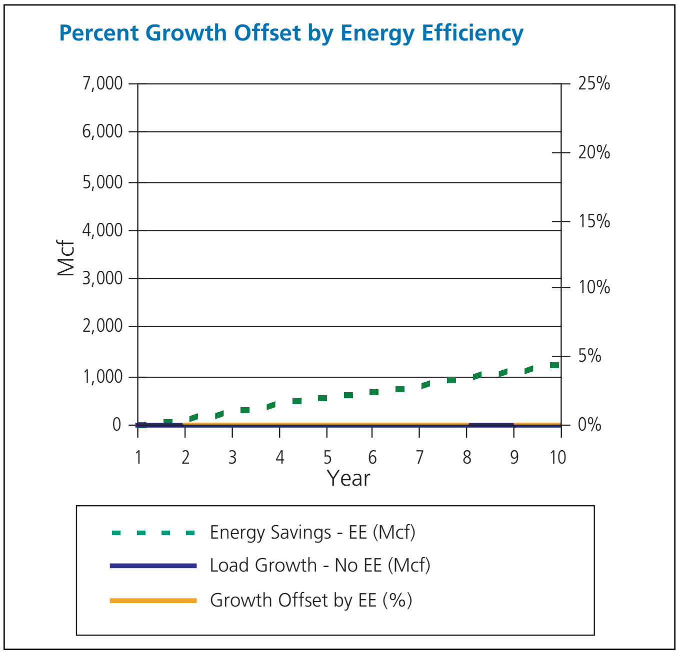
Gas



Growth Offset by EE – Increase

As EE programs ramp up, energy consumption declines. This comparison shows the growth with and without EE, and illustrates the amount of EE relative to load growth. Load growth and energy savings are not impacted by decoupling. With load growth assumed at zero, no load or percent growth offset shown.

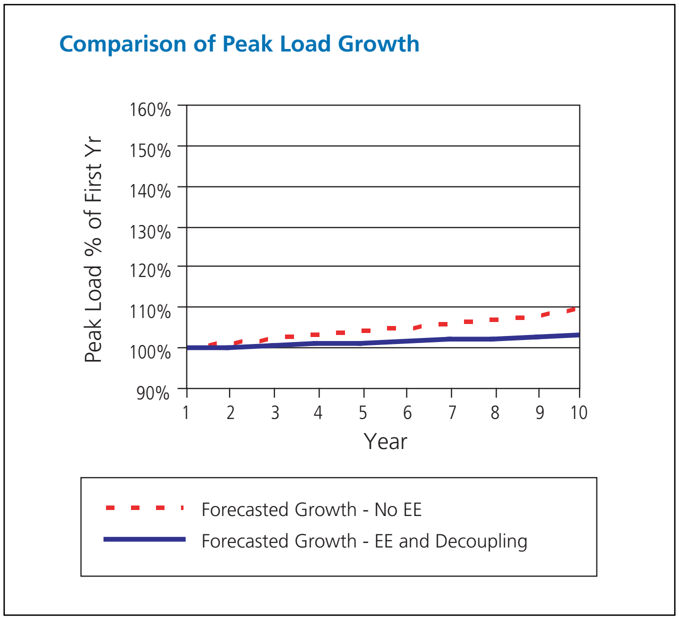




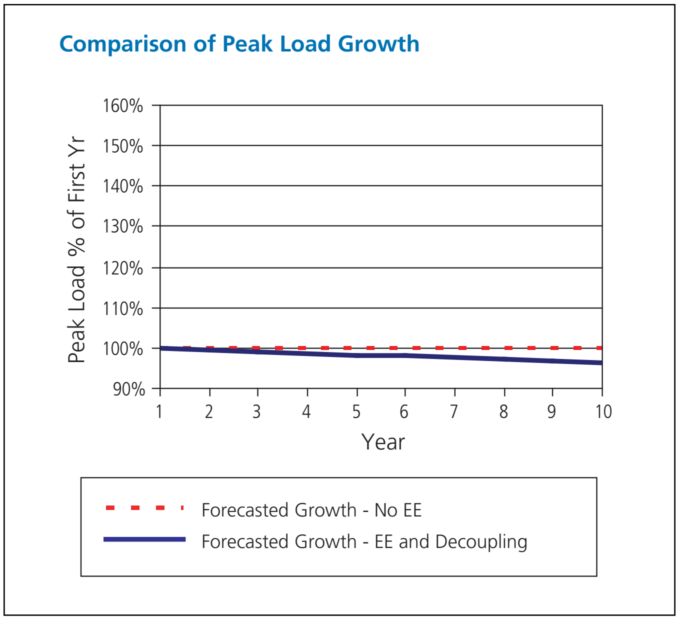
Peak Load Growth – Decrease

Peak load requirements decrease because peak capacity savings are captured due to EE measures. Peak load is not impacted by decoupling.

Electric



Gas



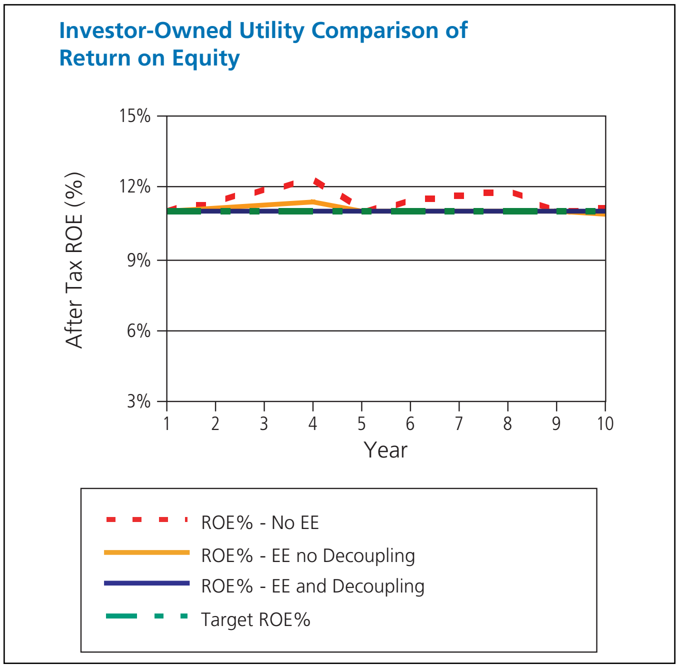
Case 2: High-Growth Electric and Gas Utility

Utility Perspective

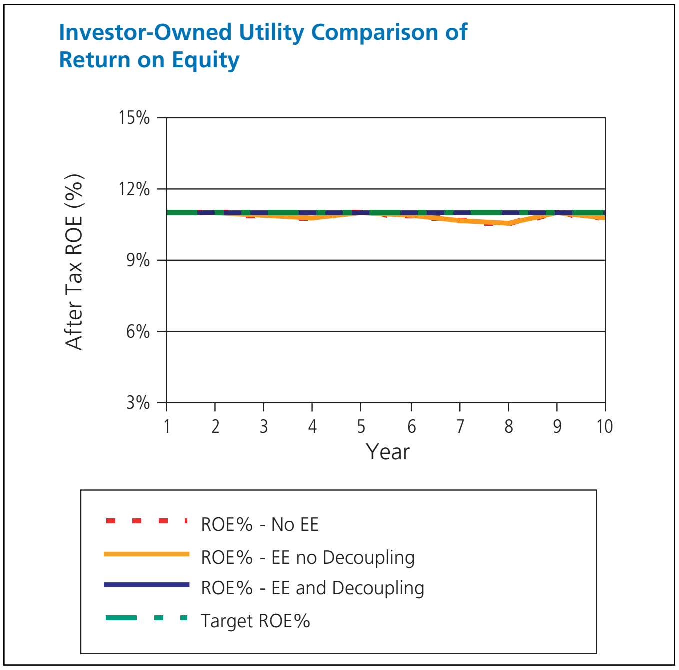
Utility Financial Health – Small Changes

The change in utility financial health depends on whether or not there are decoupling mechanisms in place, if there are shareholder incentives in place (for investor-owned utilities), the frequency of rate adjustments, and other factors. Depending on the type of utility, the measure of financial health changes. Investor-owned utility health is measured by ROE, while publicly or cooperatively owned utility health is measured by cash position or debt coverage ratio.

Electric

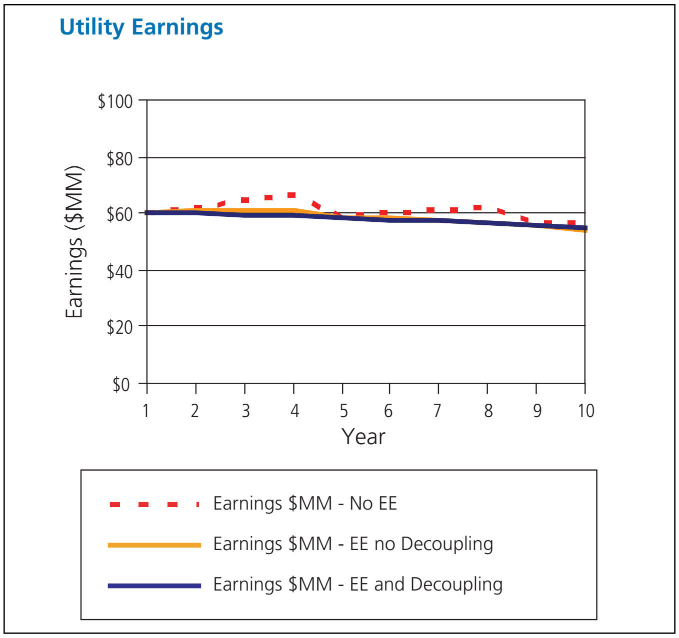


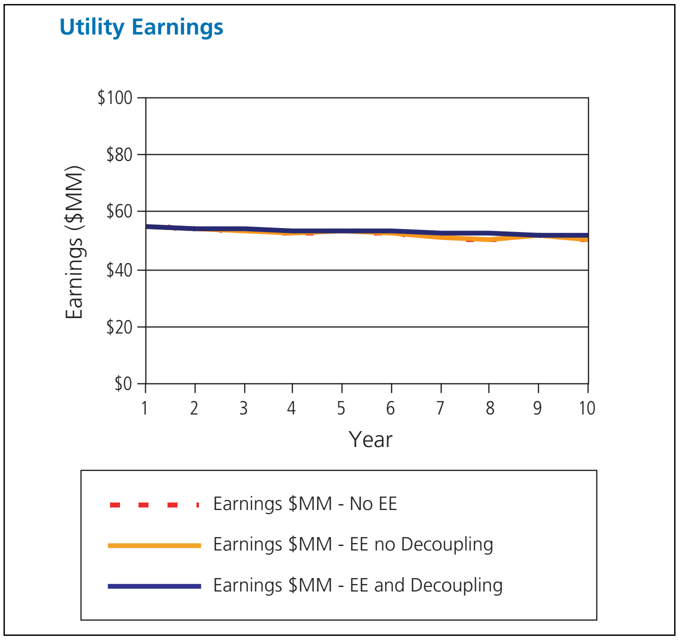
Gas



Utility Earnings – Results Vary

Utility earnings depend on growth rate, capital investment, frequency of rate adjustments, and other factors. If EE reduces capital investment, the earnings will be lower in the EE case, unless shareholder incentives for EE are introduced. However, utility return (ROE or earnings per share) may not be affected.



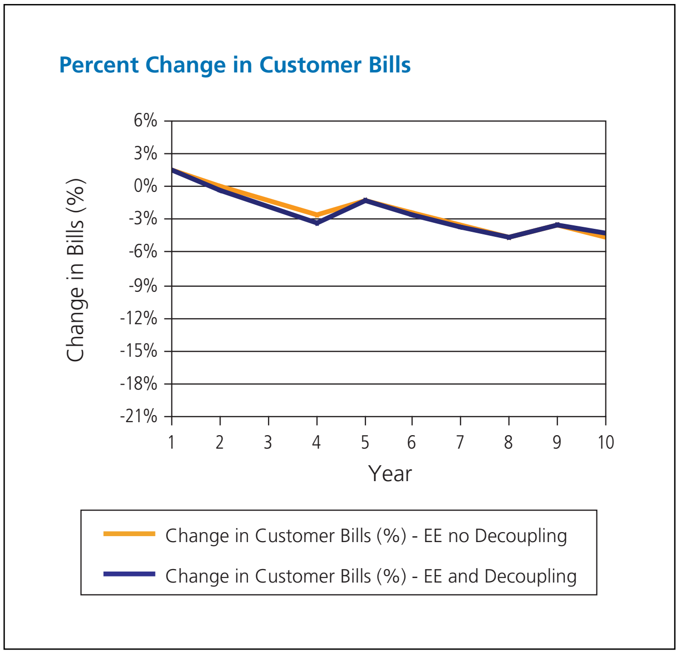


Customer Perspective

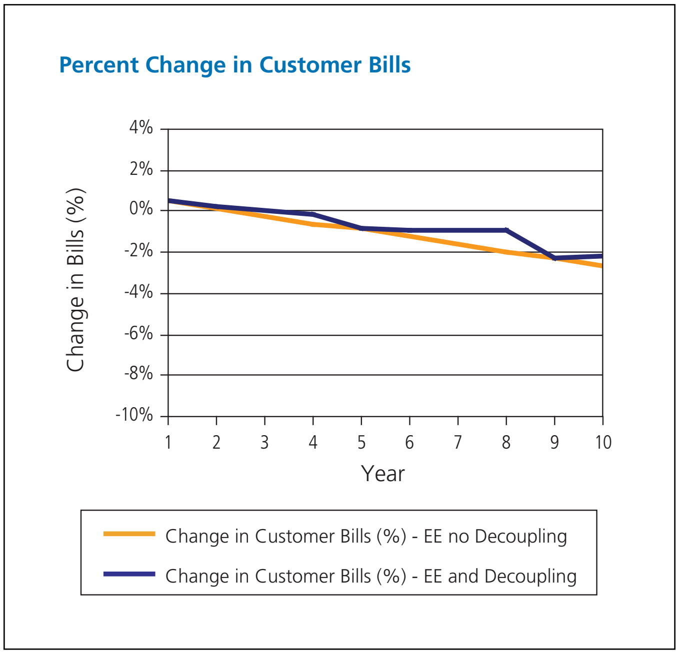
Customer Bills – Decrease

In the first year, customer utility bills increase because the cost of the EE program has not yet produced savings. Total customer bills decline over time, usually within the first three years, indicating customer savings resulting from lower energy consumption.

Electric

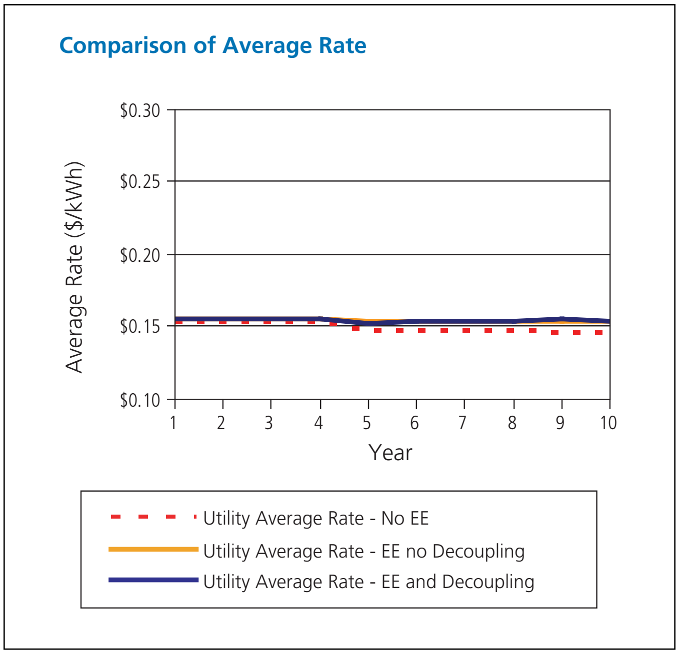


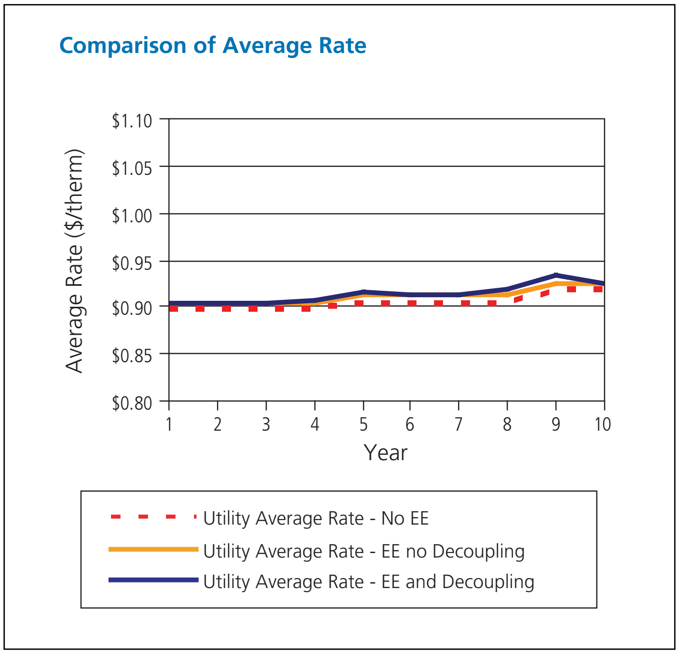
Gas



Utility Rates – Mild Increase

The rates customers pay ($/kWh, $/therm) increase when avoided costs are less than retail rates, which is typically the case for most EE programs. Rates increase because revenue requirements increase more quickly than sales.



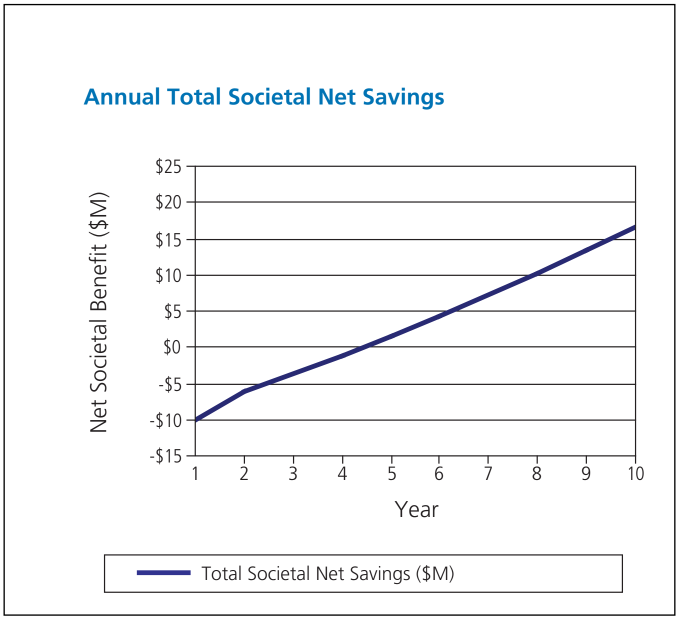


Societal Perspective

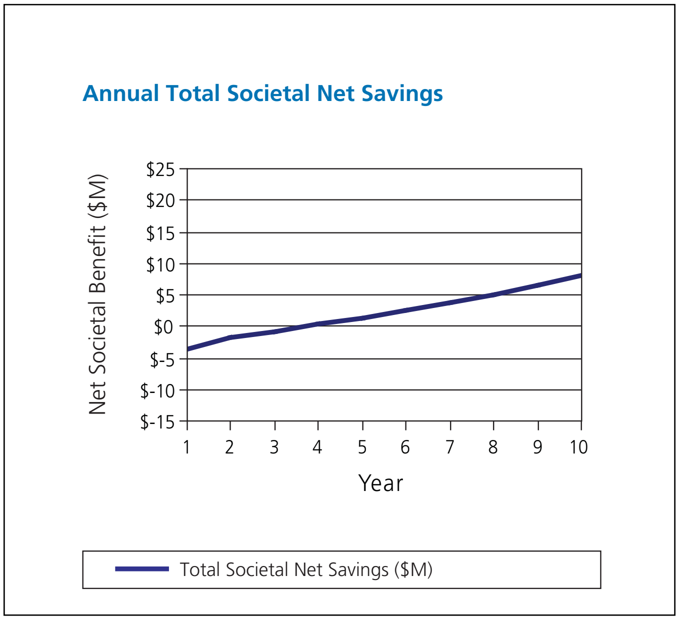
Societal Net Savings – Increase

The net savings are the difference of total utility costs, including EE program costs, with EE and without EE. In the first year, the cost of the EE program is a cost to society. Over time, cumulative EE savings lead to a utility production cost savings that is greater than the EE program cost. The graph shape is therefore upward sloping. Total Societal Net Savings is the same with and without decoupling; therefore, only one line is shown.

Electric

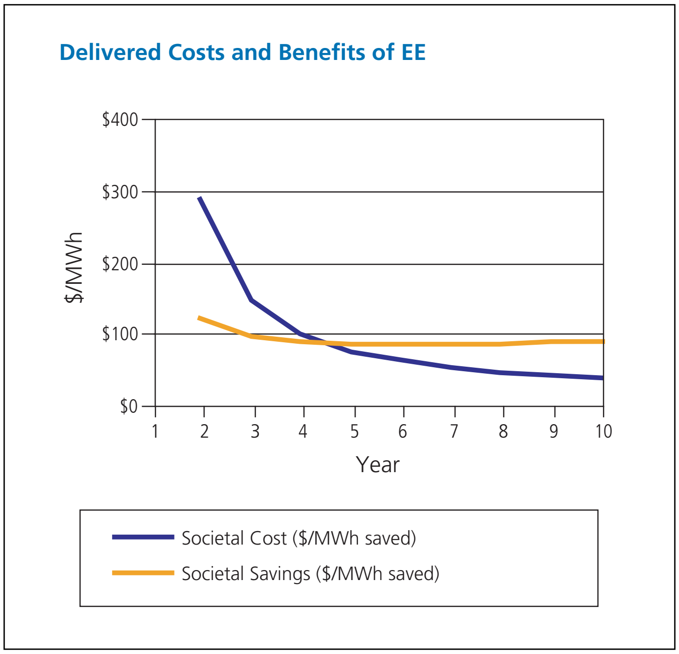


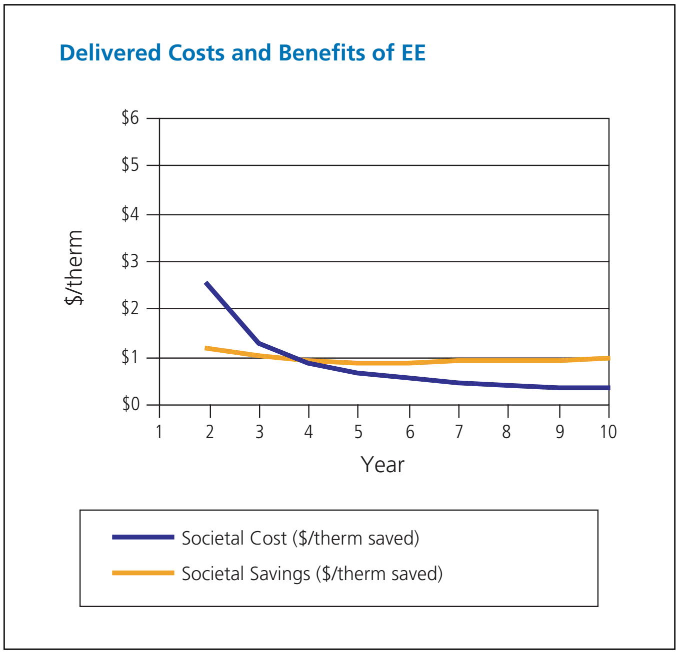
Gas



Total Societal Cost Per Unit – Declines

Total cost of providing each unit of energy (MWh, therm) declines over time because of the impacts of energy savings, decreased peak load requirements, and decreased costs during peak periods. Well-designed EE programs can deliver energy at an average cost less than that of new power sources. When the two lines cross, the annual cost of EE equals the annual savings resulting from EE. The Societal Cost and Societal Savings are the same with and without decoupling.

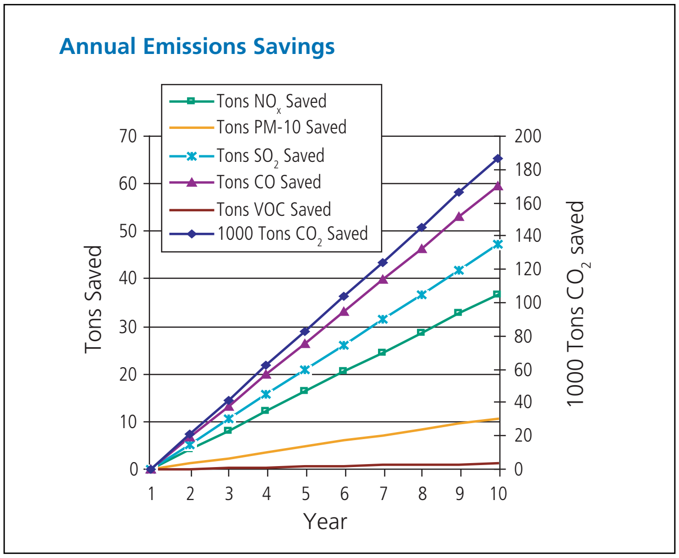




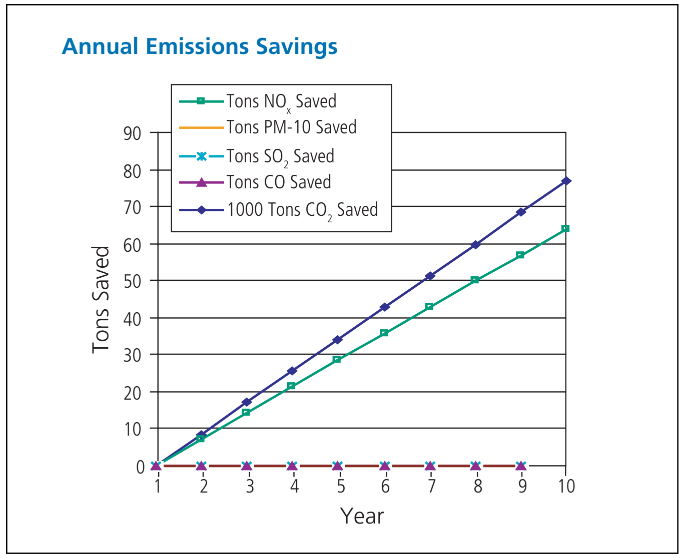
Emissions and Cost Savings – Increase

Annual tons of emissions saved increases. Emissions cost savings increases when emissions cost is monetized. Emissions costs and savings are the same with and without decoupling.

Electric

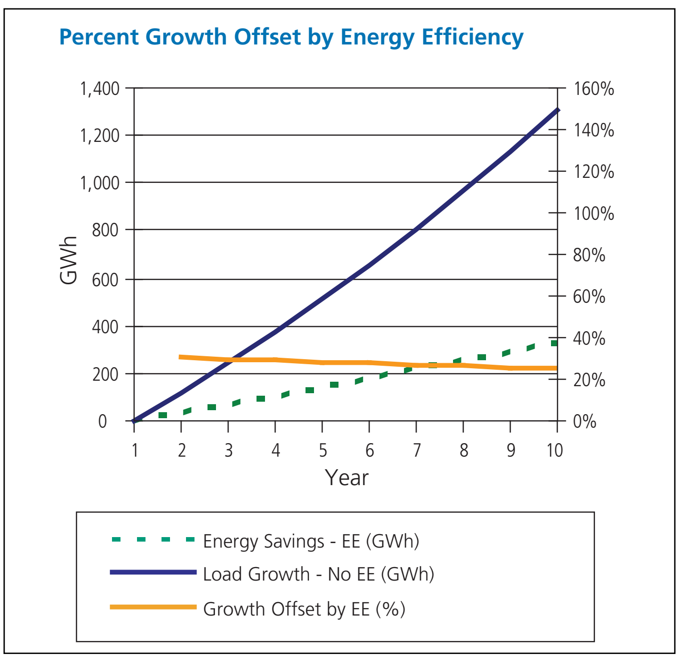


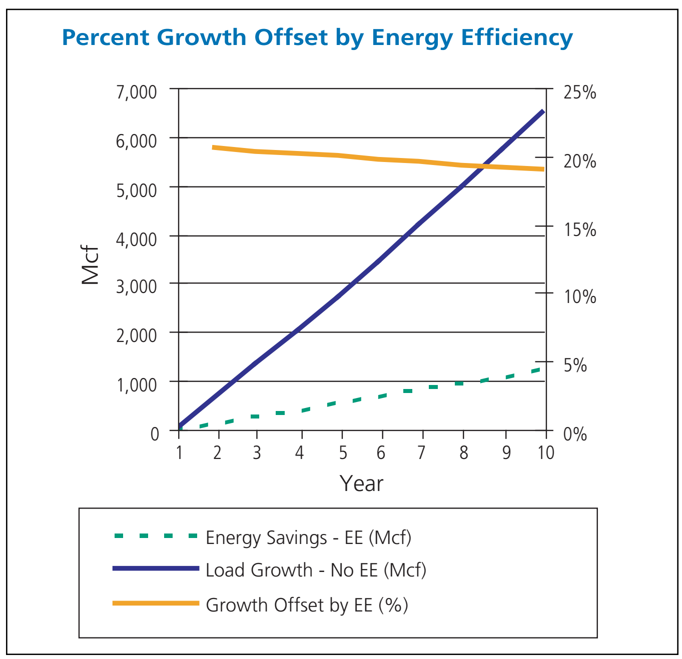
Gas



Growth Offset by EE – Increase

As EE programs ramp up, energy consumption declines. This comparison shows the growth with and without EE, and illustrates the amount of EE relative to load growth. Load growth and energy savings are not impacted by decoupling. With load growth assumed at zero, no load or percent growth offset shown.

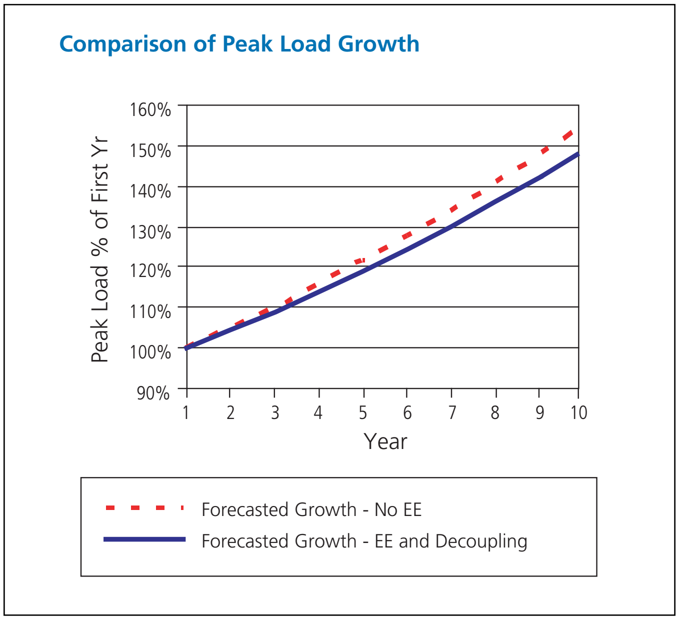




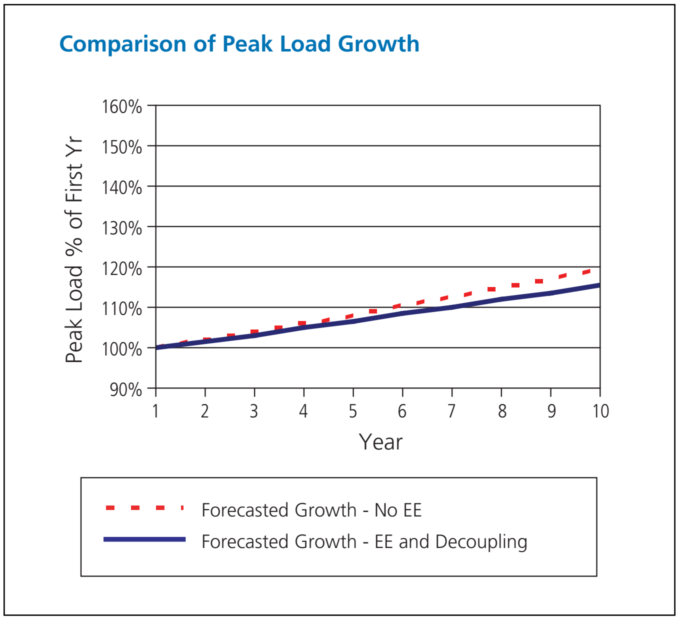
Peak Load Growth – Decrease

Peak load requirements decrease because peak capacity savings are captured due to EE measures. Peak load is not impacted by decoupling.

Electric



Gas



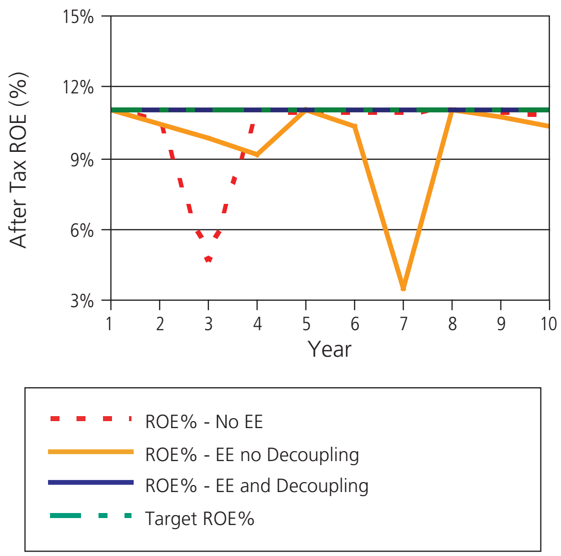
Case 3: Low-Growth with Power Plant Deferral

Utility Perspective

Utility Financial Health – Small Changes

The change in utility financial health depends on whether or not there are decoupling mechanisms in place, if there are shareholder incentives in place (for investor-owned utilities), the frequency of rate adjustments, and other factors. Depending on the type of utility, the measure of financial health changes. Investor-owned utility health is measured by ROE, while publicly or cooperatively owned utility health is measured by cash position or debt coverage ratio.

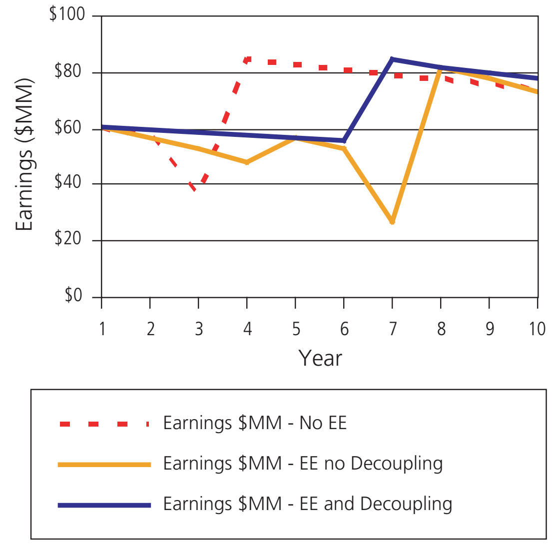
Investor-Owned Utility Comparison of Return on Equity



Utility Earnings – Results Vary

Utility earnings depend on growth rate, capital investment, frequency of rate adjustments, and other factors. If EE reduces capital investment, the earnings will be lower in the EE case, unless shareholder incentives for EE are introduced. However, utility return (ROE or earnings per share) may not be affected.

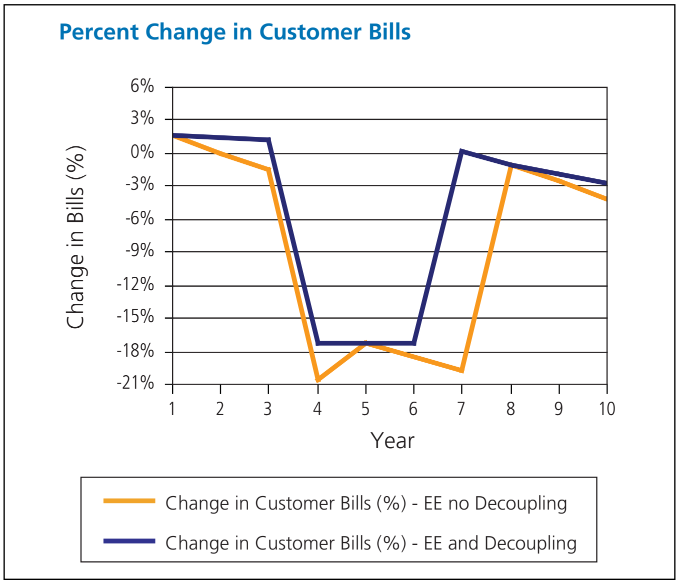
Utility Earnings



Customer Perspective

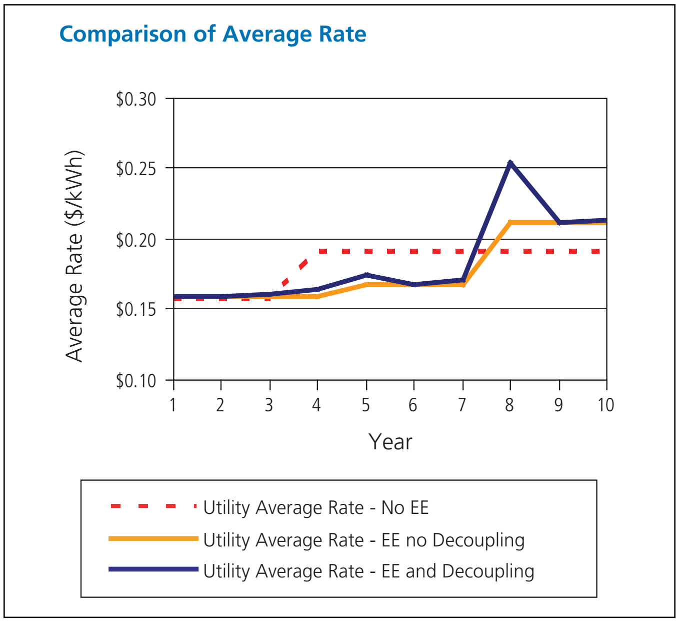
Customer Bills – Decrease

In the first year, customer utility bills increase because the cost of the EE program has not yet produced savings. Total customer bills decline over time, usually within the first three years, indicating customer savings resulting from lower energy consumption.



Utility Rates – Mild Increase

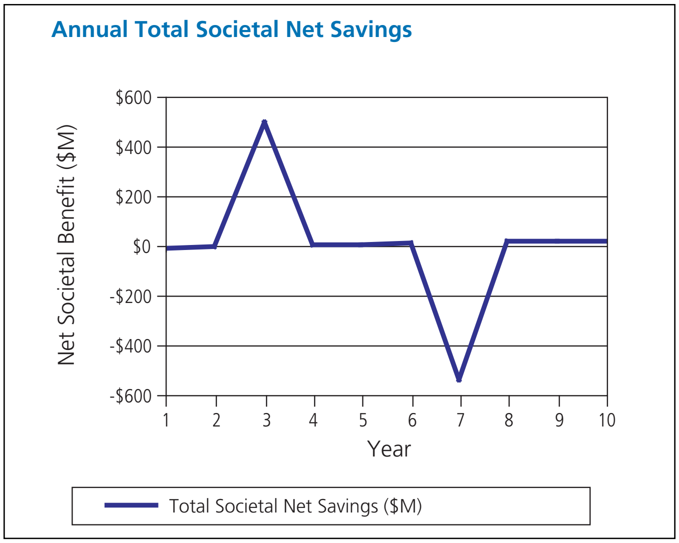
The rates customers pay ($/kWh) increase when avoided costs are less than retail rates, which is typically the case for most EE programs. Rates increase because revenue requirements increase more quickly than sales.



Societal Perspective

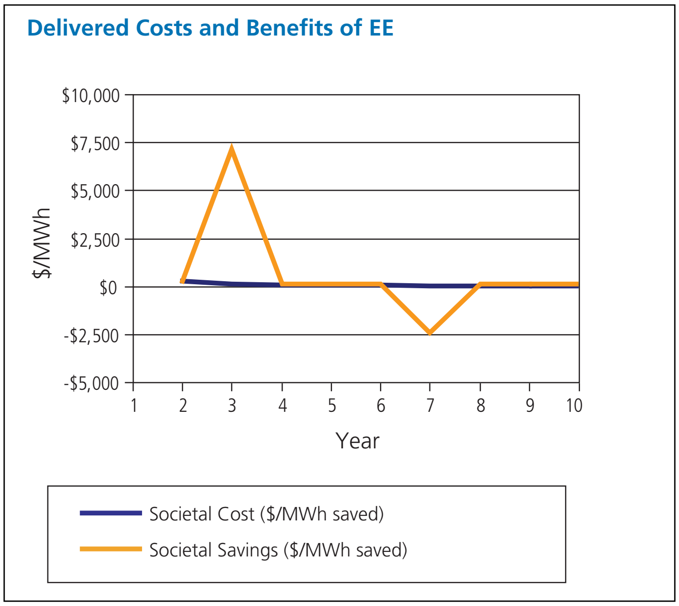
Societal Net Savings – Increase

The net savings are the difference of total utility costs, including EE program costs, with EE and without EE. In the first year, the cost of the EE program is a cost to society. Over time, cumulative EE savings lead to a utility production cost savings that is greater than the EE program cost. The graph shape is therefore upward sloping. Total Societal Net Savings is the same with and without decoupling; therefore, only one line is shown.



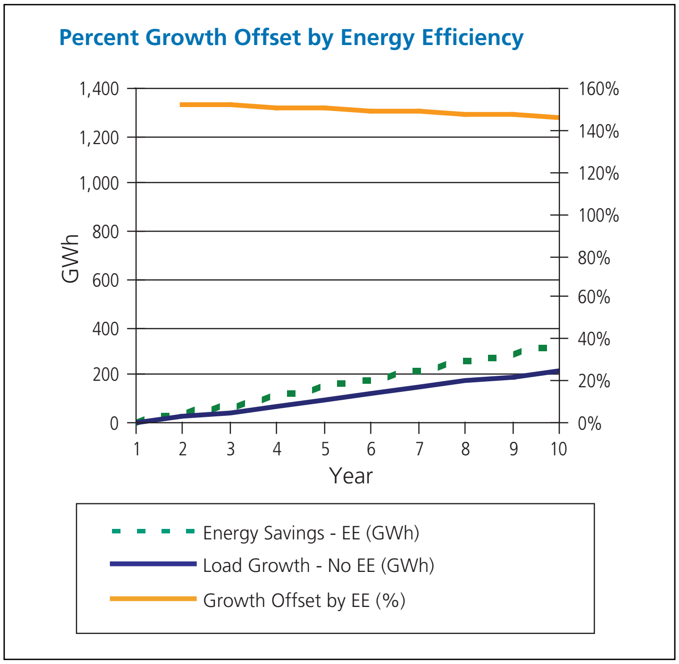
Total Societal Cost Per Unit – Declines

Total cost of providing each unit of energy (MWh) declines over time because of the impacts of energy savings, decreased peak load requirements, and decreased costs during peak periods. Well-designed EE programs can deliver energy at an average cost less than that of new power sources. Societal savings increase when an infrastructure project is delayed and then decrease when built. When the two lines cross, the annual cost of EE equals the annual savings resulting from EE.



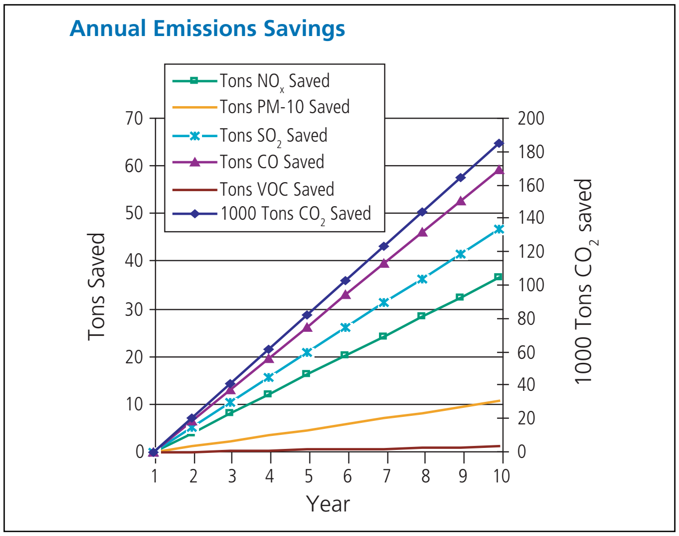
Growth Offset by EE – Increase

As EE programs ramp up, energy consumption declines. This comparison shows the growth with and without EE, and illustrates the amount of EE relative to load growth. Load growth and energy savings are not impacted by decoupling. With load growth assumed at zero, no load or percent growth offset shown.



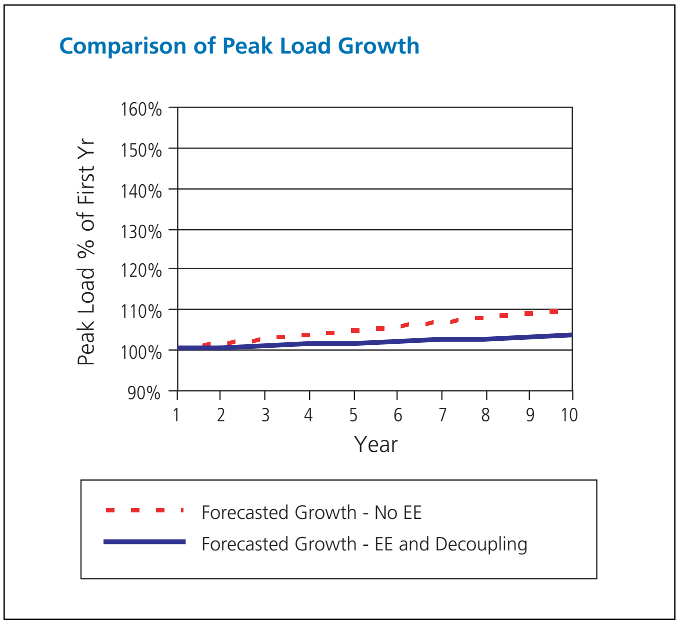
Emissions and Cost Savings - Increase

Annual tons of emissions saved increases. Emissions cost savings increases when emissions cost is monetized. Emissions costs and savings are the same with and without decoupling.



Peak Load Growth – Decrease

Peak load requirements decrease because peak capacity savings are captured due to EE measures. Peak load is not impacted by decoupling.



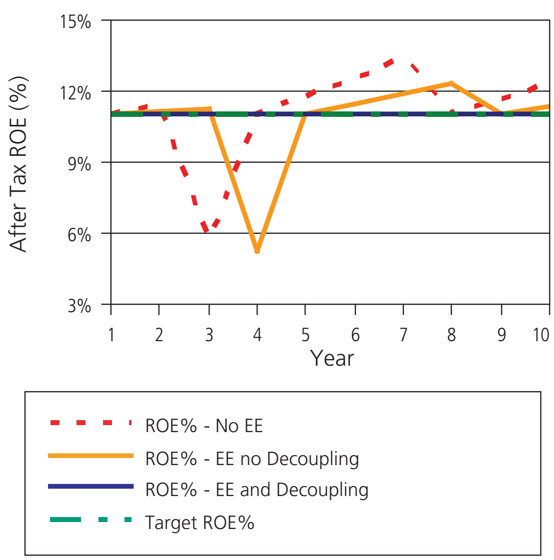
Case 4: High-Growth With Power Plant Deferral

Utility Perspective

Utility Financial Health – Small Changes

The change in utility financial health depends on whether or not there are decoupling mechanisms in place, if there are shareholder incentives in place (for investor-owned utilities), the frequency of rate adjustments, and other factors. Depending on the type of utility, the measure of financial health changes. Investor-owned utility health is measured by ROE, while publicly or cooperatively owned utility health is measured by cash position or debt coverage ratio.

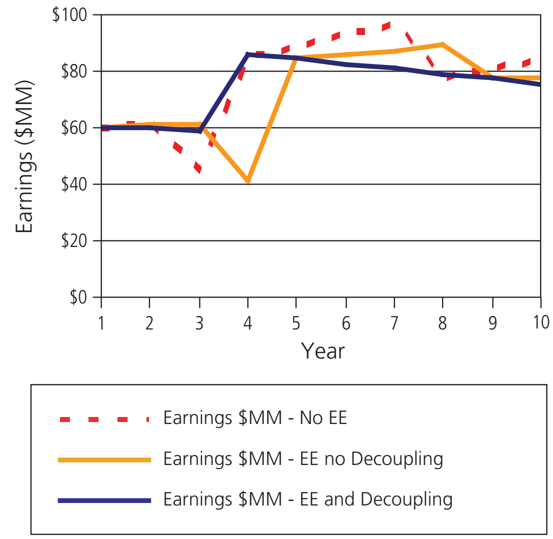
Investor-Owned Utility Comparison of Return on Equity



Utility Earnings – Results Vary

Utility earnings depend on growth rate, capital investment, frequency of rate adjustments, and other factors. If EE reduces capital intvestment, the earnings will be lower in the EE case, unless shareholder incentives for EE are introduced. However, utility return (ROE or earnings per share) may not be affected.

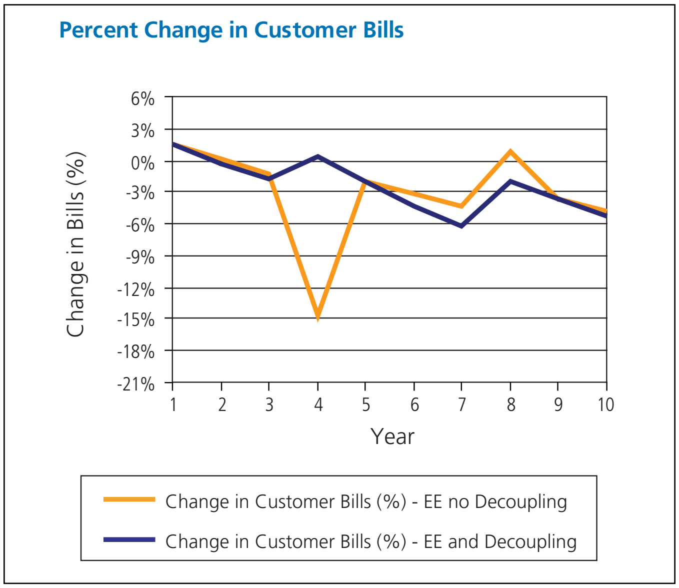
Utility Earnings



Customer Perspective

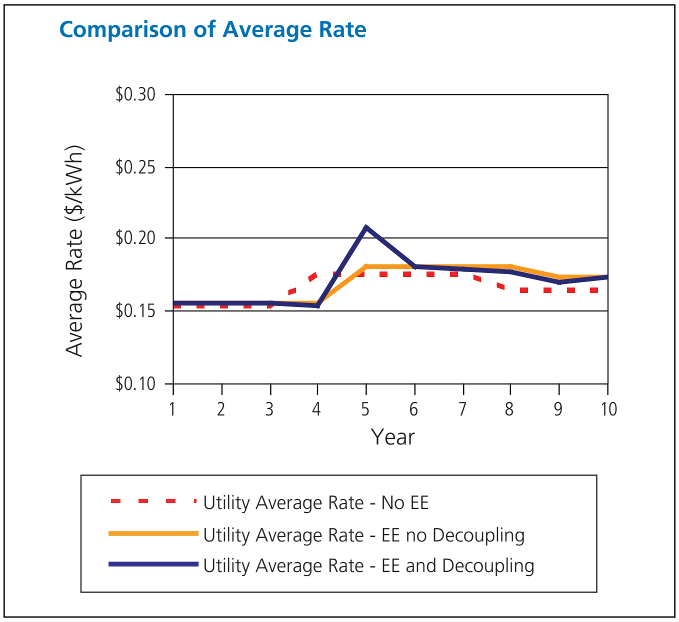
Customer Bills – Decrease

In the first year, customer utility bills increase because the cost of the EE program has not yet produced savings. Total customer bills decline over time, usually within the first three years, indicating customer savings resulting from lower energy consumption.



Utility Rates – Mild Increase

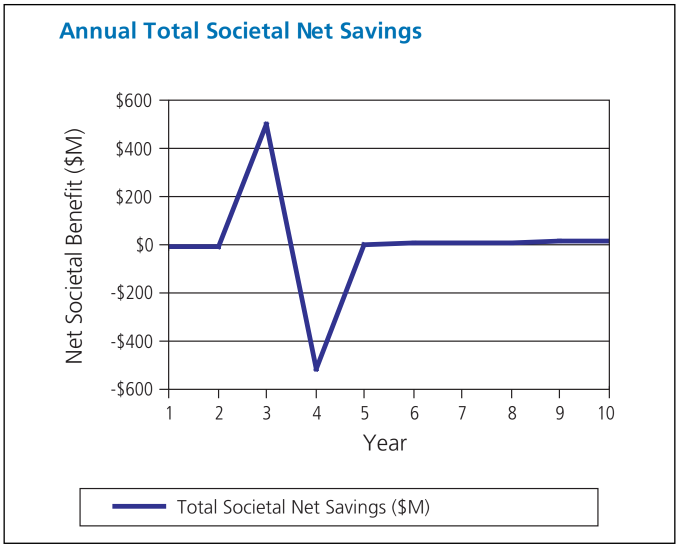
The rates customers pay ($/kWh) increase when avoided costs are less than retail rates, which is typically the case for most EE programs. Rates increase because revenue requirements increase more quickly than sales.



Societal Perspective

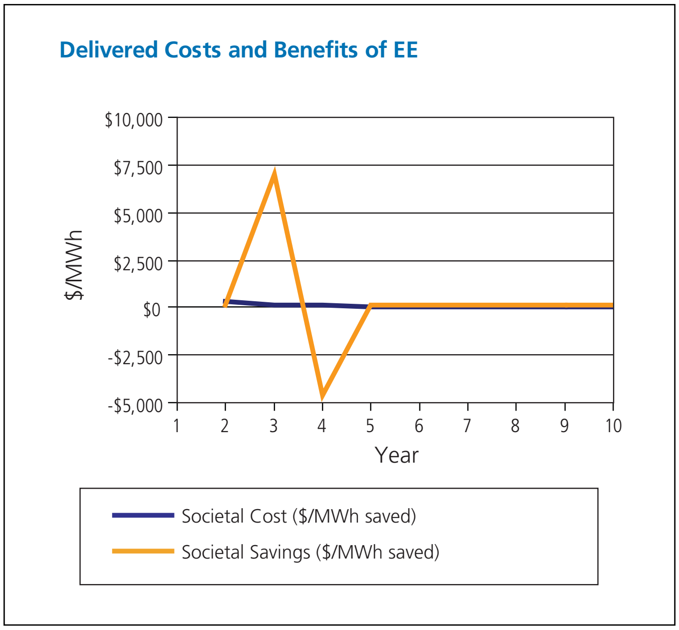
Societal Net Savings – Increase

The net savings are the difference of total utility costs, including EE program costs, with EE and without EE. In the first year, the cost of the EE program is a cost to society. Over time, cumulative EE savings lead to a utility production cost savings that is greater than the EE program cost. The graph shape is therefore upward sloping. Total Societal Net Savings is the same with and without decoupling; therefore, only one line is shown.



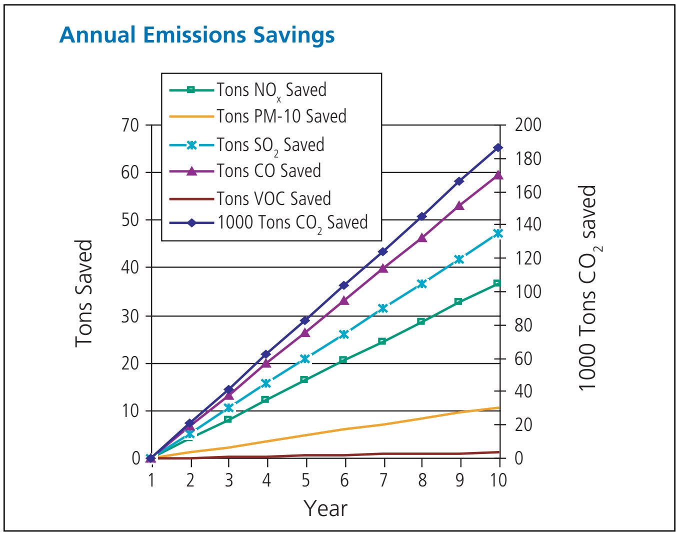
Total Societal Cost Per Unit – Declines

Total cost of providing each unit of energy (MWh) declines over time because of the impacts of energy savings, decreased peak load requirements, and decreased costs during peak periods. Well-designed EE programs can deliver energy at an average cost less than that of new power sources. Societal savings increase when an infrastructure project is delayed and then decrease when built. When the two lines cross, the annual cost of EE equals the annual savings resulting from EE.



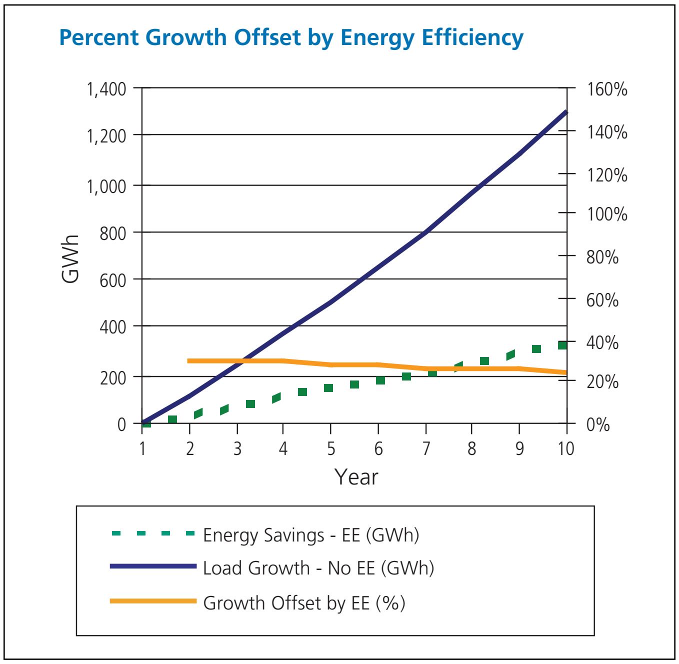
Emissions and Cost Savings – Increase

Annual tons of emissions saved increases. Emissions cost savings increases when emissions cost is monetized. Emissions costs and savings are the same with and without decoupling.



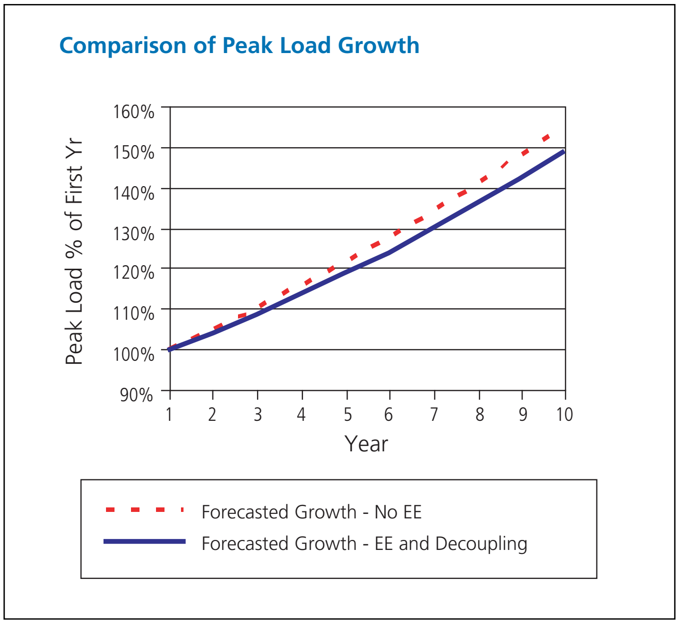
Growth Offset by EE – Increase

As EE programs ramp up, energy consumption declines. This comparison shows the growth with and without EE, and illustrates the amount of EE relative to load growth. Load growth and energy savings are not impacted by decoupling. With load growth assumed at zero, no load or percent growth offset shown.



Peak Load Growth – Decrease

Peak load requirements decrease because peak capacity savings are captured due to EE measures. Peak load is not impacted by decoupling.



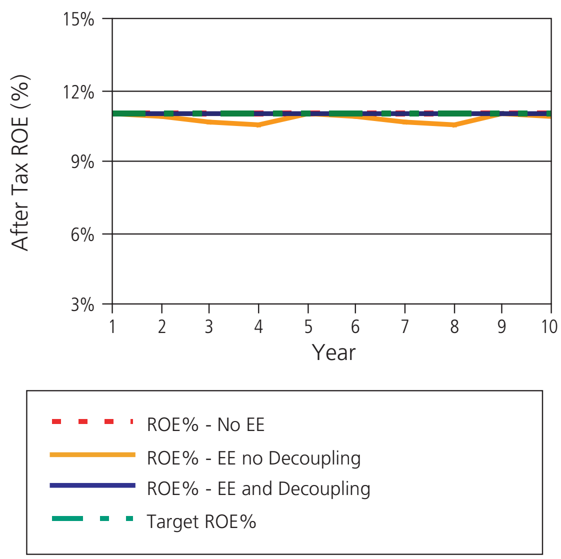
Case 5: Vertically Integrated Utility

Utility Perspective

Utility Financial Health – Small Changes

The change in utility financial health depends on whether or not there are decoupling mechanisms in place, if there are shareholder incentives in place (for investor-owned utilities), the frequency of rate adjustments, and other factors. Depending on the type of utility, the measure of financial health changes. Investor-owned utility health is measured by ROE, while publicly or cooperatively owned utility health is measured by cash position or debt coverage ratio.

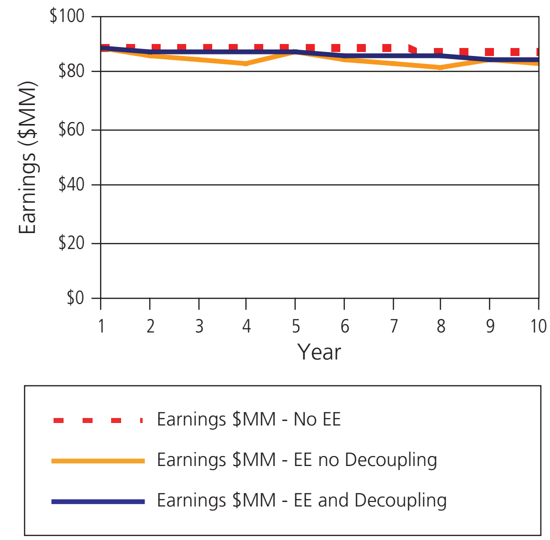
Investor-Owned Utility Comparison of Return on Equity



Utility Earnings – Results Vary

Utility earnings depend on growth rate, capital investment, frequency of rate adjustments, and other factors. If EE reduces capital investment, the earnings will be lower in the EE case, unless shareholder incentives for EE are introduced. However, utility return (ROE or earnings per share) may not be affected.

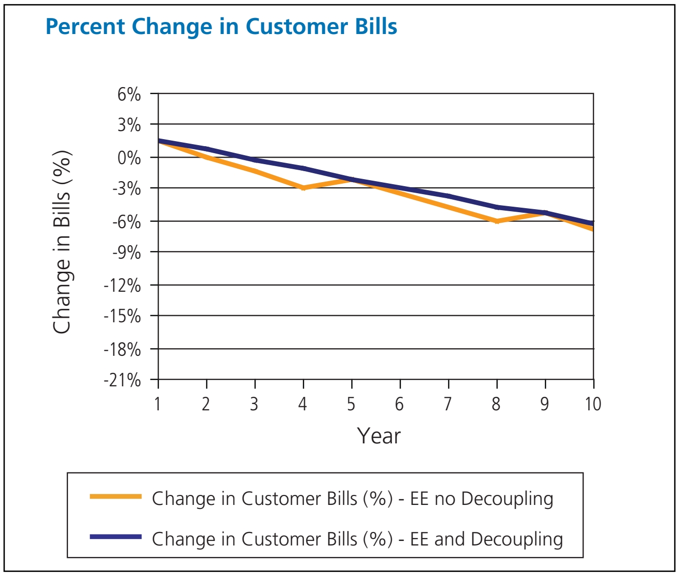
Utility Earnings



Customer Perspective

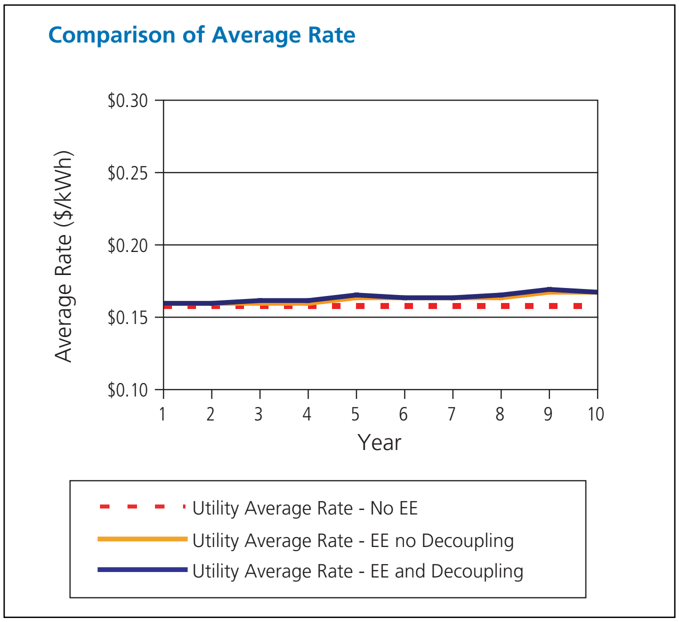
Customer Bills – Decrease

In the first year, customer utility bills increase because the cost of the EE program has not yet produced savings. Total customer bills decline over time, usually within the first three years, indicating customer savings resulting from lower energy consumption.



Utility Rates – Mild Increase

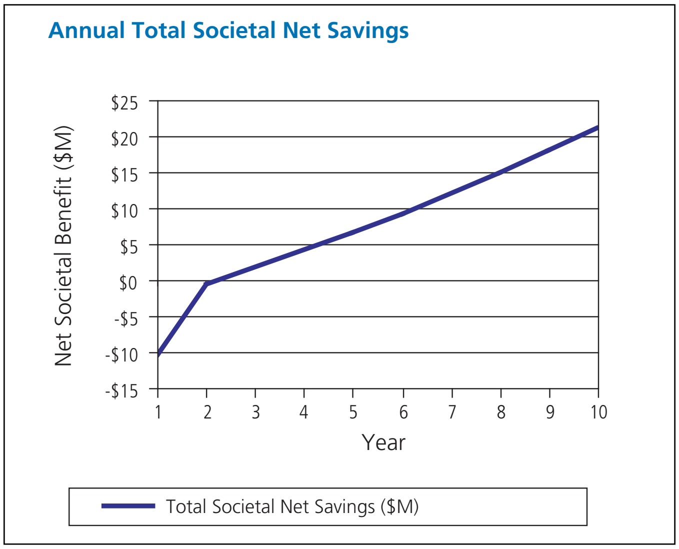
The rates customers pay ($/kWh) increase when avoided costs are less than retail rates, which is typically the case for most EE programs. Rates increase because revenue requirements increase more quickly than sales.



Societal Perspective

Societal Net Savings – Increase

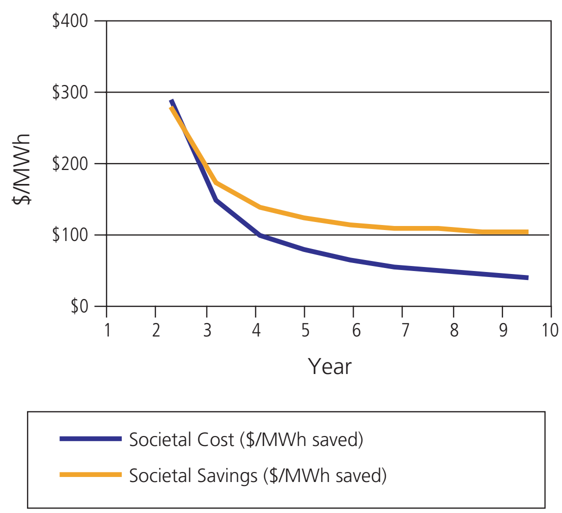
The net savings are the difference of total utility costs, including EE program costs, with EE and without EE. In the first year, the cost of the EE program is a cost to society. Over time, cumulative EE savings lead to a utility production cost savings that is greater than the EE program cost. The graph shape is therefore upward sloping. Total Societal Net Savings is the same with and without decoupling; therefore, only one line is shown.



Total Societal Cost Per Unit – Declines

Total cost of providing each unit of energy (MWh) declines over time because of the impacts of energy savings, decreased peak load requirements, and decreased costs during peak periods. Well-designed EE programs can deliver energy at an average cost less than that of new power sources. When the two lines cross, the annual cost of EE equals the annual savings resulting from EE. The Societal Cost and Societal Savings are the same with and without decoupling.

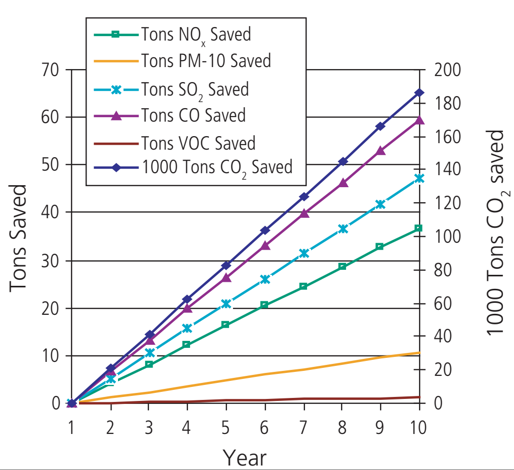
Delivered Costs and Benefits of EE



Emissions and Cost Savings – Increase

Annual tons of emissions saved increases. Emissions cost savings increases when emissions cost is monetized. Emissions costs and savings are the same with and without decoupling.

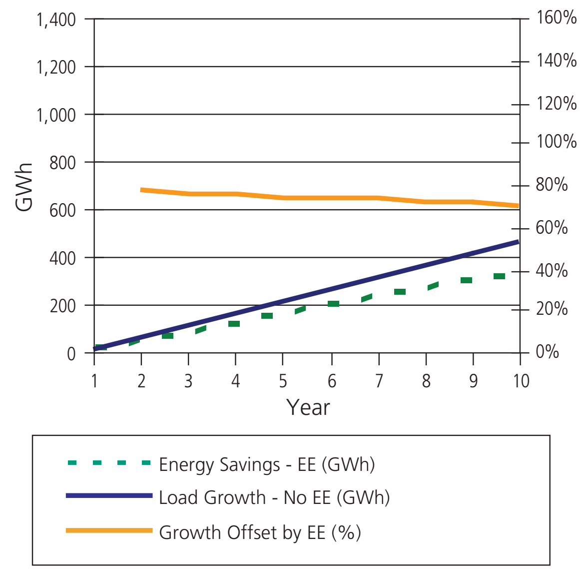
Annual Emissions Savings



Growth Offset by EE – Increase

As EE programs ramp up, energy consumption declines. This comparison shows the growth with and without EE, and illustrates the amount of EE relative to load growth. Load growth and energy savings are not impacted by decoupling. With load growth assumed at zero, no load or percent growth offset shown.

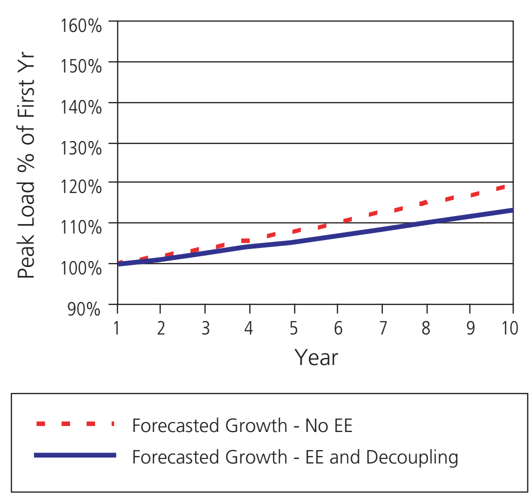
Percent Growth Offset by Energy Efficiency



Peak Load Growth – Decrease

Peak load requirements decrease because peak capacity savings are captured due to EE measures. Peak load is not impacted by decoupling.

Comparison of Peak Load Growth



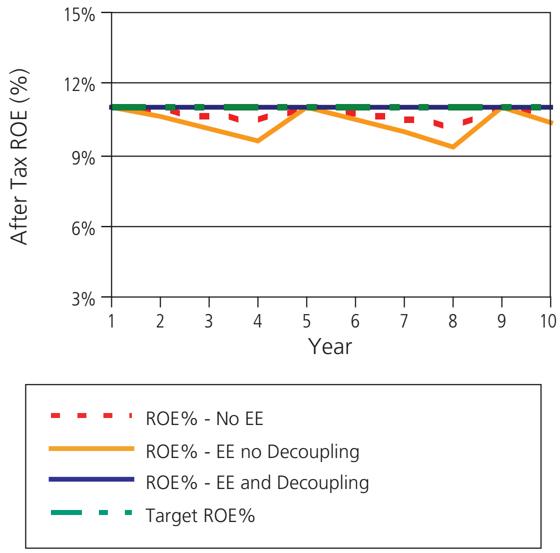
Case 6: Restructured Delivery-Only Utility

Utility Perspective

Utility Financial Health – Small Changes

The change in utility financial health depends on whether or not there are decoupling mechanisms in place, if there are shareholder incentives in place (for investor-owned utilities), the frequency of rate adjustments, and other factors. Depending on the type of utility, the measure of financial health changes. Investor-owned utility health is measured by ROE, while publicly or cooperatively owned utility health is measured by cash position or debt coverage ratio.

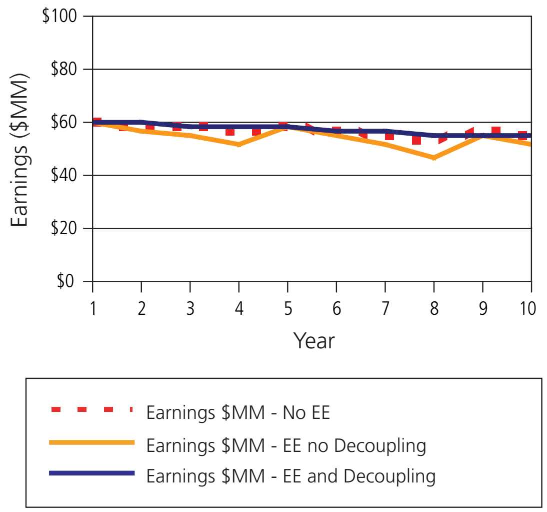
Investor-Owned Utility Comparison of Return on Equity



Utility Earnings – Results Vary

Utility earnings depend on growth rate, capital investment, frequency of rate adjustments, and other factors. If EE reduces capital investment, the earnings will be lower in the EE case, unless shareholder incentives for EE are introduced. However, utility return (ROE or earnings per share) may not be affected.

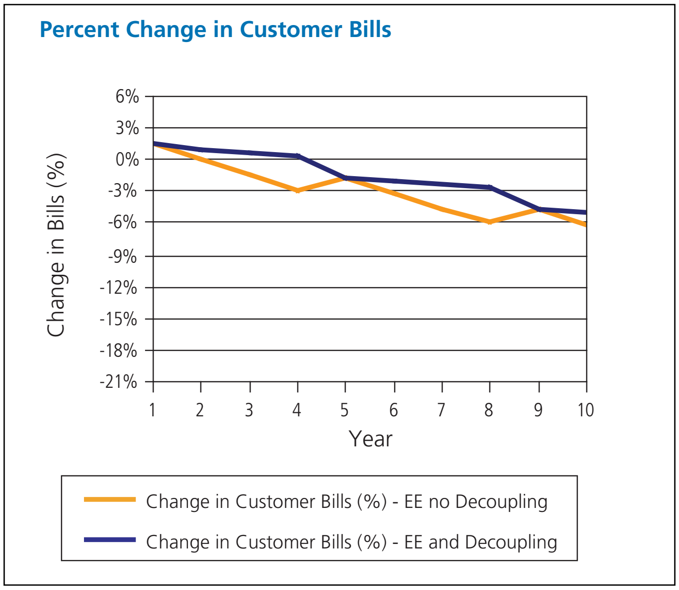
Utility Earnings



Customer Perspective

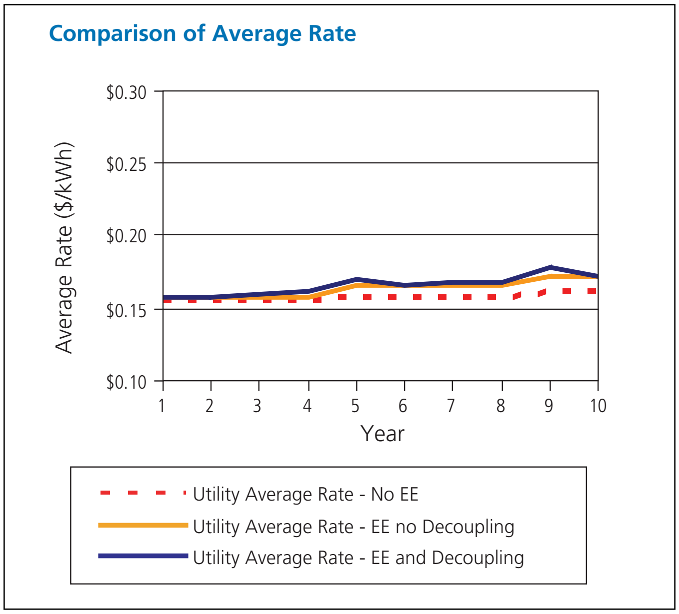
Customer Bills – Decrease

In the first year, customer utility bills increase because the cost of the EE program has not yet produced savings. Total customer bills decline over time, usually within the first three years, indicating customer savings resulting from lower energy consumption.



Utility Rates – Mild Increase

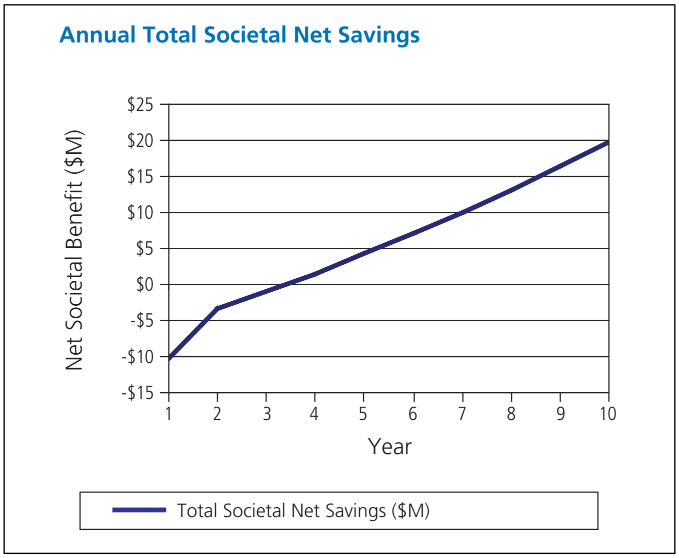
The rates customers pay ($/kWh) increase when avoided costs are less than retail rates, which is typically the case for most EE programs. Rates increase because revenue requirements increase more quickly than sales.



Societal Perspective

Societal Net Savings – Increase

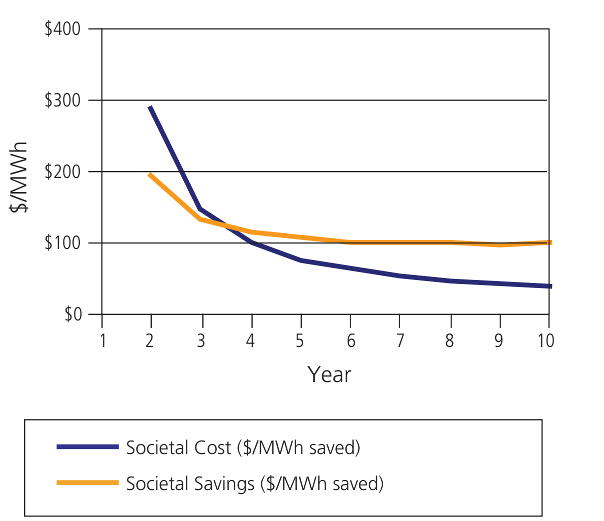
The net savings are the difference of total utility costs, including EE program costs, with EE and without EE. In the first year, the cost of the EE program is a cost to society. Over time, cumulative EE savings lead to a utility production cost savings that is greater than the EE program cost. The graph shape is therefore upward sloping. Total Societal Net Savings is the same with and without decoupling; therefore, only one line is shown.



Total Societal Cost Per Unit – Declines

Total cost of providing each unit of energy (MWh) declines over time because of the impacts of energy savings, decreased peak load requirements, and decreased costs during peak periods. Well-designed EE programs can deliver energy at an average cost less than that of new power sources. When the two lines cross, the annual cost of EE equals the annual savings resulting from EE. The Societal Cost and Societal Savings are the same with and without decoupling.

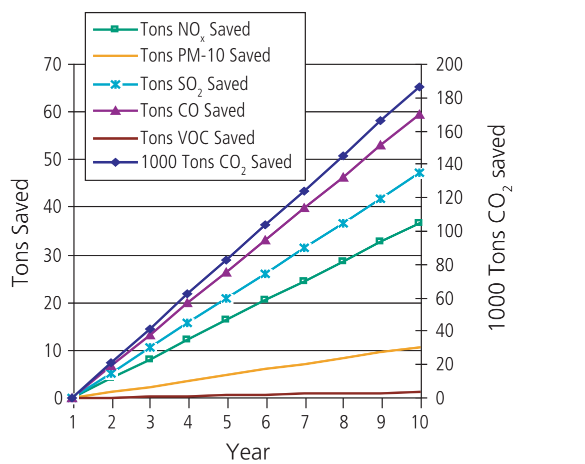
Delivered Costs and Benefits of EE



Emissions and Cost Savings – Increase

Annual tons of emissions saved increases. Emissions cost savings increases when emissions cost is monetized. Emissions costs and savings are the same with and without decoupling.

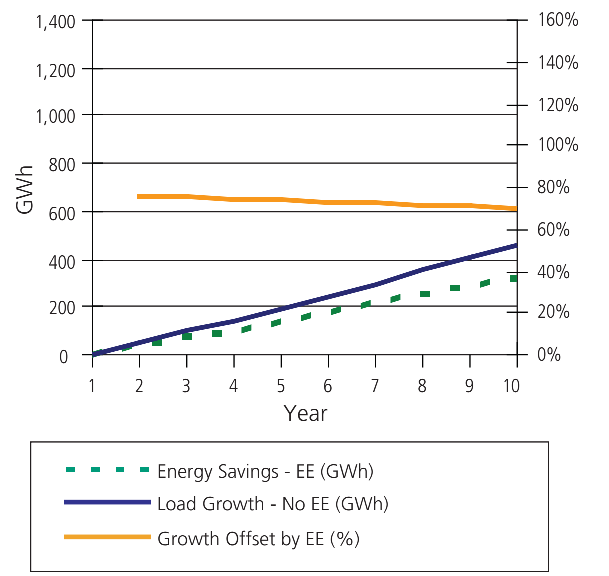
Annual Emissions Savings



Growth Offset by EE – Increase

As EE programs ramp up, energy consumption declines. This comparison shows the growth with and without EE, and illustrates the amount of EE relative to load growth. Load growth and energy savings are not impacted by decoupling. With load growth assumed at zero, no load or percent growth offset shown.

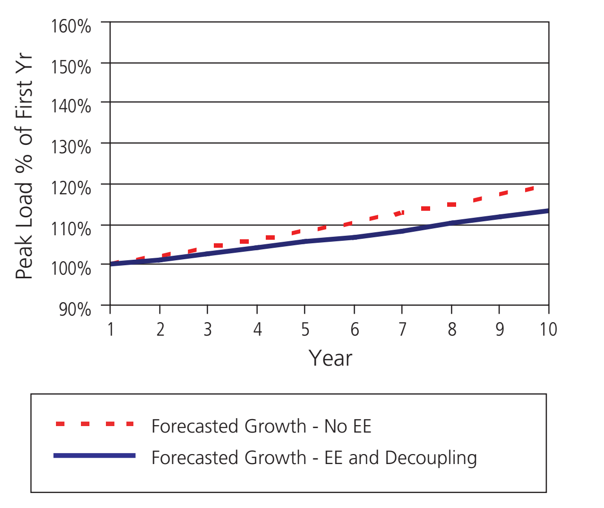
Percent Growth Offset by Energy Efficiency



Peak Load Growth – Decrease

Peak load requirements decrease because peak capacity savings are captured due to EE measures. Peak load is not impacted by decoupling.

Comparison of Peak Load Growth

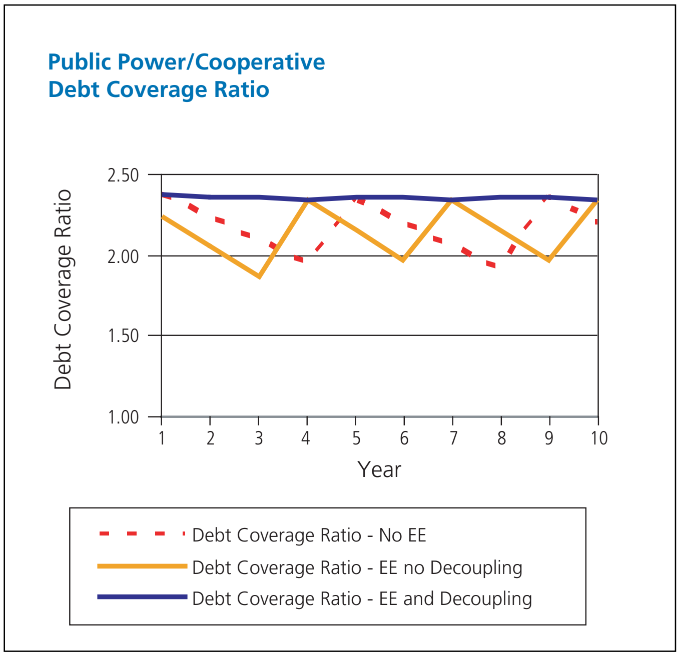


Case 7: Electric Publicly and Cooperatively Owned Debt Coverage Ratio

Utility Perspective

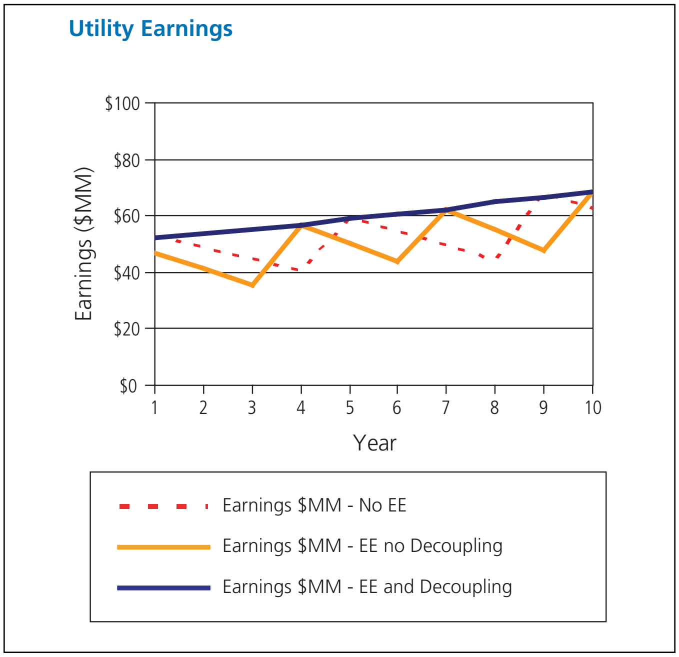
Utility Financial Health – Small Changes

The change in utility financial health depends on whether or not there are decoupling mechanisms in place, if there are shareholder incentives in place (for investor-owned utilities), the frequency of rate adjustments, and other factors. Depending on the type of utility, the measure of financial health changes. Investor-owned utility health is measured by ROE, while publicly or cooperatively owned utility health is measured by cash position or debt coverage ratio.



Utility Earnings – Results Vary

Utility earnings depend on growth rate, capital investment, frequency of rate adjustments, and other factors. If EE reduces capital investment, the earnings will be lower in the EE case, unless shareholder incentives for EE are introduced. However, utility return (ROE or earnings per share) may not be affected.

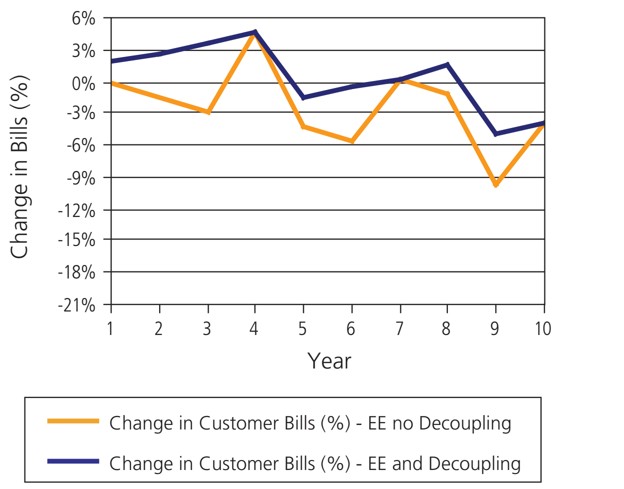


Customer Perspective

Customer Bills – Decrease

In the first year, customer utility bills increase because the cost of the EE program has not yet produced savings. Total customer bills decline over time, usually within the first three years, indicating customer savings resulting from lower energy consumption.

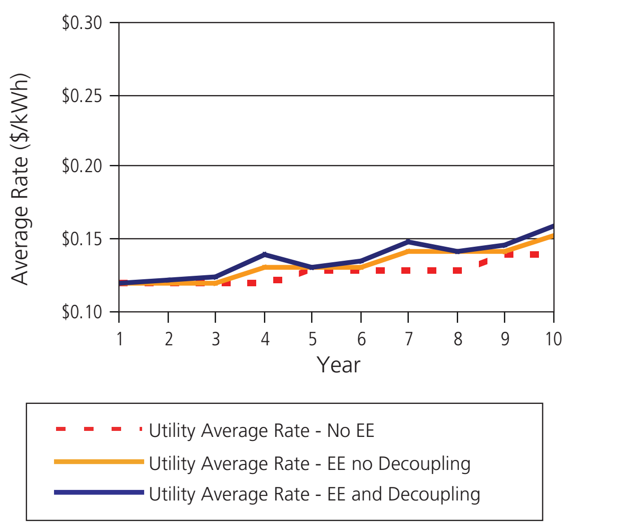
Percent Change in Customer Bills



Utility Rates – Mild Increase

The rates customers pay ($/kWh) increase when avoided costs are less than retail rates, which is typically the case for most EE programs. Rates increase because revenue requirements increase more quickly than sales.

Comparison of Average Rate

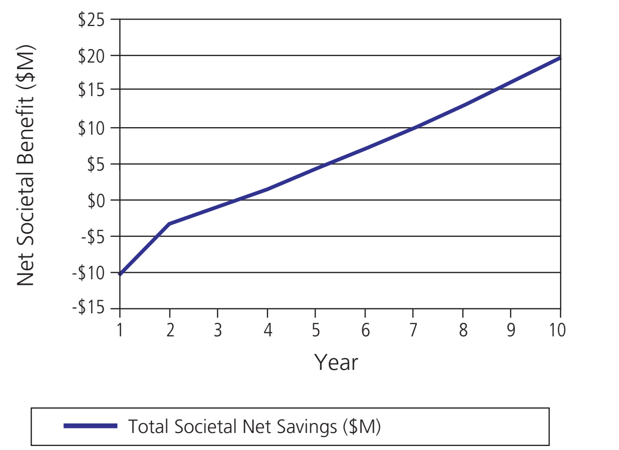


Societal Perspective

Societal Net Savings – Increase

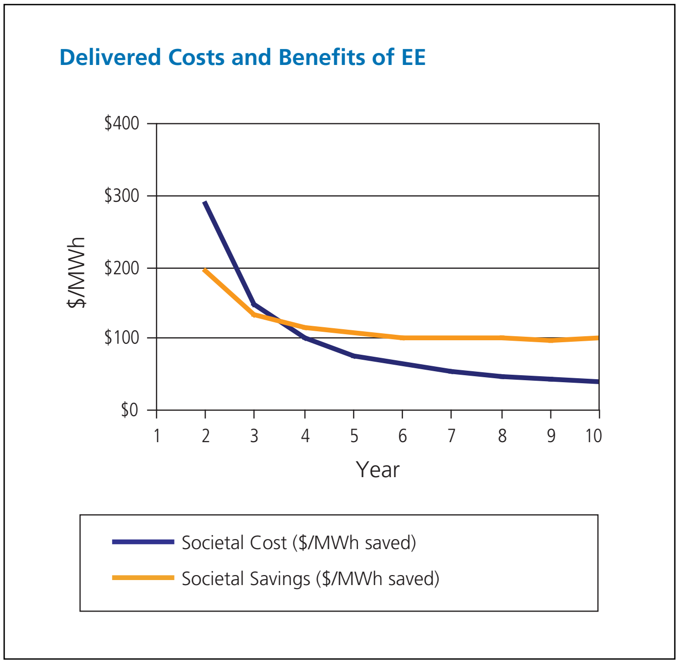
The net savings are the difference of total utility costs, including EE program costs, with EE and without EE. In the first year, the cost of the EE program is a cost to society. Over time, cumulative EE savings lead to a utility production cost savings that is greater than the EE program cost. The graph shape is therefore upward sloping. Total Societal Net Savings is the same with and without decoupling; therefore, only one line is shown.

Annual Total Societal Net Savings



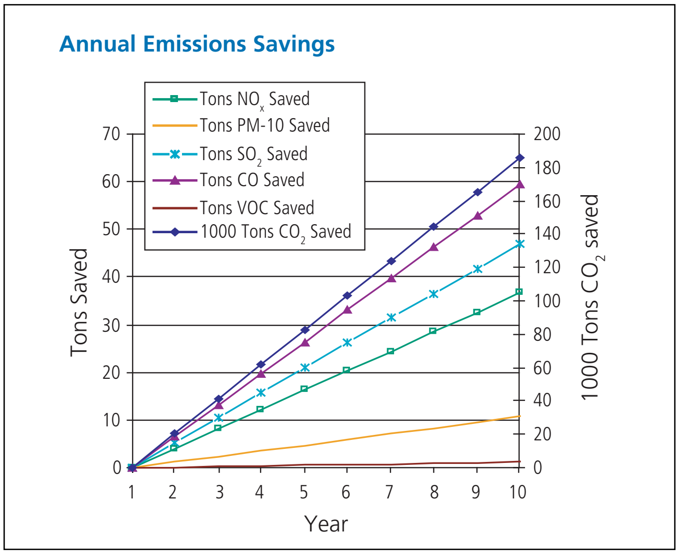
Total Societal Cost Per Unit – Declines

Total cost of providing each unit of energy (MWh) declines over time because of the impacts of energy savings, decreased peak load requirements, and decreased costs during peak periods. Well-designed EE programs can deliver energy at an average cost less than that of new power sources. When the two lines cross, the annual cost of EE equals the annual savings resulting from EE. The Societal Cost and Societal Savings are the same with and without decoupling.



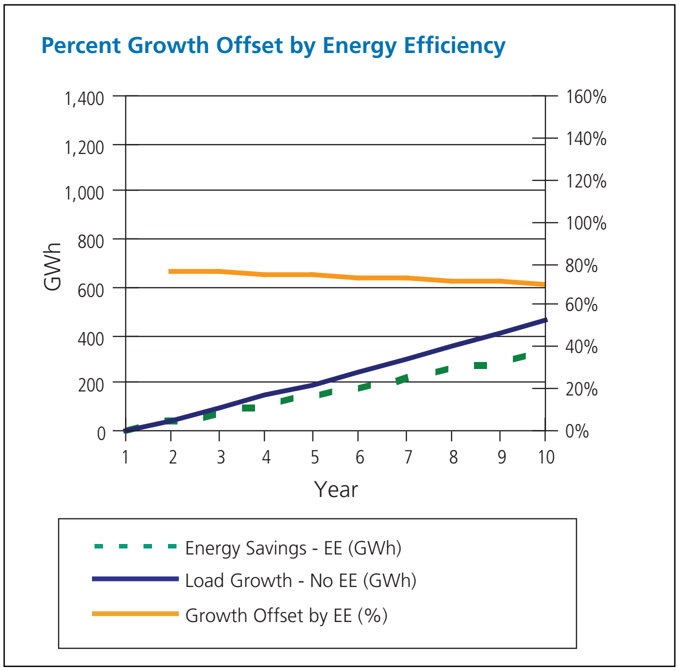
Emissions and Cost Savings – Increase

Annual tons of emissions saved increases. Emissions cost savings increases when emissions cost is monetized. Emissions costs and savings are the same with and without decoupling.



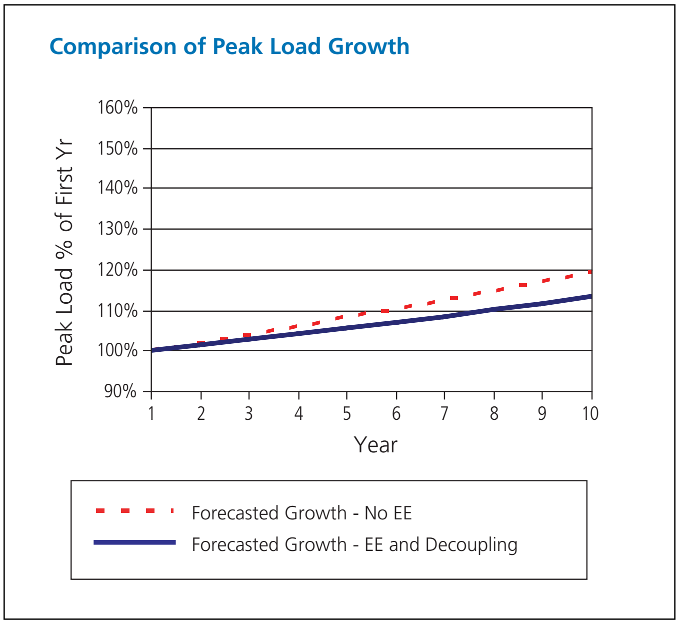
Growth Offset by EE – Increase

As EE programs ramp up, energy consumption declines. This comparison shows the growth with and without EE, and illustrates the amount of EE relative to load growth. Load growth and energy savings are not impacted by decoupling. With load growth assumed at zero, no load or percent growth offset shown.



Peak Load Growth – Decrease

Peak load requirements decrease because peak capacity savings are captured due to EE measures. Peak load is not impacted by decoupling.

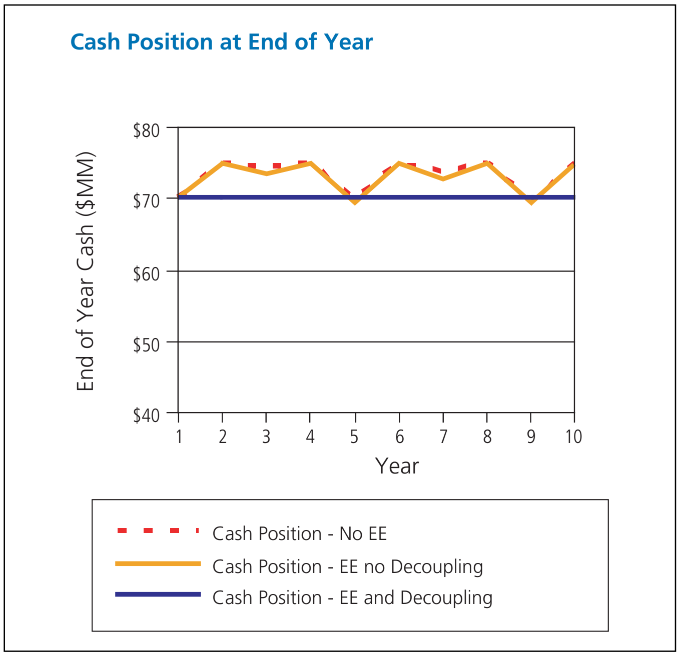


Case 8: Electric Publicly and Cooperatively Owned Cash Position

Utility Perspective

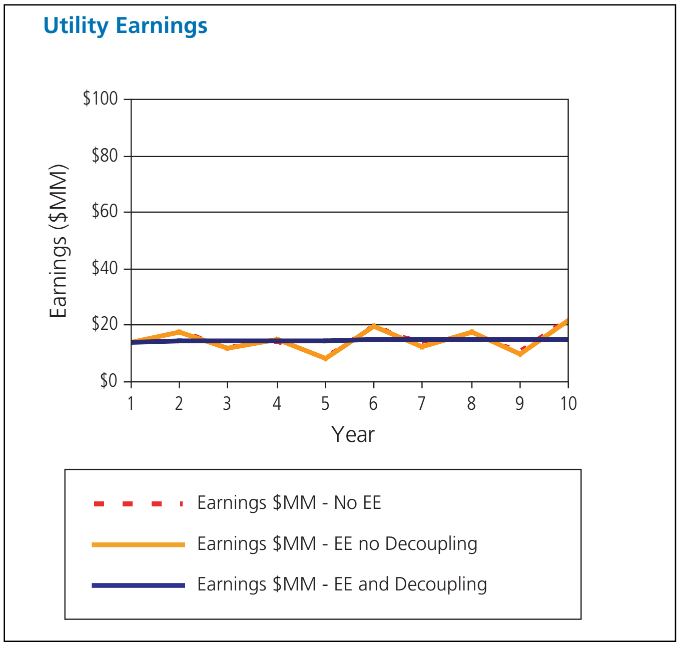
Utility Financial Health – Small Changes

The change in utility financial health depends on whether or not there are decoupling mechanisms in place, if there are shareholder incentives in place (for investor-owned utilities), the frequency of rate adjustments, and other factors. Depending on the type of utility, the measure of financial health changes. Investor-owned utility health is measured by ROE, while publicly or cooperatively owned utility health is measured by cash position or debt coverage ratio.



Utility Earnings – Results Vary

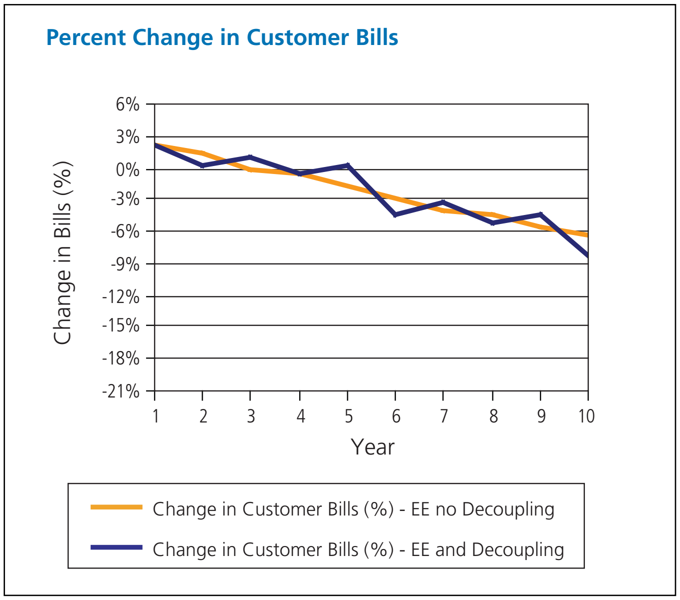
Utility earnings depend on growth rate, capital investment, frequency of rate adjustments, and other factors. If EE reduces capital investment, the earnings will be lower in the EE case, unless shareholder incentives for EE are introduced. However, utility return (ROE or earnings per share) may not be affected.



Customer Perspective

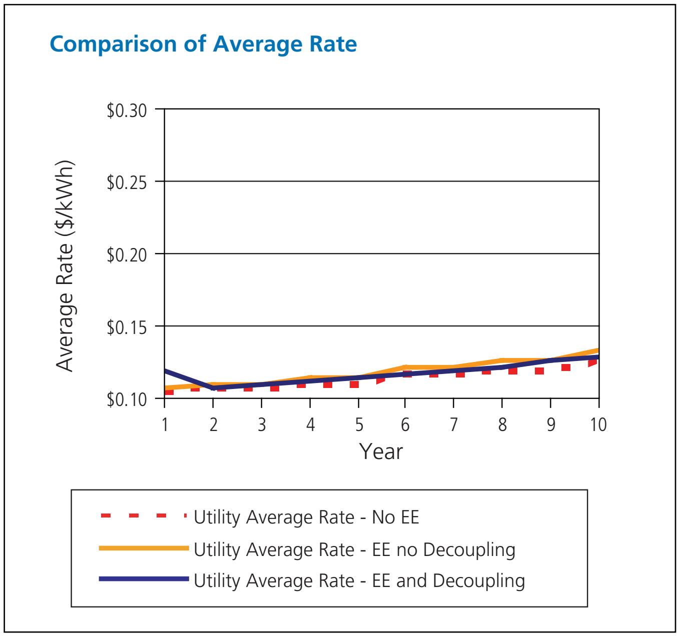
Customer Bills – Decrease

In the first year, customer utility bills increase because the cost of the EE program has not yet produced savings. Total customer bills decline over time, usually within the first three years, indicating customer savings resulting from lower energy consumption.



Utility Rates – Mild Increase

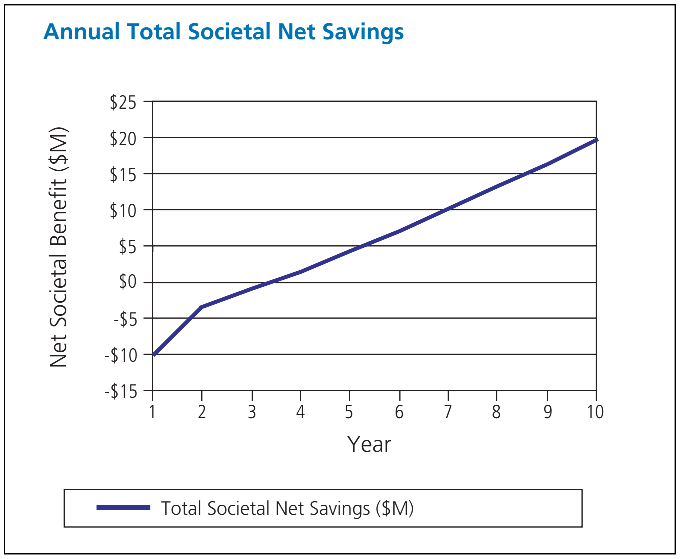
The rates customers pay ($/kWh) increase when avoided costs are less than retail rates, which is typically the case for most EE programs. Rates increase because revenue requirements increase more quickly than sales.



Societal Perspective

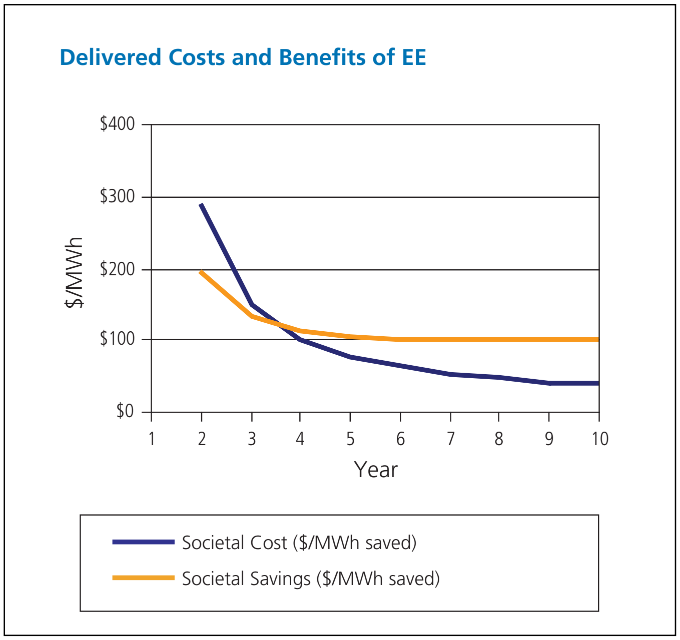
Societal Net Savings – Increase

The net savings are the difference of total utility costs, including EE program costs, with EE and without EE. In the first year, the cost of the EE program is a cost to society. Over time, cumulative EE savings lead to a utility production cost savings that is greater than the EE program cost. The graph shape is therefore upward sloping. Total Societal Net Savings is the same with and without decoupling; therefore, only one line is shown.



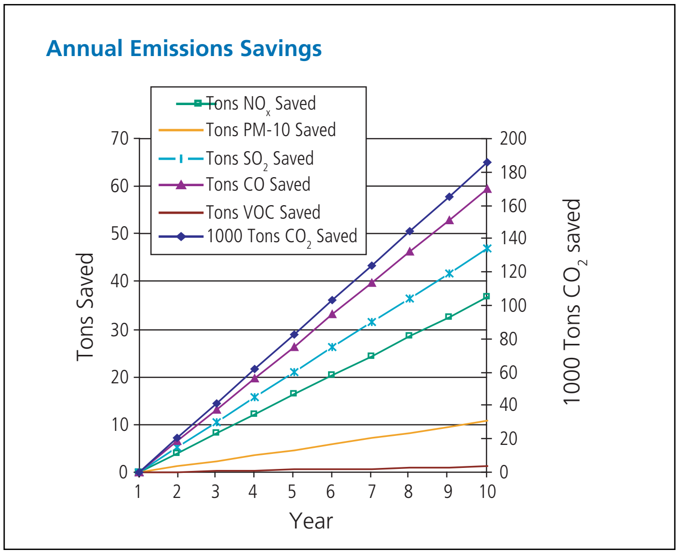
Total Societal Cost Per Unit – Declines

Total cost of providing each unit of energy (MWh) declines over time because of the impacts of energy savings, decreased peak load requirements, and decreased costs during peak periods. Well-designed EE programs can deliver energy at an average cost less than that of new power sources. When the two lines cross, the annual cost of EE equals the annual savings resulting from EE. The Societal Cost and Societal Savings are the same with and without decoupling.



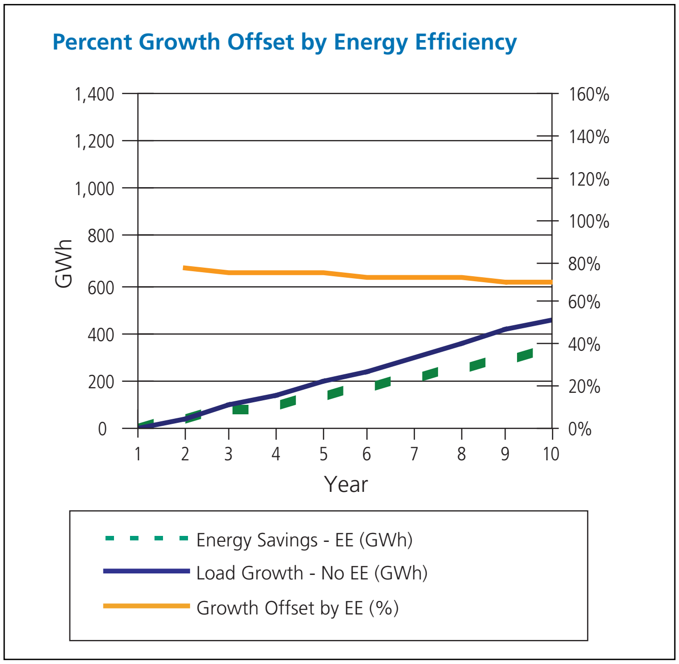
Emissions and Cost Savings – Increase

Annual tons of emissions saved increases. Emissions cost savings increases when emissions cost is monetized. Emissions costs and savings are the same with and without decoupling.



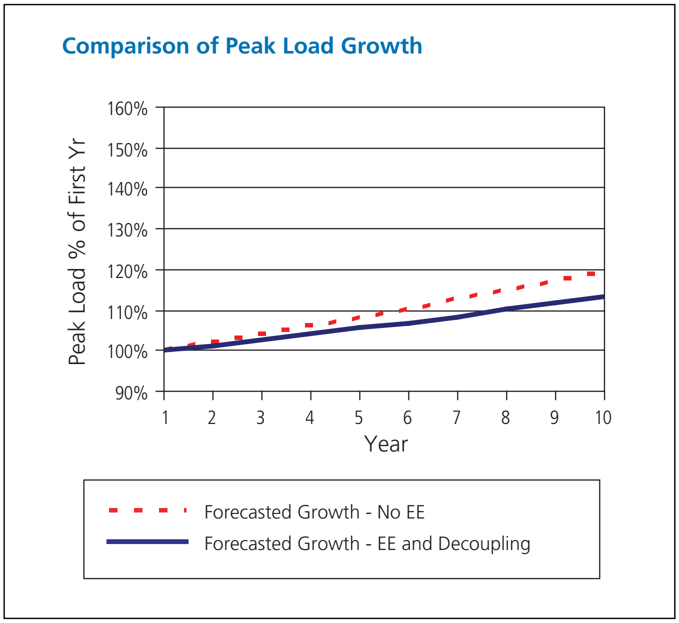
Growth Offset by EE – Increase

As EE programs ramp up, energy consumption declines. This comparison shows the growth with and without EE, and illustrates the amount of EE relative to load growth. Load growth and energy savings are not impacted by decoupling. With load growth assumed at zero, no load or percent growth offset shown.



Peak Load Growth – Decrease

Peak load requirements decrease because peak capacity savings are captured due to EE measures. Peak load is not impacted by decoupling.



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Aligning Utility Incentives with Investment in Energy Efficiency

A RESOURCE OF THE NATIONAL ACTION PLAN FOR ENERGY EFFICIENCY

NOVEMBER 2007

About This Document

This report on *Aligning Utility Incentives with Investment in Energy Efficiency* is provided to assist gas and electric utilities, utility regulators, and others in the implementation of the recommendations of the National Action Plan for Energy Efficiency (Action Plan) and the pursuit of its longer-term goals.

The Report describes the financial effects on a utility of its spending on energy efficiency programs, how those effects could constitute barriers to more aggressive and sustained utility investment in energy efficiency, and how adoption of various policy mechanisms can reduce or eliminate these barriers. The Report also provides a number of examples of such mechanisms drawn from the experience of utilities and states.

The primary intended audiences for this paper are utilities, state policy-makers, and energy efficiency advocates interested in specific options for addressing the financial barriers to utility investment in energy efficiency.

Aligning Utility Incentives with Investment in Energy Efficiency

A RESOURCE OF THE NATIONAL ACTION PLAN FOR ENERGY EFFICIENCY

NOVEMBER 2007

Aligning Utility Incentives with Investment in Energy Efficiency is a product of the National Action Plan for Energy Efficiency Leadership Group and does not reflect the views, policies, or otherwise of the federal government. The role of the U.S. Department of Energy and U.S. Environmental Protection Agency is limited to facilitation of the Action Plan.

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List of Abbreviations and Acronyms

A

APS Arizona Public Service Company

B

BA balance adjustment

BGE Baltimore Gas & Electric

BGSS Basic Gas Supply Service

C

CCRA conservation cost recovery adjustment

CCRC conservation cost recovery charge

CET conservation enabling tariff

CIP conservation improvement program or Conservation Incentive Program

CMP Central Maine Power

CPUC California Public Utilities Commission

CUA conservation and usage adjustment

D

DBA DSM balance adjustment

DCR DSM program cost recovery

DNG distribution non-gas

DOE U.S. Department of Energy

DRLS DSM revenue from lost sales

DSM demand-side management

DSMI DSM incentive

DSMRC demand-side management recovery component

E

ECCR energy conservation cost recovery

EPA U.S. Environmental Protection Agency

ER earnings rate

ERAM electric rate adjustment mechanism

F

FCA fixed cost adjustment

FCM forward capacity market

FEECA Florida Energy Efficiency and Conservation Act

FPL Florida Power and Light

H

HECO Hawaiian Electric Company

I

ISO independent system operator

K

kW kilowatt

kWh kilowatt-hour

L

LG&E Louisville Gas & Electric

LRAM lost revenue adjustment mechanism

M

MW megawatt

MWh megawatt-hour

List of Abbreviations and Acronyms (continued)

N

NARUC	National Association of Regulatory Utility Commissioners
NJNG	New Jersey Natural Gas
NJR	New Jersey Resources
NJRES	NJR Energy Services
NSP	Northern States Power Company

O

O&M	operation and maintenance

P

PBR	performance-based ratemaking
PEB	performance earnings basis
PG&E	Pacific Gas & Electric Company

R

RAP	Regulatory Assistance Project
ROE	return on equity

S

SFV	Straight Fixed-Variable
SJG	South Jersey Gas

U

UCE	Utah Clean Energy

Acknowledgements

This report on Aligning Utility Incentives with Investment in Energy Efficiency is a key product of the Year Two Work Plan for the National Action Plan for Energy Efficiency. This work plan was developed based on feedback received from Action Plan Leadership Group members and observers during fall 2006. The work plan was further refined during the March 2007 Leadership Group meeting in Washington, D.C. A full list of Leadership Group members is provided in Appendix A.

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Executive Summary

This report on Aligning Utility Incentives with Investment in Energy Efficiency describes the financial effects on a utility of its spending on energy efficiency programs, how those effects could constitute barriers to more aggressive and sustained utility investment in energy efficiency, and how adoption of various policy mechanisms can reduce or eliminate these barriers. The Report also provides a number of examples of such mechanisms drawn from the experience of utilities and states. The Report is provided to assist in the implementation of the National Action Plan for Energy Efficiency's five key policy recommendations for creating a sustainable, aggressive national commitment to energy efficiency.

Improving energy efficiency in our homes, businesses, schools, governments, and industries—which collectively consume more than 70 percent of the natural gas and electricity used in the country—is one of the most constructive, cost-effective ways to address the challenges of high energy prices, energy security and independence, air pollution, and global climate change. Despite these benefits and the success of energy efficiency programs in some regions of the country, energy efficiency remains critically underutilized in the nation's energy portfolio. It is time to take advantage of more than two decades of experience with successful energy efficiency programs, broaden and expand these efforts, and capture the savings that energy efficiency offers. Aligning the financial incentives of utilities with the delivery of cost-effective energy efficiency supports the key role utilities can play in capturing energy savings.

This Report has been developed to help parties fully implement the five key policy recommendations of the National Action Plan for Energy Efficiency. (See Figure 1-1 for a full list of options to consider under each Action Plan recommendation.) The Action Plan was released in July 2006 as a call to action to bring diverse stakeholders together at the national, regional, state, or utility level, as appropriate, and foster the discussions, decision-making, and commitments necessary to take investment in energy efficiency to a new level.

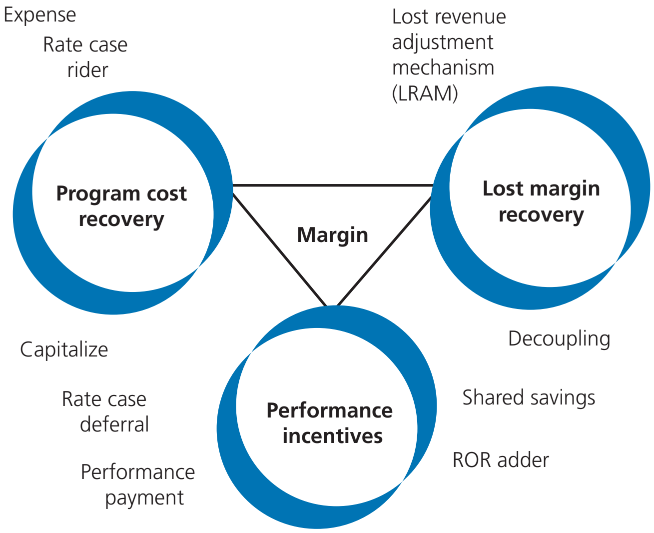
This Report directly supports the Action Plan recommendations to "provide sufficient, timely, and stable program funding to deliver energy efficiency where cost-effective" and "modify policies to align utility incentives with the delivery of cost-effective energy efficiency and modify ratemaking practices to promote energy efficiency investments." Key options to consider under this recommendation include committing to a consistent way to recover costs in a timely manner, addressing the typical utility throughput incentive and providing utility incentives for the successful management of energy efficiency programs.

There are a number of possible regulatory mechanisms for addressing these issues. Determining which mechanism will work best for any given jurisdiction is a process that takes into account the type and financial structure of the utilities in that jurisdiction; existing statutory and regulatory authority; and the size of the energy efficiency investment. The net impact of an energy efficiency cost recovery and performance incentives policy will be affected by a wide variety of other rate design, cost recovery, and resource procurement strategies, as well as broader considerations, such as the rate of demand growth and environmental and resource policies.

The Financial and Policy Context

Utility spending on energy efficiency programs can affect the utility's financial position in three ways: (1) through recovery of the direct costs of the programs; (2) through the impact on utility earnings of reduced sales; and (3) through the effects on shareholder value of energy efficiency spending versus investment in supply-side resources. The relative importance of each effect to a utility is measured by its impact on earnings. A variety of mechanisms have been developed to address these impacts, as illustrated in Figure ES-1.

Figure ES-1. Cost Recovery and Performance Incentive Options



How these impacts are addressed creates the incentives and disincentives for utilities to pursue energy efficiency investment. The relative importance of each of these depends on specific context—the impacts of energy efficiency programs will look different to gas and electric utilities, and to investor-owned, publicly owned, and cooperatively owned utilities. Comprehensive policies addressing all three levels of impact generally are considered more effective in spurring utilities to pursue efficiency aggressively. Ultimately, however, it is the cumulative net effect on utility earnings or net income of a policy that will determine the alignment of utility financial interests with energy efficiency investment. The same effect can be achieved in different ways, not all of which will include explicit mechanisms for each level. Chapter 2 of this Report explores the financial effects of and policy issues associated with utility energy efficiency spending.

Program Cost Recovery

The most immediate impact is that of the direct costs associated with program administration (including evaluation), implementation, and incentives to program participants. Reasonable opportunity for program cost recovery is a necessary condition for utility program spending, as failure to recover these costs produces a direct dollar-for-dollar reduction in utility earnings, all else being equal, and sends a discouraging message regarding further investment.

Policy-makers have a wide variety of tools available to them within the broad categories of expensing and capitalization to address cost recovery. Program costs can be recovered as expenses or can be treated like capital items by accruing program costs with carrying charges, and then amortizing the balances with recovery over a period of years. Chapter 4 reviews both general options as well as several approaches for the tracking, accrual, and recovery of program costs. Case studies for Arizona, Iowa, Florida, and Nevada are presented to illustrate the actual application of the mechanisms.

Each of these tools can have different financial impacts, but the key factors in any case are the determination of the prudence of program expenditures and the timing of cost recovery. How each of these is addressed will affect the perceived financial risk of the policy. The more uncertain the process for determining the prudence of expenditures, and the longer the time between an expenditure and its recovery, the greater the perceived financial risk and the less likely a utility will be to aggressively pursue energy efficiency.

Lost Margin Recovery and the Throughput Incentive

The second impact, sometimes called the lost margin recovery issue is the effect on utility financial margins caused by the energy efficiency-produced drop in sales. Utilities incur both fixed and variable costs. Fixed costs include a return of (depreciation) and a return on (interest plus earnings) capital (a utility's physical infrastructure), as well as property taxes and certain operation and maintenance (O&M) costs. These costs do not vary as a function of sales in the short-run. However, most utility rate designs attempt to recover a portion of these fixed costs through volumetric prices—a price per kilowatt-hour or per therm. These prices are based on an estimate of sales: price = revenue requirement/ sales.1 If actual sales are either higher or lower than the level estimated when prices are set, revenues will be higher or lower. All else being equal, if an energy efficiency program reduces sales, it reduces revenues proportionately, but fixed costs do not change. Less revenue, therefore, means that the utility is at some risk for not recovering all of its fixed costs. Ultimately, the drop in revenue will impact the utility's earnings for an investor-owned utility, or net operating margin for publicly and cooperatively owned utilities.

Few energy efficiency policy issues have generated as much debate as the issue of the impact of energy efficiency programs on utility margins. Arguments on all sides of the lost margin issue can be compelling. Many observers would agree that significant and sustained investment in energy efficiency by utilities, beyond that required under statute or order, will not occur without implementation of some type of mechanism to ensure recovery of lost margins. Others argue that the lost margin issue cannot be treated in isolation; margin recovery is affected by a wide variety of factors, and special adjustments for energy efficiency constitute single issue ratemaking.[2]

Care should be taken to ensure that two very different issues are not incorrectly treated as one. The first issue is whether a utility should be compensated for the under-recovery of fixed costs when energy efficiency programs or events outside of the control of the utility (e.g., weather or a drop in economic activity) reduce sales below the level on which current rates are based. *Lost revenue adjustment mechanisms* (LRAMs) have been designed to estimate and collect the margin revenues that might be lost due to a successful energy efficiency program. These mechanisms compensate utilities for the effect of reduced sales due to efficiency, but they do not change the linkage between sales and profit. Few states currently use these mechanisms.

The second issue is whether potential lost margins should be addressed as a stand-alone matter of cost recovery or by *decoupling* revenues from sales—an approach that fundamentally changes the relationship between sales and revenues, and thus margins. Decoupling not only addresses lost margin recovery, but also removes the throughput incentive—the incentive for utilities to promote sales growth, which is created when fixed costs are recovered through volumetric charges. The *throughput incentive* has been identified by many as the primary barrier to aggressive utility investment in energy efficiency.

Chapter 5 examines the cause of and options for recovery of lost margins, and case studies are presented for decoupling in Idaho, New Jersey, Maryland, and Utah, and for the application of a LRAM in Kentucky.

Utility Performance Incentives

The two impacts described above pertain to potential direct disincentives for utilities to engage in energy efficiency program investment. The third impact concerns incentives for utilities to undertake such investment. Under traditional regulation, investor-owned utilities earn returns on capital invested in generation, transmission, and distribution. Unless given the opportunity to profit from the energy efficiency investment that is intended to substitute for this capital investment, there is a clear financial incentive to prefer investment in supply-side assets, since these investments contribute to enhanced shareholder value. Providing financial incentives to a utility if it performs well in delivering energy efficiency can change that business model by making efficiency profitable rather than merely a break-even activity.

The three major types of performance mechanisms have been most prevalent include:

- Performance target incentives.
- Shared savings incentives.
- Rate of return adders.

Performance target incentives provide payment—often a percentage of the total program budget—for achievement of specific metrics, usually including savings targets. Most states providing such incentives set performance ranges; incentives are not paid unless a utility achieves some minimum fraction of proposed savings, and incentives are capped at some level above projected savings.

Shared savings mechanisms provide utilities the opportunity to share with ratepayers the net benefits resulting from successful implementation of energy efficiency programs. These structures also include specific performance targets that tie the percentage of net savings awarded to the percentage of goal achieved. Some, but not all, shared savings mechanisms include penalty provisions requiring utilities to pay customers when minimum performance targets are not achieved.

Rate of return adders provide an increase in the return on equity (ROE) applied to capitalized energy efficiency expenditures. This approach currently is not common as a performance incentive for several reasons. First, this mechanism requires energy efficiency program costs to be capitalized, which relatively few utilities prefer. Second, at least as applied in several cases, the adder is not tied to performance—it simply is applied to all capitalized energy efficiency costs as a way to broadly incent a utility for efficiency spending. On the other hand, capitalization, in theory, places energy efficiency on more equal financial terms with supply-side investments to begin with. Thus, any adder could be viewed more as a risk-premium for investment in a regulatory asset.

The premise that utilities should be paid incentives as a condition for effective delivery of energy efficiency programs is not universally accepted. Some argue that utilities are obligated to pursue energy efficiency if that is the policy of a state, and that performance incentives require customers to pay utilities to do something that they should do anyway. Others have argued more directly that the basic business of a utility is to deliver energy, and that providing financial incentives over-and-above what could be earned by efficient management of the supply business simply raises the cost of service to all customers and distorts management behavior.

Chapter 6 reviews these mechanisms in greater detail and provides case studies drawn from Massachusetts, Minnesota, Hawaii, and California.

Table ES-1 summarizes the current level of state activity with regard to the financial mechanisms describe above.

Understanding Objectives—Developing Policy Approaches That Fit

The overarching goal in every jurisdiction that considers an energy efficiency investment policy is to generate and capture substantial net economic benefits. Achieving this goal requires aligning utility financial interests with investment in energy efficiency. The right combination of cost recovery and performance incentive mechanisms to support this alignment requires a balancing of a variety of more specific objectives common to the ratemaking process. Chapter 3 reviews how these objectives might influence design of a cost recovery and performance incentive policy, and highlights elements of the policy context that will affect policy design. Each of these objectives are not given equal weight by policy-makers, but most are given at least some consideration in virtually every discussion of cost recovery and performance incentives.

- **Strike an Appropriate Balance of Risk/Reward Between Utilities/Customers.** If a mechanism is well-designed and implemented, customer benefits will be large enough to allow sharing some of this benefit as a way to reduce utility risk and strengthen institutional commitment; all parties will be better off than if no investment had been made.
- **Promote Stabilization of Customer Rates and Bills.** While it is prudent to explore policy designs that, among available options, minimize potential rate volatility, the pursuit of rate stability should be balanced against the broader interest of lowering the overall cost of providing electricity and natural gas.
- **Stabilize Utility Revenues.** Even if cost recovery policy covers program costs, fixed cost recovery and performance incentives, how this recovery takes

Table ES-1. The Status of Energy Efficiency Cost Recovery and Incentive Mechanisms for Investor-Owned Utilities

State	Direct Cost Recovery			Fixed Cost Recovery		Performance Incentives
	Rate Case	System Benefits Charge	Tariff Rider/ Surcharge	Decoupling	Lost Revenue Adjustment Mechanism	
Alabama	Yes					
Alaska						
Arizona	Yes (electric)	Yes (electric)		Pending (gas)		Yes (electric)
Arkansas				Yes (gas)		
California	Yes	Yes		Yes		Yes
Colorado	Yes		Yes	Pending		Yes
Connecticut		Yes (electric)			Yes	Yes
Delaware	Yes			Pending		
District of Columbia	Yes			Pending (electric)		
Florida			Yes (electric)			
Georgia	Yes					Yes (electric)
Hawaii				Pending (electric)		Yes
Idaho	Yes (electric)			Yes (electric)		
Illinois	Yes (electric)					
Indiana	Yes			Yes (gas)	Yes	Yes
Iowa	Yes		Yes			
Kansas						Yes
Kentucky			Yes	Pending (gas)	Yes	Yes
Louisiana						
Maine		Yes (electric)				
Maryland				Yes (gas) Pending (electric)		
Massachusetts		Yes (electric)		Pending (electric)	Yes	Yes (electric)
Michigan				Pending (gas)		
Minnesota	Yes			Yes		Yes
Mississippi	Yes					
Missouri				Yes (gas)		
Montana	Yes (gas)	Yes (electric)				Yes
Nebraska						
Nevada	Yes (electric)			Yes (gas)		Yes (electric)
New Hampshire		Yes (electric)		Pending (electric)		Yes (electric)

Table ES-1. The Status of Energy Efficiency Cost Recovery and Incentive Mechanisms for Investor-Owned Utilities (continued)

State	Direct Cost Recovery			Fixed Cost Recovery		Performance Incentives
	Rate Case	System Benefits Charge	Tariff Rider/ Surcharge	Decoupling	Lost Revenue Adjustment Mechanism	
New Jersey		Yes		Yes (gas) Pending (electric)		
New Mexico	Yes			Pending (gas)		
New York		Yes (electric)		Yes		
North Carolina				Yes (gas)		
North Dakota						
Ohio			Yes (electric)	Yes (gas)	Yes (electric)	Yes (electric)
Oklahoma						
Oregon		Yes		Yes (gas)		
Pennsylvania	Yes					
Rhode Island		Yes (electric)		Yes		Yes
South Carolina						Yes
South Dakota						
Tennessee						
Texas	Yes					
Utah	Yes (electric)		Yes (electric)	Yes (gas)		
Vermont		Yes (electric)			Yes	Yes
Virginia				Pending (gas)		
Washington	Yes (electric)		Yes (electric)	Yes (gas)		
West Virginia						
Wisconsin	Yes (electric)	Yes (electric)		Pending (electric)		
Wyoming						

Source: Kushler et al., 2006. (Current as of September 2007.) Please see Appendix C for specific state citations.

place can affect the pattern of cash flow and earnings. Large episodic jumps in earnings (produced, for example, by a decision to allow recovery of accrued under-recovery of fixed costs in a lump sum), can cloud financial analysts' ability to discern the true financial performance of a company.

- **Administrative Simplicity and Managing Regulatory Costs.** Simplicity requires that any/all mechanisms be transparent with respect to both calculation of recoverable amounts and overall impact on utility earnings. Every mechanism will impose some incremental cost on all parties, since some regulatory responsibilities are inevitable. The objective, therefore, is to structure mechanisms that lend themselves to a consistent and more formulaic process. This objective can be satisfied by providing clear rules prescribing what is considered acceptable/necessary as part of an investment plan.

Finding the right policy balance hinges on a wide range of factors that can influence how a cost recovery and performance incentive measure will actually work. These factors will include: industry structure (gas or electric utility, public or investor-owned, restructured or bundled); regulatory structure and process (types of test year, current rate design policies); and utility operating environment (demand growth and volatility, utility cost and financial structure, structure of the energy efficiency portfolio). Given the complexity of many of these issues, most states defer to state utility regulators to fashion specific cost recovery and performance incentive mechanism(s).

Emerging Models

Although the details of the policies and mechanisms for addressing the financial impacts of energy efficiency programs continue to evolve in jurisdictions across the country, the basic classes of mechanisms have been understood, applied, and debated for more than two decades. Most jurisdictions currently considering policies to remove financial disincentives to utility investment in energy efficiency are considering one or more of the mechanisms described above. Still, the persistent debate over recovery of lost margins and performance incentives in particular creates an interest in new approaches.

In April 2007, Duke Energy proposed what is arguably the most sweeping alternative to traditional cost recovery, margin recovery and performance incentive approaches since the 1980s. Offered in conjunction with an energy efficiency portfolio in North Carolina, Duke's Energy Efficiency Rider encapsulates program cost recovery, recovery of lost margins, and shareholder incentives into one conceptually simple mechanism tied to the utility's avoided cost. The approach is based on the notion that, if energy efficiency is to be viewed from the utility's perspective as equivalent to a supply resource, the utility should be compensated for its investment in energy efficiency by an amount roughly equal to what it would otherwise spend to build the new capacity that is to be avoided. The Duke proposal would authorize the company, "to recover the amortization of and a return on 90 percent of the costs avoided by producing save-a-watts."

The proposal clearly represents an innovation in thinking regarding elimination of financial disincentives for utilities, and has intuitive appeal for its conceptual simplicity. The Duke proposal does represent a distinct departure from cost recovery and shareholder incentives convention. What is a simple and compelling concept is embedded in a formal mechanism that is quite complex, and the mechanism will likely engender substantial debate.

A second emerging model is represented by the ISO New England's capacity auction process. This process allows demand-side resources to be bid into an auction alongside supply-side resources, and utilities and third-party energy efficiency providers are allowed to participate in the auction with energy efficiency programs. Winning bids receive a revenue stream that could, under certain circumstances, be used to offset direct program costs or lost margins, or could provide a source of performance incentives. The treatment of revenues received from the auction by a utility, however, is subject to allocation by its state utility commission(s), and the traditional approach to the treatment of off-system revenues is to credit them against jurisdictional revenue requirements. Therefore, the capability of this model to address the impacts described above depends largely on state regulatory policy. Whether this model ultimately is transferable to other areas of the country depends greatly on how power markets are structured in these areas.

Final Thoughts

The history of utility energy efficiency investment is rich with examples of how state legislatures, regulatory commissions, and the governing bodies of publicly and cooperatively owned utilities have explored their cost recovery policy options. As these options are reconsidered and reconfigured in light of the trend toward higher utility investment in energy efficiency, this experience yields several lessons with respect to process.

- **Set cost recovery and incentive policy based on the direction of the market's evolution.** The rapid development of technology, the likely integration of energy efficiency and demand response, continuing evolution of utility industry structure, the likelihood of broader action on climate change, and a wide range of other uncertainties argue for cost recovery and incentive policies that can work with intended effect under a variety of possible futures.

- **Apply cost recovery mechanisms and utility performance incentives in a broad policy context.** The policies that affect utility investment in energy efficiency are many and varied and each will control, to some extent, the nature of financial incentives and disincentives that a utility faces. Policies that could impact the design of cost recovery and incentive mechanisms include those having to do with carbon emissions reduction; non-CO2 environmental control, such as NOX cap-and-trade initiatives; rate design; resource portfolio standards; and the development of more liquid wholesale markets for load reduction programs.

- **Test prospective policies.** Complex mechanisms that have many moving parts cannot easily be understood unless the performance of the mechanisms is simulated under a wide range of conditions. This is particularly true of mechanisms that rely on projections of avoided costs, prices, or program impacts. Simulation of impacts using financial modeling and/or use of targeted pilots can be effective tools to test prospective policies.

- **Policy rules must be clear.** There is a clear link between the risk a utility perceives in recovering its costs, and disincentives to invest in energy efficiency. This risk is mitigated in part by having cost recovery and incentive mechanisms in place, but the efficacy of these mechanisms depends very much on the rules governing their application. While state regulatory commissions often fashion the details of cost recovery, lost margin recovery, and performance incentive mechanisms, the scope of their actions is governed by legislation. In some states, significant expenditures on energy efficiency by utilities are precluded by lack of clarity regarding regulators' authority to address one or more of the financial impacts of these expenditures. Legislation specifically authorizing or requiring various mechanisms creates clarity for parties and minimizes risk.

- **Collaboration has value.** The most successful and sustainable cost recovery and incentive policies are those that are based on a consultative process that, in general, includes broad agreement on the aims of the energy efficiency investment policy.

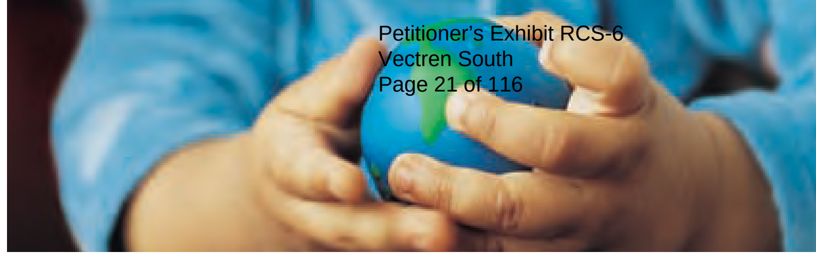
- **Flexibility is essential.** Most of the states that have had significant efficiency investment and cost recovery policies in place for more than a few years have found compelling reasons to modify these policies at some point. These changes reflect an institutional capacity to acknowledge weaknesses in existing approaches and broader contextual changes that render prior approaches ineffective. Policy stability is desirable, and policy changes that have significant impacts on earnings or prices can be particularly challenging. However, it is the stability of impact rather than adherence to a particular model that is important in addressing financial disincentives to invest.

- **Culture matters.** One important test of a cost recovery and incentives policy is its impact on corporate culture. A policy providing cost recovery is an essential first step in removing financial disincentives associated with energy efficiency investment, but it will not change a utility's core business model. Earnings are still created by investing in supply-side assets and selling more energy. Cost recovery plus a policy enabling recovery of lost margins might make a utility indifferent to selling or saving a kilowatt-hour or therm, but still will not make the business case for aggressive pursuit of energy efficiency. A full complement of cost recovery, lost margin recovery, and performance incentive mechanisms can change this model, and likely will be needed to secure sustainable funding for energy efficiency at levels necessary to fundamentally change resource mix.

Notes

1. Revenue requirement refers to the sum of the costs that a utility is authorized to recover through rates.

2. For example, see the National Association of State Utility Consumer Advocates' Resolution on Energy Conservation and Decoupling, June 12, 2007.



1: Introduction

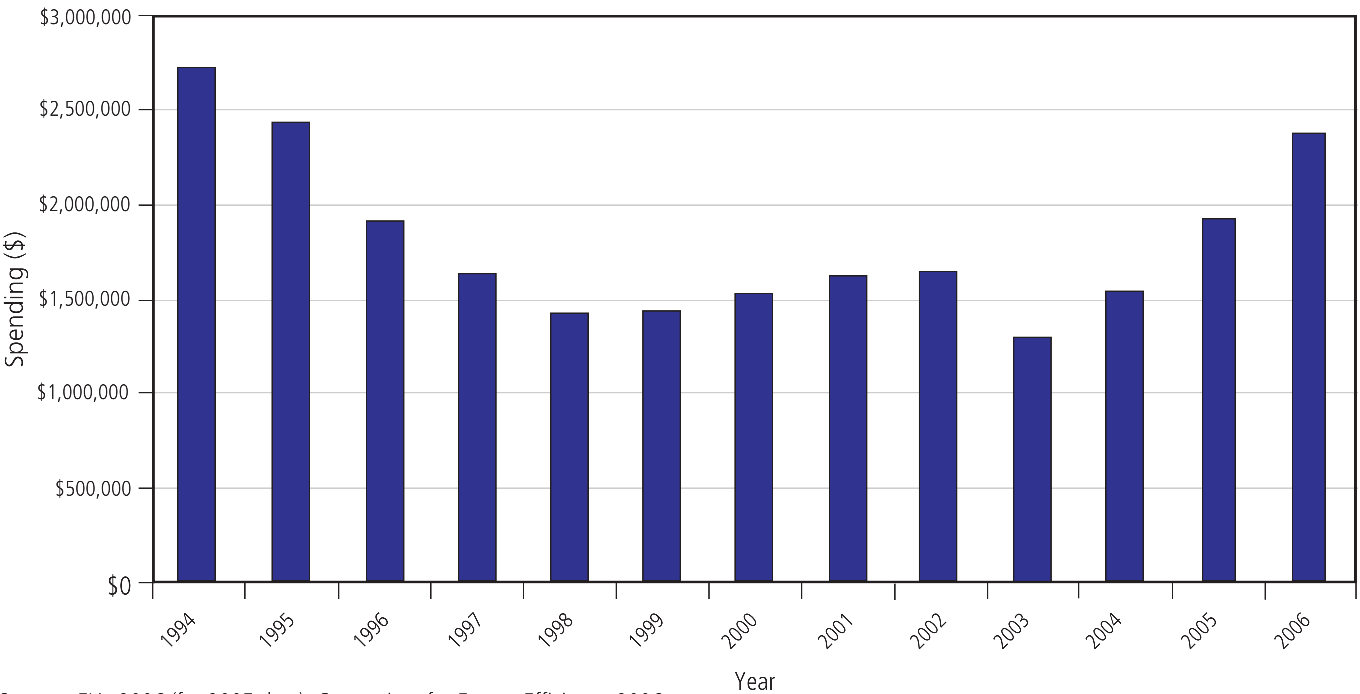
Improving the energy efficiency of homes, businesses, schools, governments, and industries—which collectively consume more than 70 percent of the natural gas and electricity used in the United States—is one of the most constructive, cost-effective ways to address the challenges of high energy prices, energy security and independence, air pollution, and global climate change. Mining this efficiency could help us meet on the order of 50 percent or more of the expected growth in U.S. consumption of electricity and natural gas in the coming decades, yielding many billions of dollars in saved energy bills and avoiding significant emissions of greenhouse gases and other air pollutants.[1]

Recognizing this large untapped opportunity, more than 60 leading organizations representing diverse stakeholders from across the country joined together to develop the National Action Plan for Energy Efficiency.[2] The Action Plan identifies many of the key barriers contributing to underinvestment in energy efficiency; outlines five key policy recommendations for achieving all cost-effective energy efficiency, focusing largely on state-level energy efficiency policies and programs; and provides a number of options to consider in pursuing these recommendations (Figure 1-1). As of November 2007, nearly 120 organizations have endorsed the Action Plan recommendations and made public commitments to implement them in their areas. Aligning utility incentives with the delivery of cost-effective energy efficiency is key to making the Action Plan a reality.

1.1 Energy Efficiency Investment

Actual and prospective investment in energy efficiency programs is on a steep climb, driven by a variety of resource, environmental, and customer cost mitigation concerns. Nevada Power is proposing substantial increases in energy efficiency funding as a strategy for

Figure 1-1. Annual Utility Spending on Electric Energy Efficiency



Sources: EIA, 2006 (for 2005 data); Consortium for Energy Efficiency, 2006.

Figure 1-2. National Action Plan for Energy Efficiency Recommendations and Options

Recognize energy efficiency as a high-priority energy resource.

Options to consider:

- Establishing policies to establish energy efficiency as a priority resource.
- Integrating energy efficiency into utility, state, and regional resource planning activities.
- Quantifying and establishing the value of energy efficiency, considering energy savings, capacity savings, and environmental benefits, as appropriate.

Make a strong, long-term commitment to implement cost-effective energy efficiency as a resource.

Options to consider:

- Establishing appropriate cost-effectiveness tests for a portfolio of programs to reflect the long-term benefits of energy efficiency.
- Establishing the potential for long-term, cost-effective energy efficiency savings by customer class through proven programs, innovative initiatives, and cutting-edge technologies.
- Establishing funding requirements for delivering long-term, cost-effective energy efficiency.
- Developing long-term energy saving goals as part of energy planning processes.
- Developing robust measurement and verification procedures.
- Designating which organization(s) is responsible for administering the energy efficiency programs.
- Providing for frequent updates to energy resource plans to accommodate new information and technology.

Broadly communicate the benefits of and opportunities for energy efficiency.

Options to consider:

- Establishing and educating stakeholders on the business case for energy efficiency at the state, utility, and other appropriate level, addressing relevant customer, utility, and societal perspectives.
- Communicating the role of energy efficiency in lowering customer energy bills and system costs and risks over time.
- Communicating the role of building codes, appliance standards, and tax and other incentives.

Provide sufficient, timely, and stable program funding to deliver energy efficiency where cost-effective.

Options to consider:

- Deciding on and committing to a consistent way for program administrators to recover energy efficiency costs in a timely manner.
- Establishing funding mechanisms for energy efficiency from among the available options, such as revenue requirement or resource procurement funding, system benefits charges, rate-basing, shared-savings, and incentive mechanisms.
- Establishing funding for multi-year period.

Modify policies to align utility incentives with the delivery of cost-effective energy efficiency and modify ratemaking practices to promote energy efficiency investments.

Options to consider:

- Addressing the typical utility throughput incentive and removing other regulatory and management disincentives to energy efficiency.
- Providing utility incentives for the successful management of energy efficiency programs.
- Including the impact on adoption of energy efficiency as one of the goals of retail rate design, recognizing that it must be balanced with other objectives.
- Eliminating rate designs that discourage energy efficiency by not increasing costs as customers consume more electricity or natural gas.
- Adopting rate designs that encourage energy efficiency by considering the unique characteristics of each customer class and including partnering tariffs with other mechanisms that encourage energy efficiency, such as benefit-sharing programs and on-bill financing.

Source: National Action Plan for Energy Efficiency, 2006a.

compliance with the state's aggressive resource portfolio standard. Funding in California has roughly doubled since 2004 as utilities supplement public charge monies with "procurement funds."[3] Michigan and Illinois have been debating significant efficiency funding requirements, and the Texas legislature has doubled the percentage of load growth that must be offset by energy efficiency, implying a significant increase in efficiency program funding. Integrated resource planning cases and various regulatory settlements from Delaware to North Carolina and Missouri are producing new investment in energy efficiency. Data recently compiled by the Consortium for Energy Efficiency (2006) show total estimated energy efficiency spending by electric utilities exceeding $2.3 billion in 2006, on par with peak energy efficiency spending in the mid-1990s. With the rise in funding, there is broad interest across the country in refashioning regulatory policies to eliminate financial disincentives and barriers to utility investment in energy efficiency.

1.1.1 Understanding Financial Disincentives to Utility Investment

Not unexpectedly, the rise in interest in energy efficiency investment has produced a resurgent interest in how the costs associated with energy efficiency programs are recovered, and whether, in the light of what many believe to be compelling reasons for greater program spending, utilities have sufficient incentive to aggressively pursue these investments.

Energy efficiency programs can have several financial impacts on utilities that create disincentives for utilities to promote energy efficiency more aggressively. Policymakers have developed several mechanisms intended to minimize or eliminate these impacts.

Utility concerns for these three impacts have had a profound effect on energy efficiency investment policy at the corporate and state level for over 20 years, and the concerns continue to create tension as utilities are called upon to boost energy efficiency spending.

Although the nature of today's cost recovery and incentives discussion may be reminiscent of a similar discussion almost two decades ago, the context in which this discussion is taking place is very different. Not only have parties gained valuable experience related to the use of various cost recovery and incentive mechanisms, but the policy landscape has also been reshaped fundamentally.

Industry Structure

The past two decades have witnessed significant industry reorganization in both wholesale and retail power and natural gas markets. Investor-owned electric utilities, particularly in the Northeast and sections of

Table 1-1. Utility Financial Concerns

Potential Impact	Potential Solutions
Energy efficiency expenditures adversely impact utility cash flow and earnings if not recovered in a timely manner.	• Recovery through general rate case • Energy efficiency cost recovery surcharges • System benefits charge
Energy efficiency will reduce electricity or gas sales and revenues and potentially lead to under-recovery of fixed costs.	• Lost revenue adjustment mechanisms that allow recovery of revenue to cover fixed costs • Decoupling mechanisms that sever the link between sales and margin or fixed-cost revenues • Straight fixed-variable (SFV) rate design (allocate fixed costs to fixed charges)
Supply-side investments generate substantial returns for investor-owned utilities. Typically, energy efficiency investments do not earn a return and are, therefore, less financially attractive.[4]	• Capitalize efficiency program costs and include in rate base • Performance incentives that reward utilities for superior performance in delivering energy efficiency

the Midwest, unbundled (i.e., separated the formerly integrated functions of generation, transmission, and distribution) in anticipation of retail competition. Investor-owned natural gas utilities also have gone through a similar unbundling process, albeit one that has been quite different in its form.[5] Unbundling creates two effects relevant to the issues of energy efficiency cost recovery and incentives.

First, unbundling of industry structure also unbundles the value of demand-side programs, in the sense that none of the entities created by unbundling an integrated company can capture the full value of an energy efficiency investment. An integrated utility can capture the value of an energy efficiency program associated with avoided generation, transmission, and distribution costs. The distribution company produced by unbundling an integrated utility can only directly capture the value associated with avoided distribution. One of the principal arguments for public benefits funds was that they could effectively re-bundle this value.[6]

Second, unbundling changes the financial implications of energy efficiency investment as a function of changing cost-of-service structures. The corporate entity subject to continued traditional cost-of-service regulation following unbundling typically is the distribution or wires company. The actual electricity or natural gas sold to consumers is often purchased by consumers directly from competitive or, more commonly, default service providers. In some states, this is also the distribution company. The distribution company adds a distribution service charge to this commodity cost, often levied per unit of throughput, which represents its cost to move the power or gas over its system to the customer. Often, this charge as levied by electric utilities reflects a higher percentage of fixed costs than had been the case when the utility provided bundled service, simply because the utility no longer incurs the variable costs associated with power production.[7] In the case of the distribution company, the potential impact on utility earnings of a drop in sales volume is more pronounced.[8]

Renewed Focus on Resource Planning

Industry restructuring was accompanied by a steep decline in the popularity and practice of resource planning, which had supported much of the early rise in energy efficiency programming. The last several years have seen a resurgence of interest in resource planning (in both bundled and restructured markets) and renewal of interest in ratepayer-funded energy efficiency as a resource option capable of mitigating some of this market volatility.[9]

The intervening years have reshaped the practice of resource planning into a more sophisticated and, sometimes, multi-state process, focused much more on an acknowledgement of and accommodation to the costs and risks surrounding the acquisition of new resources. Energy efficiency investments increasingly are given proper value for their ability to mitigate a variety of policy and financial risks.

Distinctions With a Difference: Gas v. Electric Utilities and Investor-Owned v. Publicly and Cooperatively Owned Utilities

Throughout this Report, distinctions are made between gas and electric utilities and between those that are investor- and publicly or cooperatively owned. In some cases, these distinctions create very important differences in how barriers might be perceived and in whether particular cost recovery and incentive mechanisms are applicable and appropriate. For example, gas and electric utilities face very different market dynamics and can have different cost structures. Declining gas use per customer across the industry creates greater financial sensitivity to the revenue impacts of energy efficiency programs. Publicly and cooperatively owned utilities operate under different financial and, in most states, regulatory structures than investor-owned companies. And just the fact that publicly and cooperatively owned utilities are owned by their customers creates a different set of expectations and obligations. At the same time, all utilities are sensitive to many of the same financial implications, particularly regarding recovery of direct program costs and lost margins. Wherever possible, the Report highlights specific instances in which these distinctions are particularly important.

Rising Commodity Costs and Flattening Sales

The run-up in natural gas prices over the past several years has made the case for gas utility implementation of energy efficiency programs more compelling as a strategy for helping manage customer energy costs. However, where once these programs were implemented in at least a modestly growing gas market, efficiency programs are now combined with flat or declining use per customer, making recovery of program costs and lost margins a more urgent matter.

Acknowledgement of Climate Risk

There is a growing recognition among state policy-makers and electric utilities that action is required to mitigate the impacts of climate change and/or hedge against the likelihood of costly climate policies. Energy efficiency investments are valued for their ability to reduce carbon emissions at low cost by reducing the use of existing high-carbon emitting sources and the deferral of the need for new fossil capacity. Some of the largest electric utilities in the country are forming their business strategies around the likelihood of action on climate policy, and making energy efficiency pivotal in these strategies. Although the environmental attributes of energy efficiency have long been emphasized in arguing the business case for energy efficiency investment, particularly in the electric industry, today that argument appears largely to be over, and attention is shifting to the practical elements of policies that can support scaled-up investment in efficiency.[10]

As utilities increasingly turn to energy efficiency as a key resource, they will look more closely at the links between efficiency, sales, and financial margins, sharpening the question of whether ratemaking policies that reward increases in sales are sustainable. Perhaps less obvious, as policies are implemented to reduce carbon emissions, they likely will create new pathways for capturing the financial value of efficiency that, in turn, will require policy-makers to consider whether current approaches to cost recovery and incentives are aligned with these broader policies.

Advancing Technology

The technology and therefore, the practice of energy efficiency, appear on the edge of significant transformation, particularly in the electric utility industry. The formerly bright line between energy efficiency and demand response[11] is blurring with the growing adoption of advanced metering technologies, innovative pricing regimes, and smart appliances.[12] Emerging technologies enable utilities to more precisely target valuable load reductions, and offer consumers prices that more closely represent the time-varying costs to provide energy. Ultimately, when consumers can receive and act on time- and location-specific energy prices, this will affect the types of energy efficiency measures possible and needed, and efficiency program design and funding will change accordingly. With respect to the immediate issues of cost recovery and incentives, the incorporation of increasing amounts of demand response in utility resource portfolios can change the financial implications of these portfolios, as programs targeted at peak demand reduction as opposed to energy consumption reduction can have a substantially different impact on the recovery of fixed costs.[13]

1.1.2 Current Status

The answer to *"what has changed?"* then, is that the rationale for investment in efficiency has been rethought, refocused, and strengthened, with ratepayer funding rising to levels eclipsing those of the late 1980s/early 1990s. And as funding rises, the need to address and resolve the issues surrounding energy efficiency program cost recovery and performance incentives take on greater importance and urgency. At the same time, many of the utilities being asked to make this investment are structured differently today than two decades ago during the last efficiency investment boom, so today's efficiency initiatives will have different financial impacts on the utility. Table 1-2 presents a best estimate of the current status of energy efficiency cost recovery and utility performance incentive activity across the country. Where a cell reads "Yes" without reference to gas or electric, the policy applies to both gas and electric utilities.

Table 1-2 reveals that many states have implemented policies that support cost recovery and/or performance incentives to some extent. Even those states that are not shown as having a specific program cost recovery policy

Table 1-2. The Status of Energy Efficiency Cost Recovery and Incentive Mechanisms for Investor-Owned Utilities

State	Direct Cost Recovery			Fixed Cost Recovery		Performance Incentives
	Rate Case	System Benefits Charge	Tariff Rider/ Surcharge	Decoupling	Lost Revenue Adjustment Mechanism	
Alabama	Yes					
Alaska						
Arizona	Yes (electric)	Yes (electric)		Pending (gas)		Yes (electric)
Arkansas				Yes (gas)		
California	Yes	Yes		Yes		Yes
Colorado	Yes		Yes	Pending		Yes
Connecticut		Yes (electric)			Yes	Yes
Delaware	Yes			Pending		
District of Columbia	Yes			Pending (electric)		
Florida			Yes (electric)			
Georgia	Yes					Yes (electric)
Hawaii				Pending (electric)		Yes
Idaho	Yes (electric)			Yes (electric)		
Illinois	Yes (electric)					
Indiana	Yes			Yes (gas)	Yes	Yes
Iowa	Yes		Yes			
Kansas						Yes
Kentucky			Yes	Pending (gas)	Yes	Yes
Louisiana						
Maine		Yes (electric)				
Maryland				Yes (gas) Pending (electric)		
Massachusetts		Yes (electric)		Pending (electric)	Yes	Yes (electric)
Michigan				Pending (gas)		
Minnesota	Yes			Yes		Yes
Mississippi	Yes					

Source: Kushler et al., 2006. (Current as of September 2007.) Please see Appendix C for specific state citations.

Table 1-2. The Status of Energy Efficiency Cost Recovery and Incentive Mechanisms for Investor-Owned Utilities (continued)

State	Direct Cost Recovery			Fixed Cost Recovery		Performance Incentives
	Rate Case	System Benefits Charge	Tariff Rider/ Surcharge	Decoupling	Lost Revenue Adjustment Mechanism	
Missouri				Yes (gas)		
Montana	Yes (gas)	Yes (electric)				Yes
Nebraska						
Nevada	Yes (electric)			Yes (gas)		Yes (electric)
New Hampshire		Yes (electric)		Pending (electric)		Yes (electric)
New Jersey		Yes		Yes (gas) Pending (electric)		
New Mexico	Yes			Pending (gas)		
New York		Yes (electric)		Yes		
North Carolina				Yes (gas)		
North Dakota						
Ohio			Yes (electric)	Yes (gas)	Yes (electric)	Yes (electric)
Oklahoma						
Oregon		Yes		Yes (gas)		
Pennsylvania	Yes					
Rhode Island		Yes (electric)		Yes		Yes
South Carolina						Yes
South Dakota						
Tennessee						
Texas	Yes					
Utah	Yes (electric)		Yes (electric)	Yes (gas)		
Vermont		Yes (electric)			Yes	Yes
Virginia				Pending (gas)		
Washington	Yes (electric)		Yes (electric)	Yes (gas)		
West Virginia						
Wisconsin	Yes (electric)	Yes (electric)		Pending (electric)		
Wyoming						

Source: Kushler et al., 2006. (Current as of September 2007.) Please see Appendix C for specific state citations.

do allow recovery of approved program costs through rate cases. The table also shows that there is a substantial amount of activity surrounding gas revenue decoupling. However, despite the significant level of activity around the country, relatively few states have implemented comprehensive policies that address program cost recovery, recovery of lost margins, and performance incentives. The challenge to policy-makers is whether the level of investment envisioned can be achieved without broader action to implement such comprehensive policies.

1.2 Aligning Utility Incentives with Investment in Energy Efficiency Report

This report on Aligning Utility Incentives with Investment in Energy Efficiency describes the financial effects on a utility of its spending on energy efficiency programs; how those effects could constitute barriers to more aggressive and sustained utility investment in energy efficiency; and how adoption of various policy mechanisms can reduce or eliminate these barriers. This Report also provides a number of examples of such mechanisms drawn from the experience of a number of utilities and states.

The Report was prepared in response to a need identified by the Action Plan Leadership Group (see Appendix A for a list of group members) for additional practical information on mechanisms for reducing these barriers to support the Action Plan recommendations to "provide sufficient, timely, and stable program funding to deliver energy efficiency where cost-effective" and "modify policies to align utility incentives with the delivery of cost-effective energy efficiency and modify ratemaking practices to promote energy efficiency investments." Key options to consider under this recommendation include committing to a consistent way to recover costs in a timely manner, addressing the typical utility throughput incentive, and providing utility incentives for the successful management of energy efficiency programs.

There are a number of possible regulatory mechanisms for addressing both options, as well as for ensuring recovery of prudently incurred energy efficiency program costs. Determining which mechanism will work best for any given jurisdiction is a process that takes into account the type and financial structure of the utilities in that jurisdiction, existing statutory and regulatory authority, and the size of the energy efficiency investment. The net impact of an energy efficiency cost recovery and performance incentives policy will be affected by a wide variety of other factors, including rate design and resource procurement strategies, as well as broader considerations such as the rate of demand growth and environmental and resource policies.

Specifically, the Report provides a description of three financial effects that energy efficiency spending can have on a utility:

- Failure to recover program costs in a timely way has a direct impact on utility earnings.
- Reductions in sales due to energy efficiency can reduce utility financial margins.
- As a substitute for new supply-side resources, energy efficiency reduces the earnings that a utility would otherwise earn on the supply resource.

This Report examines how these effects create disincentives to utility investment in energy efficiency and the policy mechanisms that have been developed to address these disincentives. In addition, this Report examines the often complex policy environment in which these effects are addressed, emphasizing the need for clear policy objectives and for an approach that explicitly links together the impacts of policies to address utility financial disincentives. Two emerging models for addressing financial disincentives are described, and the Report concludes with a discussion of key lessons for states interested in developing policies to align financial incentives with utility energy efficiency investment.

The subject of financial disincentives and possible remedies has been debated for over two decades, and there remain several unresolved and contentious issues. This Report does not attempt to resolve these issues. Rather, by providing discussion of the financial effects of utility efficiency investment, and of the possible policy options for addressing these effects, this Report is intended to deepen the understanding of these issues. In addition, this Report is intended to provide specific examples of regulatory mechanisms for addressing financial effects for those readers exploring options for reducing financial disincentives to sustained utility investment in energy efficiency.

This Report was prepared using an extensive review of the existing literature on energy efficiency program cost recovery, lost margin recovery, and utility performance incentives—a literature that reaches back over 20 years. In addition, this Report uses a broad review of state statutes and administrative rules related to utility energy efficiency program cost recovery. Key documents for the reader interested in additional information include:

- *Aligning Utility Interests with Energy Efficiency Objectives: A Review of Recent Efforts at Decoupling and Performance Incentives*, Martin Kushler, Dan York, and Patti Witte, American Council for an Energy Efficient Economy, Report Number U061, October 2006.
- *Decoupling for Electric and Gas Utilities: Frequently Asked Questions (FAQ)*, September 2007, available at <http://www.naruc.org>.
- A variety of documents and presentations developed by RAP, available online at <http://www.raponline.org>.
- Ken Costello, *Revenue Decoupling for Natural Gas Utilities—Briefing Paper*, National Regulatory Research Institute, April 2006.
- American Gas Association, *Natural Gas Rate Round-Up, Update on Decoupling Mechanisms—April 2007*.
- DOE, *State and Regional Policies That Promote Energy Efficiency Programs Carried Out by Electric and Gas Utilities: A Report to the United States Congress Pursuant to Section 139 of the Energy Policy Act of 2005*, March 2007.
- *Revenue Decoupling: A Policy Brief of the Electricity Consumers Resource Counci*l, January 2007.

1.2.1 How to Use This Report

This Report focuses on the issues associated with financial implications of utility-administered programs. For the most part, these issues are the same whether the funding flows from a system benefits charge or is authorized by regulatory action, with the exception that a system benefits charge effectively resolves issues associated with program cost recovery. In addition, the issues related to the effect of energy efficiency on utility financial margins apply whether the efficiency is produced by a utility-administered program or through building codes, appliance standards, or other initiatives aimed at reducing energy use. This Report is intended to help the reader answer the following questions:

- How are utilities affected financially by their investments in energy efficiency?
- What types of policy mechanisms can be used to address the various financial effects of energy efficiency investment?
- What are the pros and cons of these mechanisms?
- What states have employed which types of mechanisms and how have they been structured?
- What are the key differences related to financial impacts between publicly and investor-owned utilities and between electric and gas utilities?
- What new models for addressing these financial effects are emerging?
- What are the important steps to take in attempting to address financial barriers to utility investment in energy efficiency?

This Report is intended for utilities, regulators and regulatory staff, consumer representatives, and energy efficiency advocates with an interest in addressing these financial barriers.

1.2.2 Structure of the Report

Chapter 2 of the Report outlines the basic financial effects associated with utility energy efficiency investment, reviews the key related policy issues, and provides a case study of how a comprehensive approach to addressing financial disincentives to utility energy efficiency investment can have an impact on utility corporate culture. Chapter 3 outlines a range of possible objectives that policy-makers should consider in designing policies to address financial incentives.

Chapters 4, 5, and 6 provide examples of specific program cost recovery, lost margin recovery, and utility performance incentive mechanisms, as well as a review of possible pros and cons. Chapter 7 provides an overview of two emerging cost recovery and performance incentive models, and the Report concludes with a discussion of important lessons for developing a policy to eliminate financial disincentives to utility investment in energy efficiency.

1.2.3 Development of the Report

The Report on Aligning Utility Incentives with Investment in Energy Efficiency is a product of the Year Two Work Plan for the National Action Plan for Energy Efficiency. In addition to direction and comment by the Action Plan Leadership Group, this Guide was prepared with highly valuable input of an Advisory Group. Val Jensen of ICF International served as project manager and primary author of the Report with assistance from Basak Uluca, under contract to the U.S. Environmental Protection Agency.

The Advisory Group members are:

- Lynn Anderson, Idaho Public Service Commission
- Jeff Burks, PNM Resources
- Sheryl Carter, Natural Resources Defense Council
- Dan Cleverdon, DC Public Service Commission
- Roger Duncan, Austin Energy
- Jim Gallagher, New York State Public Service Commission
- Marty Haught, United Cooperative Service
- Leonard Haynes, Southern Company
- Mary Healey, Connecticut Office of Consumer Counsel
- Denise Jordan, Tampa Electric Company
- Don Low, Kansas Corporation Commission
- Mark McGahey, Tristate Generation and Transmission Association, Inc.
- Barrie McKay, Questar Gas Company
- Roland Risser, Pacific Gas & Electric
- Gene Rodrigues, Southern California Edison
- Michael Shore, Environmental Defense
- Raiford Smith, Duke Energy
- Henry Yoshimura, ISO New England Inc.

1.3 Notes

1. See the *National Action Plan for Energy Efficiency* (2006), available at <www.epa.gov/cleanenergy/actionplan/report.htm>.
2. See <www.epa.gov/actionplan>.
3. "Procurement funds" are monies that are approved by the California Public Utilities Commission for procurement of new resources as part of what is essentially an integrated resource planning process in California.
4. Publicly and cooperatively owned utilities operate under different financial structures than investor-owned utilities and do not face the same issue of earnings comparability, as they do not pay returns to equity holders.
5. Unbundling in the gas industry took a much different form than it did in the electric industry. Gas utilities were never integrated, in the sense that they were responsible for production, transmission, and distribution. Gas utilities always have principally served the distribution function. However, prior to the early 1980s, most gas utilities were responsible for contracting for gas to meet residential, commercial, and industrial demand. Gas industry restructuring led to larger customers being given the ability to purchase gas and transportation service directly, as well as to an end to the typical long-term bundled supply/transportation contracting that gas utilities formerly had engaged in.
6. Some wholesale markets are developing mechanisms to account for the value of demand-side programs. For example, ISO-New England's Forward Capacity Auction allows providers of demand resources to bid demand reductions into the auction.

7. Although natural gas utilities have never had the capital-intensive financial structure common to integrated electric utilities, they historically have tended to be more vulnerable financially to declines in sales because a much greater fraction of the cost of gas service has been associated with the cost of the gas commodity. Prior to gas industry restructuring this problem was even more acute for those utilities procuring gas under contracts with take-or-pay or fixed-charge clauses.

8. According to the Regulatory Assistance Project, the loss of sales due to successful implementation of energy efficiency will lower utility profitability, and the effect may be quite powerful under traditional rate design. "For example, a 5% decrease in sales can lead to a 25% decrease in net profit for an integrated utility. For a stand-alone distribution utility, the loss to net profit is even greater—about double the impact." See Harrington, C., C. Murray, and L. Baldwin (2007). *Energy Efficiency Policy Toolkit*. Regulatory Assistance Project. p. 21. <www.raponline.org>

9. A number of studies have examined the ability of energy efficiency and particularly, demand response programs, to reduce power prices by cutting demand during high-price periods. Because the marginal costs of power typically exceed average costs during these periods, efficiency programs targeted at high demand periods often will yield benefits for all ratepayers, even non-participants. See, for example, *Direct Testimony of Bernard Neenan on Behalf of the Citizens Utility Board and the City Of Chicago*, Cub-City Exhibit 3.0 October 30, 2006, ICC Docket No. 06-0617, State Of Illinois, Illinois Commerce Commission.

10. See, for example: "Greenhouse Gauntlet," 2007 CEO Forum, *Public Utilities Fortnightly*, June 2007. Pacific Gas and Electric (2007). *Global Climate Change, Risks, Challenges, Opportunities and a Call to Action*. </www.pge.com/includes/docs/pdfs/about_us/environment/features/global_climate_06.pdf>

11. Energy efficiency traditionally has been defined as an overall reduction in energy use due to use of more efficiency equipment and practices, while load management, as a subset of demand response has been defined as reductions or shifts in demand with minor declines and sometimes increases in energy use.

12. There remain important distinctions between dispatchable demand response and energy efficiency, including the ability to participate in wholesale markets.

13. For example, a demand-response program that reduces coincident peak demand but has little impact on sales could lead to a financial benefit for a utility, as its costs might decrease by more than its revenues if the cost of delivering power at the peak period exceeds the price for that power.

2: The Financial and Policy Context for Utility Investment in Energy Efficiency

This chapter outlines the potential financial effects a utility may face when investing in energy efficiency and reviews key related policy issues. In addition, it provides a case study of how a comprehensive approach to addressing financial disincentives to utility energy efficiency investment can have an impact on utility corporate culture and explores the issue of regulatory risk.

2.1 Overview

Investment in energy efficiency programs has three financial effects that map generally to specific types of costs incurred by utilities.

- Failure to recover program costs in a timely way has a direct impact on utility earnings.
- Reductions in sales due to energy efficiency can reduce utility financial margins.
- As a substitute for new supply-side resources, energy efficiency reduces the earnings that a utility would otherwise earn on the supply resource.

How these effects are addressed creates the incentives and disincentives for utilities to pursue investment in energy efficiency. Ultimately, it is the combined effect on utility margins of policies to address these impacts that will determine how well utility financial interests align with investment in energy efficiency.

These effects are artifacts of utility regulatory policy and the general practice of electricity and natural gas rate-setting. Individual state regulatory policy and practice will influence how these effects are addressed in any given jurisdiction. Even where broad consensus exists on the need to align utility and customer interests in the promotion of energy efficiency, the policy and institutional context surrounding each utility dictates the specific nature of incentives and disincentives "on the street." The purpose of this chapter is to briefly review some of the important policy considerations that will affect how the financial implications introduced above are treated.

Two broad distinctions are important when considering policy context. The first is between investor-owned and publicly and cooperatively owned utilities. Every state regulates investor-owned utilities.[1] Most states do not regulate publicly or cooperatively owned utilities except in narrow circumstances. Instead, these entities typically are regulated by local governing boards in the case of municipal utilities, or are governed by boards representing cooperative members. Public and cooperative utilities face many of the same financial implications of energy efficiency investment. They set prices in much the same way as investor-owned utilities, and have fixed cost coverage obligations just as investor-owned utilities do. Because these utilities are owned by their customers, it is commonly accepted that customer and utility interests are more easily aligned. However, because municipal utilities often fund city services through transfers of net operating margins into other city funds, there can be pressure to maintain sales and revenues despite policies supportive of energy efficiency.

The second distinction is between electric and natural gas utilities. This distinction is less between forms of regulation and more between the nature of the gas and electric utility businesses. Natural gas utilities historically have operated as distributors. Although many gas utilities continue to purchase gas on behalf of customers, the costs of these purchases are simply passed through to customers without mark-up. Many electric utilities, by contrast, build and operate generating facilities.

Thus, the capital structures of the two types of utilities have differed significantly.[2] Electric utilities, while more capital intensive in the aggregate, historically have had higher variable costs of operation relative to the total cost of service than gas utilities. In other words, while electric utilities required more capital, fixed capital costs represented a larger fraction of the jurisdictional revenue requirement for gas utilities. This has made gas utilities more sensitive to unexpected sales fluctuations and fostered greater interest in various forms of lost margin recovery.

Much of the discussion of mechanisms for aligning utility and customer interests related to energy efficiency investment assumes the utility is an investor-owned electric utility. However, some issues and their appropriate resolution will differ for publicly and cooperatively owned utilities and for natural gas utilities. These differences will be highlighted where most significant.

This chapter reviews each of the three financial effects of utility energy efficiency spending and then briefly examines some of the policy issues that each raises. More detailed examples of policy mechanisms for addressing each effect are provided in following chapters.

2.2 Program Cost Recovery

The first effect is associated with energy efficiency program cost recovery—recovery of the direct costs associated with program administration (including evaluation), implementation, and incentives to program participants. Reasonable opportunity for program cost recovery is a necessary condition for utility program spending. Failure to recover these costs produces a direct dollar-for-dollar reduction in utility earnings, and discourages further investment. If, for whatever reason, a utility is unable to recover $500,000 in costs associated with an energy efficiency program, it will see a $500,000 drop in its net margin.

Policies directing utilities to undertake energy efficiency programs in most cases authorize utilities to seek recovery of program costs, even though actual recovery of all costs is never guaranteed.[3] Clarity with respect to the cost recovery process is critical, as broad uncertainty regarding the timing and threshold burden of proof can itself constitute almost as much a disincentive to utility investment as actual refusal to allow recovery of program costs.[4] A reasonable and reliable system of program cost recovery, therefore, is a necessary first element of a policy to eliminate financial disincentives to utility investment in energy efficiency.

Policy-makers have a wide variety of tools available to them to address cost recovery. These tools can have very different financial implications depending on the specific context. More important, history has shown that recovery is not, in fact, a given. Chapter 5 provides a more complete treatment of program cost recovery mechanisms. However, with respect to the broader policy context, several points are important to note here. All are related to risk.

2.2.1 Prudence

State regulatory commissions, as well as the governing boards of publicly and cooperatively owned utilities, have fundamental obligations to ensure that the costs passed along to ratepayers are just and reasonable and were prudently incurred. Sometimes commissions have found these costs to be appropriately born by shareholders (such as "image advertising") rather than ratepayers. Other times, costs are disallowed because they are considered "unreasonable" for the good or service procured or delivered. Finally, regulators and boards might determine that a certain activity would not have been undertaken by prudent managers and thus costs associated with the activity should not be recoverable from ratepayers.

While within the scope of regulatory authority,[5] such disallowances can create some uncertainty and risk for utilities if the rules governing prudence and reasonableness are not clear.[6] Regulated industries traditionally have been viewed as risk averse, in part because with their returns regulated, risk and reward are not symmetrical. Utilities that have been faced with significant disallowances tend to be particularly averse to incurring any cost that is not pre-approved or for which there is a risk that a particular expense will be disallowed.

Program cost recovery requires a negotiation between regulators and utilities to create more certainty regarding prudence and reasonableness and therefore, to assure utilities that energy efficiency costs will be recoverable. Many states provide this balance by requiring utilities to submit energy efficiency portfolio plans and budgets for review and sometimes approval.[7] The utility receives assurance that its proposed expenditures are *decisionally prudent,* and regulators are assured that proposed expenditures satisfy policy objectives. Such pre-approval processes do not preclude regulatory review of actual expenditures or findings that actual program implementation was imprudently managed.

2.2.2 The Timing of Cost Recovery

Cost recovery timing is important for two reasons:

1. If there is a significant lag between a utility's expenditure on energy efficiency programs and recovery of those costs, the utility incurs a carrying cost—it must finance the cash flow used to support the program expenditure. Even if a utility has sufficient cash flow to support program funding, these funds could have been applied to other projects were it not for the requirement to implement the program.

2. The length of the time lag directly affects a utility's perception of cost recovery risk. The composition of regulatory commissions and boards changes frequently and while commissions may respect the decisions of their predecessors, they are not bound to them. Therefore, a change in commissions can lead to changes in or reversals of policy. More important, the longer the time lag, the greater the likelihood that unexpected events could occur that affect a utility's cash flow.

The timing issues can be addressed in several ways. The two most prevalent approaches are to allow a utility to book program costs in a deferral account with an appropriate carrying charge applied, or to establish a tariff rider or surcharge that the utility can adjust periodically to reflect changes in program costs. Neither approach precludes regulators from reviewing actual costs to determine reasonableness and making appropriate adjustments. However, the deferral approach can create what is known as a regulatory asset, which can rapidly grow and, when it is added to the utility's cost of service, cause a jump in rates depending on how the asset is treated.[8]

2.3 Lost Margin Recovery

The objective of an energy efficiency program is to cost-effectively reduce consumption of electricity or natural gas. However, reducing consumption also reduces utility revenues and, under traditional rate designs that recover fixed costs through volumetric charges, lower revenues often lead to under-recovery of a utility's fixed costs. This, in turn, can lead to lower net operating margins and profits and what is termed the *"lost margin"* effect. This same effect can create an incentive in certain cases for utilities to try to increase sales and thus, revenues, between rate cases—this is known as the *throughput incentive.* Because fixed costs (including financial margins) are recovered through volumetric charges, an increase in sales can yield increased earnings, as long as the costs associated with the increased sales are not climbing as fast.

Treatment of lost margin recovery, either in a limited fashion or through some form of what is known as *"decoupling,"* raises basic issues of not only what the regulatory obligation is with regard to utility earnings, but also of the regulators' role in determining the utility's business model. Few energy efficiency policy issues have produced as much debate as the issue of the impact of energy efficiency programs on utility margins (Costello, 2006; Eto et al., 1994; National Action Plan for Energy Efficiency, 2006b; Sedano, 2006).

2.3.1 Defining Lost Margins

The lost margin effect is a direct result of the way that electricity and natural gas prices are set under traditional regulation. And while the issue might be more immediate for investor-owned utilities where profits are at stake, the root financial issues are the same whether the utility is investor-, publicly, or cooperatively owned.

Defining Terms

A variety of terms are used to describe the financial effect of a reduction in utility sales caused by energy efficiency. All of these relate to the practice of traditional ratemaking, wherein some portion of a utility's fixed costs are recovered through a volumetric charge. Because these costs are fixed, higher-than-expected sales will lead to higher-than-expected revenue and possible over-recovery of fixed costs. Lower-than-expected sales will lead to under-recovery of these costs. The terminology used to describe the phenomenon and its impacts can be confusing, as a variety of different terms are used to describe the same effect. Key terms include:

- **Throughput**—utility sales.
- **Throughput incentive**—the incentive to maximize sales under volumetric rate design.
- **Throughput disincentive**—the disincentive to encourage anything that reduces sales under traditional volumetric rate design.
- **Fixed-cost recovery**—the recovery of sufficient revenues to cover a utility's fixed costs.
- **Lost revenue**—the reduction in revenue that occurs when energy efficiency programs cause a drop in sales below the level used to set the electricity or gas price. There generally also is a reduction in cost as sales decline, although this reduction often is less than revenue loss.
- **Lost margin**—the reduction in revenue to cover fixed costs, including earnings or profits in the case of investor-owned utilities. Similar to lost revenue, but concerned only with fixed-cost recovery, or with the opportunity costs of lost margins that would have been added to net income or created a cash buffer in excess of that reflected in the last rate case. The amount of margin that might be lost is a function of both the change in revenue and the any change in costs resulting from the change in sales.

The National Action Plan for Energy Efficiency used *throughput incentive* to describe this effect. Where possible, this Report will also use that phrase. It will also describe the effect using the phrases *under-recovery of margin revenue* or *lost margins,* for the most part to describe issues related to the effect of energy efficiency on recovery of fixed costs.

Traditional cost-of-service ratemaking is based on the same simple arithmetic used in Table 2-1.[9]

average price = revenue requirement/estimated sales[10]

revenue requirement = variable costs + depreciation + other fixed costs + (capital costs × rate of return)

revenue = actual sales × average price

Capital costs are equal to the original cost of plant and equipment used in the generation, transmission, and distribution of energy, minus accumulated depreciation.

The rate of return, in the case of an investor-owned utility, is a weighted blend of the interest cost on the debt used to finance the plant and equipment and an ROE that represents the return to shareholders. The dollar value of this ROE generally represents allowed profit or "margin." Publicly and cooperatively owned utilities do not earn profit per se, and so the rate of return for these enterprises is the cost of debt.[11] The sum of depreciation, other fixed costs (e.g., fixed O&M, property taxes, labor), and the dollar return on invested capital represents a utility's total fixed costs.

If actual sales fall below the level estimated when rates are set, the utility will not collect revenue sufficient to match its authorized revenue requirement. The portion

Table 2-1. The Arithmetic of Rate-Setting

	Baseline (rate setting proceeding)	Case 1 (2% reduction in sales)	Case 2 (2% increase in sales)
1. Variable costs	$1,000,000	$980,000	$1,020,000
2. Depreciation + other fixed costs	$500,000	$500,000	$500,000
3. Capital cost	$5,000,000	$5,000,000	$5,000,000
4. Debt	$3,000,000	$3,000,000	$3,000,000
5. Interest (@10%)	$300,000	$300,000	$300,000
6. Equity	$2,000,000	$2,000,000	$2,000,000
7. Rate of return on equity (ROE@ 10%)	10%	10%	10%
8. Authorized earnings	$200,000	$200,000	$200,000
9. Revenue requirement (1+2+5+8)	$2,000,000	$1,980,000	$2,020,000
10. Sales (kWh)	20,000,000	19,600,000	20,400,000
11. Average price (9÷10)	$0.10	$0.101	$0.99
12. Earned revenue (11×10)	$2,000,000	$1,960,000	$2,040,000
13. Revenue difference (12–9)	0	-$40,000	+$40,000
14. % of authorized earnings (13÷8)	0	-20%	+20%

Note: Sample values used to illustrate the arithmetic of rate-setting.

of the revenue requirement most exposed is a utility's margin. For legal and financial reasons, a utility will use available revenues to cover the costs of interest, depreciation, property taxes, and so forth, with any remaining revenues going to this margin, representing profit for an investor-owned utility.[12,13]

If sales rise above the levels estimated in a rate-setting process, a utility will collect more revenue than required to meet its revenue requirement, and the excess above any increased costs will go to higher earnings.[14] Table 2-1 provides an example based on an investor-owned utility, and Chapter 4 of the Action Plan—the Business Case for Energy Efficiency—provides a very clear illustration of this impact under a variety of scenarios. The results illustrated are sensitive to the relative proportion of fixed and variable costs in a utility's cost of service. The higher the proportion of the variable costs, the lower the impact of a drop in sales. A gas utility's cost-of-service typically will have a higher proportion of fixed costs than an electric utility's and, therefore, the gas utility can be more financially sensitive to changes in sales relative to a test year level.[15]

This example only examines the impact on earnings due to a sales-produced change in revenue. Margins obviously also are affected by costs, and while many costs are considered fixed in the sense that they do not vary as a function of sales, they are under the control of utilities. Therefore, increases in sales and revenue above a test year level do not necessarily translate into higher margins, and the impact of a reduction in sales on margins depends on how a utility manages its costs.

Although the revenue difference appears small, it can be significant due to the effects on financial margins. The Case 1 revenue deficit of $40,000 represents 20 percent of the allowed ROE. In other words, a 2 percent drop in sales below the level assumed in the rate case translates into a 20 percent drop in earnings or margin, all else being equal. Similarly, sales that are 2 percent higher than assumed yield a 20 percent increase in earnings above authorized levels.

The magnitude of the impact is, in this example, directly related to the efficacy of the efficiency program. Many other factors can have a similar impact on utility revenues—for instance, sales can vary greatly from the rate case forecast assumptions due to weather or economic conditions in the utility's service territory. But unlike the weather or the economy, energy efficiency is the most important factor affecting sales that lies within the utility's control or influence, and successful energy efficiency programs can reduce sales enough to create a disincentive to engage in such programs.

In Case 2, actual sales exceed estimated levels. Once rates are set, a utility may have a financial incentive to encourage sales in excess of the level anticipated during the rate-setting process, since additional units of energy sold compensate for any unanticipated increased costs, and may improve earnings.[16]

Chapter 5 explores mechanisms that can be used to address both cases. Generally, two approaches have been used. First, several states have implemented what are termed lost revenue adjustment mechanisms (LRAMs) that attempt to estimate the amount of fixed-cost or margin revenue that is "lost" as a result of reduced sales. The estimated lost revenue is then recovered through an adjustment to rates. The second approach is known generically as "decoupling." A decoupling mechanism weakens or eliminates the relationship between sales and revenue (or more narrowly, the revenue collected to cover fixed costs) by allowing a utility to adjust rates to recover authorized revenues independent of the level of sales. Decoupling actually can take many forms and include a variety of adjustments.

LRAM and decoupling not only represent alternative approaches to addressing the lost margins effect, but they also reflect two different policy questions related to the relationship between utility sales and profits.

Provide compensation for lost margins?

Should a utility be compensated for the under-recovery of allowed margins when energy efficiency programs—or events outside of the control of the utility, such as weather or a drop in economic activity—reduce sales below the level on which current rates are based? The financial implication—with all else being held equal—is easy to illustrate as shown in Table 4-1. In practice, however, determining what is lost as a direct result of the implementation of energy efficiency programs is not so simple. The determination of whether this loss should stand alone or be treated in context of all other potential impacts on margins also can be challenging. For example, during periods between rate cases, revenues and costs are affected by a wide variety of factors, some within management control and some not. The impacts of a loss of revenue due to an energy efficiency program could be offset by revenue growth from customer growth or by reductions in costs. On the other hand, the addition of new customers imposes costs which, depending on rate structure, can exceed incremental revenues.

Change the basic relationship between sales and profit?

Should lost margins be addressed as a stand-alone matter of cost recovery, or should they be considered within a policy framework that changes the relationship between sales, revenues, and margins—in other words by decoupling revenues from sales? Decoupling not only addresses lost margins due to efficiency program implementation. It also removes the incentive a utility might otherwise have to increase throughput, and can reduce resistance to policies like efficient building codes, appliance standards, and aggressive energy efficiency awareness campaigns that would reduce throughput.

Decoupling also can have a significant impact on both utility and customer risk. For example, by smoothing earnings over time, decoupling reduces utility financial risk, which some have argued can lead to reductions in the utility's cost-of-capital. (For a discussion of this issue, see Hansen, 2007, and Delaware PSC, 2007.) Depending on precisely how the decoupling mechanism is structured, it can shift some risks associated with sales unpredictability (e.g., weather, economic growth) to consumers.[17] This is a design decision within the control of policy-makers, and not an inherent characteristic of decoupling. The issue of the effect of decoupling on risk and therefore, on the cost-of-capital, likely will receive greater attention as decoupling increasingly is pursued. The existing literature and current experience is inconclusive, and the policy discussion would benefit from a more complete examination of the issue than is possible in this Report.

Ultimately, the policy choice must be made based on practical considerations and a reasonable balancing of interests and risks. Most observers would agree that significant and sustained investment in energy efficiency by utilities, beyond that required by statute or order, will not occur absent implementation of some type of lost margin recovery mechanism. More important, a policy that hopes to encourage aggressive utility investment in energy efficiency most likely will not fundamentally change utility behavior as long as utility margins are directly tied to the level of sales. The increasing number of utility commissions investigating decoupling is clear evidence that this question has moved front and center in development of energy efficiency investment policies across the country.

2.4 Performance Incentives

The first two financial impacts described above pertain to obvious disincentives for utilities to engage in energy efficiency program investment. The third effect concerns incentives for utilities to undertake such investment. Full recovery of program costs and collection of allowed revenue eliminates potential financial penalties associated with funding energy efficiency programs. However, simply eliminating financial penalties will not fundamentally change the utility business model, because that model is premised on the earnings produced by supply-side investment. In fact, the earnings inequality between demand- and supply-side investment even where program costs and lost margins are addressed can create a significant barrier to aggressive investment in energy efficiency. An enterprise organized to focus on and profit by investment in supply is not easily converted to one that is driven to reduce demand. This is particularly true in the absence of clear financial incentives or fundamental changes in the business environment.[18]

This issue is fundamental to a core regulatory function—balancing a utility's obligation to provide service at the lowest reasonable cost and providing utilities the opportunity to earn reasonable returns. For example, assume that an energy efficiency program can satisfy an incremental resource requirement at half the cost of a supply-side resource, and that in all other financial terms the efficiency program is treated like the supply resource. Cost recovery is assured and lost margins are addressed. In this case, the utility will earn 50 percent of the return it would earn by building the power plant. Consumers as a whole clearly would be better off by paying half as much for the same level of energy service. However, the utility's earnings expectations are now changed, with a potential impact on its stock price, and total returns to shareholders could decline. There could be additional benefits, to the extent that investors perceive the utility less vulnerable to fuel price or climate risk, but under the conventional approach to valuing businesses, the utility would be less attractive. This is an extreme example, and it is more likely that this trade-off plays out more modestly over a longer period of time. Nevertheless, the prospective loss of earnings from a shift towards greater reliance on demand-side resources is a concern among investor-owned utilities, and it will likely influence some utilities' perspective on aggressive investment in energy efficiency.[19]

The importance of performance incentives is not universally accepted. Some parties will argue that utilities are obligated to pursue energy efficiency if that is the policy of the State. Those taking this view will see performance incentives as requiring customers to pay utilities to do something that should be done anyway. Others have argued that the basic business of a utility is to deliver energy, and that providing financial incentives over-and-above what could be earned by efficient management of the supply business simply raises the cost of service to all customers and distorts management behavior.

Those holding this latter view often prefer that energy efficiency investment be managed by an independent third-party (see, for example, ELCON, 2007). Existing third-party models, such as those in Oregon, Vermont, and Wisconsin, have received generally high marks, but these models carry a variety of implications beyond those related to lost margins and performance incentives. Policy-makers interested in a third party model must balance the potentially beneficial effects for ratepayers with what is typically a lower level of control over the third party, and increased complexity in integrating supply- and demand-side resource policy.

Apart from this threshold issue, regulators face a variety of options for providing incentives to utilities (see Chapter 7), ranging from mechanisms that tie a financial reward to specific performance metrics, including savings, to options that enable a sharing of program benefits, to rewards based on levels of program spending.[20] The latter type of mechanism, while sometimes derided as an incentive to spend, not save, has been applied in some cases simply because it is easier to develop and implement, and it can be combined with pre- and post-implementation reviews to ensure that ratepayer funds are being used effectively.

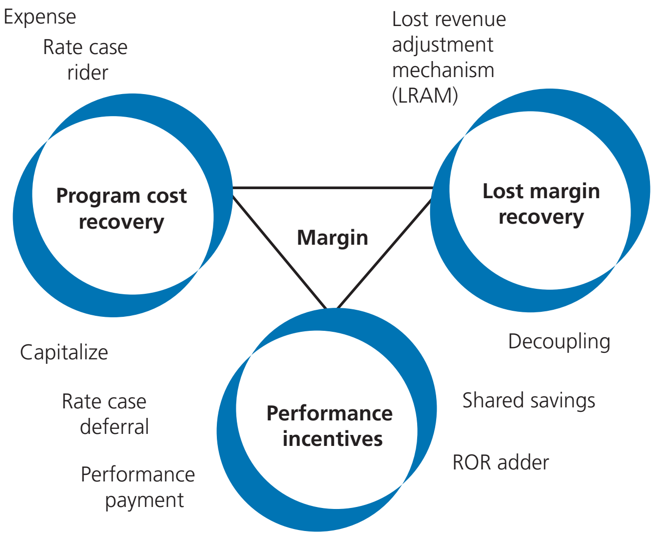
Providing financial incentives to a utility if it performs well in delivering energy efficiency potentially can change the existing utility business model by making efficiency profitable rather than merely a break-even activity. Today such incentives are the exception rather than the norm. For example, California policy-makers have acknowledged that successfully reorienting utility resource acquisition policy to place energy efficiency first in the resource "loading order" requires that performance incentives be re-instituted (see CPUC, 2006).

2.5 Linking the Mechanisms

Each of the financial effects suggests a different potential policy response, and policy-makers can and have approached the challenge in a variety of ways. It is the net financial effect of a package of cost recovery and incentive policies that matters in devising a policy framework to stimulate greater investment in energy efficiency. A variety of policy combinations can yield roughly the same effect. However, to the extent that mechanisms are developed to address all financial effects, care must be taken to ensure that the interactions among these are understood.

The essential foundation of the policy framework is program cost recovery. While confidence in its ability to recover these direct costs is central to a utility's willingness to invest in energy efficiency, a number of options are available for recovery, some of which also address lost margins and performance incentives. Some states directly provide for lost margin recovery for losses due to efficiency programs through a decoupling or LRAM while others create performance incentive policies that indirectly compensate for some or all lost margins. Minnesota, for example, abandoned its lost margin recovery mechanism in favor of a performance incentive after finding that levels of margin recovery had become so large that their recovery could not be supported by the

Figure 2-1. Linking Cost Recovery, Recovery of Lost Margins, and Performance Incentives



commission. Although it has been difficult to determine the precise impact of the change in policy, the utilities in Minnesota have indicated that they are generally satisfied given that prudent program cost recovery is guaranteed and significant performance incentives are available.[21,22] Finally, the combination of program cost recovery and a decoupling mechanism could create a positive efficiency investment environment, even absent performance incentives. Depending on its structure, a decoupling mechanism can create more earnings stability, which, all else being equal, can reduce risk.[23]

2.6 "The DNA of the Company:" Examining the Impacts of Effective Mechanisms on the Corporate Culture

A policy that addresses all three financial effects will, in theory, have a powerful impact on utility behavior and, ultimately, corporate culture, turning what for many utilities is a compliance function into a key element of business strategy.[24] Perhaps the clearest example of this is Pacific Gas & Electric.

PG&E has one of the richest histories of investment in energy efficiency of any utility in the country, dating to the late 1970s. A vital part of that history has been California's policy with respect to program cost recovery, treatment of fixed-cost recovery and performance incentives. Decoupling, in the form of electric rate adjustment mechanism (ERAM), was instituted in 1982. ERAM was suspended as the state embarked on its experiment with utility industry restructuring. While that specific mechanism has not been reinstituted, 2001 legislation effectively required reintroduction of decoupling, which each investor-owned utility has pursued, though in slightly different forms. Similarly, utility performance incentives were authorized more than a decade ago, but were suspended in 2002 amidst of a broad rethinking of the administrative structure for energy efficiency investment in the State. A September 2007 decision by the California Public Utilities Commission (CPUC), reinstated utility performance incentives through an innovative risk/reward mechanism offering utilities collectively up to $450 million in incentives over a three-year period. At the same time, this mechanism will impose penalties on utilities for failing to meet performance targets (see Section 7.3 for a more complete description).

The policy framework in California supports very aggressive investment in energy efficiency, placing energy efficiency first in the resource loading order through adoption of the state's Energy Action Plan. The Energy Action Plan also established that utilities should earn a return on energy efficiency investments commensurate with foregone return on supply-side assets. Public proceedings directed by CPUC set three-year goals for each utility, and the payment of performance incentives will be based on meeting these goals.

PG&E's current energy efficiency investment levels are approaching an all-time high, totaling close to $1 billion over the 2006–2008 period. Base funding comes from the state's public goods charge, but a substantial fraction now comes as the result of the State's equivalent of integrated resource planning proceedings. These procurement proceedings, through which the loading order is implemented, will continue to maintain energy efficiency funding at levels in excess of the public goods charge, as the state pursues aggressive savings goals.

A view only to savings targets and spending levels might suggest that a discussion of disincentive to investment and utility corporate culture is irrelevant in PG&E's case. However, support for these aggressive investments appears to be run deep within the California investor-owned utilities, and clearly this policy would struggle were it not for utility support. Even so, has this policy actually shaped utility corporate culture?

Discussions with PG&E management suggest the answer is "yes" (personal communication with Roland Risser, Director of Customer Energy Efficiency, Pacific Gas & Electric Company, May 2, 2007). Although investment levels always have been high in absolute terms, the company's view in the 1980s initially had been that, as long as energy efficiency investment did not hurt financially, the company would not resist that investment. However, the combined effect of ERAM and utility performance incentives turned what had been a compliance function into a vital piece of the company's business, and a defining aspect of corporate culture that has produced the largest internal energy efficiency organization in the country.[25]

The policy and financial turbulence created by the state's attempt at industry restructuring challenged this culture, first as ERAM and performance incentives were halted, and then as the regulatory environment turned sour with the energy crisis. However, a combination of a new policy recommitment to demand-side management (DSM), and the arrival of a new PG&E CEO have combined to reset the context for utility investment in efficiency and strengthen corporate commitment. Decoupling is again in place and CPUC has adopted a new performance incentive structure.

The significant escalation in efficiency funding driven by California's Energy Action Plan, in addition to resource procurement proceedings, required the company to address the role of energy efficiency investment in more fundamental terms internally. The choices made in the procurement proceedings allocated funding to energy efficiency resources—funding that otherwise would have gone to support acquisition of conventional supply. While in most organizations such allocation processes can create fierce competition, the environment within PG&E has significantly reduced potential conflict and even more firmly embedded energy efficiency in the company's clean energy strategy.

The culture shift certainly is the product of a combination of forces, including the arrival of a new CEO with a strong commitment to climate protection; a state policy environment that is intensely focused on clean energy development; an investment community interested in how utilities hedge their climate risks; and the re-emergence of favorable treatment of fixed-cost coverage and performance incentives. It is not clear that progressive cost recovery and incentive policies are solely responsible for this change, but without these policies it is unlikely that efficiency investment would have become a central element of corporate strategy, embedded "in the DNA of the Company" (personal communication with Roland Risser, PG&E).

Would the same cost recovery and incentive structure have the same effect elsewhere? That answer is unclear, though it is unlikely that simply adopting mechanisms similar to what are in place in California would effect overnight change. Corporate culture is formed over extended periods of time and is influenced by the whole of an operating environment and the leadership of the company. Nevertheless, according to senior PG&E staff, the effect of the cost recovery and incentive policies is undeniable—in this case it was the catalyst for the change.

2.7 The Cost of Regulatory Risk

A comprehensive cost recovery and incentive policy can help institutionalize energy efficiency investment within a utility. At the same time, the absence of a comprehensive approach, or the inconsistent and unpredictable application of an approach, can create confusion with respect to regulatory policy and institutionalize resistance to energy efficiency investment. A significant risk that policy-makers could disallow recovery of program costs and/or collection of incentives, even if such investments have been encouraged, imposes a real, though hard-to-quantify cost on utilities. While a significant disallowance can have direct financial implications, a less tangible cost is associated with the institutional friction a disallowance will create. Organizational elements within a utility responsible for energy efficiency initiatives will find it increasingly difficult to secure resources. Programs that are offered will tend to be those that minimize costs rather than maximize savings or cost-effectiveness. Easing this friction will not be as simple as a regulatory message that it will not happen again, and in fact the disallowance could very well have been justified, should have happened, and would happen again.

Regulators clearly cannot give up their authority and responsibility to ensure just and reasonable rates based on prudently incurred costs. And changes in the course of policy are inevitable, making flexibility and adaptability essential. All parties must realize, however, that the consistent application of policy with respect to cost recovery and incentives matters as much if not more than the details of the policies themselves. The wide variety of cost recovery and incentive mechanisms provides opportunities to fashion a similar variety of workable policy approaches. Significant and sustained investment in energy efficiency by utilities very clearly requires a broad and firm consensus on investment goals, strategy, investment levels, measurement, and cost recovery. It is this consensus that provides the necessary support for consistent application of cost recovery and incentives mechanisms.[26]

2.8 Notes

1. However, as they explored industry restructuring, a number of states stripped utility commissions of regulatory authority over generation and, in some cases, transmission to varying degrees.

2. In fact, many gas utilities do make investment in plant and equipment beyond gas distribution pipes—gas peaking and storage facilities, for example.

3. Recovery of costs always is based on demonstration that the costs were prudently incurred.

4. The forward period for which energy efficiency program costs is approved can be quite important to the success of programs. Year-by-year approval requirements complicate program planning, and longer term commitments to the market actors cannot be made. The trend among states is to move toward longer program implementation periods, e.g., three years. Thus, to the extent that program costs are reviewed as part of proposed implementation plans, initial approval for spending is conferred for the three-year period, providing program stability and flexibility.

5. Courts can rule on appeal that regulatory disallowances were not supported by the facts of a case or by governing statute.

6. In fact, some such disallowances have had the effect of clarifying these rules.

7. Another approach to achieving this balance is using stakeholder collaboratives to review, help fashion, and, where appropriate based on this review, endorse certain utility decisions. Where these collaboratives produce stipulations that can be offered to regulators, they provide some additional assurance to regulators that parties who might otherwise challenge the prudence or reasonableness of an action, have reviewed the proposed action and found it acceptable. Though sometimes time-and resource-intensive, such collaboratives have been helpful tools for reducing utility prudence risk related to energy efficiency expenditures.

8. In addition, because such regulatory asset accounts are backed not by hard assets but by a regulatory promise to allow recovery, their use can raise concern in the financial community particularly for utilities with marginal credit ratings.

9. The lost margin issue actually arises as a function of rate designs that intend to recover fixed costs through volumetric (per kilowatt-hour or therm) charges. A rate design that placed all fixed costs of service in a fixed charge per customer (SFV rate) would largely alleviate this problem. However such rates significantly reduce a consumer's incentive to undertake efficiency investments, since energy use reductions would produce much lower customer bill savings relative to a the situation under a rate design that included fixed costs in volumetric charges. In addition, fixed-variable rates are criticized as being regressive (the lower the use, the higher the average cost per unit consumed) and unfair to low-income customers. See Chapter 5, "Rate Design," of the Action Plan for an excellent discussion of this process.

10. This equation is a simplification of the rate-setting process. The actual rates paid per kilowatt-hour or therm often will be higher or lower than the average revenue per unit.

11. Note, however, that publicly owned utilities typically must transfer some fraction of net operating margins to other municipal funds, and cooperatively owned utilities typically pay dividends to the member of the co-op. These payments are the practical equivalent of investor-owned utility earnings. In addition, these utilities typically must meet bond covenants requiring that they earn sufficient revenue to cover a multiple of their interest obligations. Therefore, there can be competing pressures for publicly and cooperatively owned utilities to maintain or increase sales at the same time that they promote energy efficiency programs.

12. Although a utility is not obligated to pay returns to shareholders in the same sense that it is obligated to pay for fuel or to pay the interest associated with debt financing, failure to provide the opportunity to earn adequate returns will lead equity investors to view the utility as a riskier or less desirable investment and will require a higher rate of return if they are to invest in the utility. This will increase the utility's overall cost of service and its rates.

13. Publicly and cooperatively owned utilities do not earn profits per se and thus, have no return on equity. However, they do earn financial margins calculated as the difference between revenues earned and the sum of variable and fixed costs. These margins are important as they fund cooperative member dividends and payments to the general funds of the entities owning the public utilities.

14. The actual impact on margins of a change in sales depends critically on the extent to which fixed costs are allocated to volumetric charges. Actual electricity and natural gas prices usually include both a fixed customer charge and a price per unit of energy consumed. The larger the share of fixed costs included in this price per unit, the more a utility's margin will fluctuate with changes in sales.

15. A gas utility's cost of service does not include the actual commodity cost of gas which is flowed through directly to customers without mark-up.

16. Some states require utilities to participate in a rate case every two or three years. Others hold rate cases only when a utility believes it needs to change its prices in light of changing costs or the regulatory agency believes that a utility is over-earning.

17. Unless properly structured, a decoupling mechanism also can lead to a utility over-earning—collecting more margin revenue than it is authorized to collect.

18. An alternative has been for state utility commissions to require adherence to least-cost planning principles that require the less expensive energy efficiency to be "built," rather than the new supply-side resource. However, this approach does not alter the basic financial landscape described above.

19. The California Public Utilities Commission's recent ruling regarding utility performance rewards explicitly recognized this issue.

20. The actual implementation of an incentive mechanism may address more than financial incentives. For example, The Minnesota Commission considers its financial incentive mechanism as effectively addressing the financial impact of the reduction in revenue due to an energy efficiency program.

21. State EE/RE Technical Forum Call #8, Decoupling and Other Mechanisms to Address Utility Disincentives for Implementing Energy Efficiency, May 19, 2005. <http://www.epa.gov/cleanenergy/stateandlocal/efficiency.htm#decoup>

22. The Minnesota Legislature recently adopted legislation directing the Minnesota Public Service Commission to adopt criteria and standards for decoupling, and to allow one or more utilities to establish pilot decoupling programs. S.F. No. 145, 2nd Engrossment 85th Legislative Session (2007–2008).

23. As noted, some argue that this risk reduction should translate into a corresponding reduction in the cost of capital, although views are mixed regarding the extent to which this reduction can be quantified.

24. For a broader discussion of how cost recovery and incentive mechanisms can affect the business model for utility investment in energy efficiency, see NERA Economic Consulting (2007). *Making a Business of Energy Efficiency: Sustainable Business Models for Utilities. Prepared for Edison Electric Institute.*

25. This infrastructure was significantly scaled back during California's restructuring era.

26. One way to manage the regulatory risk issue is to make the regulatory goals very clear and long-term in nature. Setting energy savings targets—for example, by using an Energy Efficiency Resource Standard—can remove some part of the utility's risk. If the utility meets the targets, and can show that the targets were achieved cost-effectively, prudence and reasonableness are easier to establish, and cost recovery and incentive payments become less of an issue. Otherwise, more issues are under scrutiny: did the utility seek "enough" savings? Did it pursue the "right" technologies and markets? With a high-level, simple, and long-term target, such issues become less germane.

3: Understanding Objectives—Developing Policy Approaches That Fit

This chapter explores a range of possible objectives for policy-makers' consideration when exploring policies to address financial disincentives. It also addresses the broader context in which these objectives are pursued.

3.1 Potential Design Objectives

Each jurisdiction could value the objectives of the energy efficiency investment process and the objectives of cost recovery and incentive policy design differently. Jurisdictional approaches are formed by a variety of statutory constraints, as well as by the ownership and financial structures of the utilities; resource needs; and related local, state, and federal resource and environmental policies. ***The overarching objective in every jurisdiction that considers an energy efficiency investment policy should be to generate and capture substantial net economic benefits***. This broad objective sometimes is expressed as a spending target, but more often as an energy or demand reduction target, either absolute (e.g., 500 MW by 2017) or relative (e.g., meet 10, 50, or 100 percent of incremental load growth or total sales). Increasingly, states are linking this objective to others that promote the use of cost-effective energy efficiency as an environmentally preferred option. The objectives outlined below guide how a cost recovery and incentive policy is crafted to support this overarching objective.

A review of the cost recovery and incentive literature, as well as the actual policies established across the country, reveals a fairly wide set of potential policy objectives. Each one of these is not given equal weight by policy-makers, but most of these are given at least some consideration in virtually every discussion of cost recovery and performance incentives. Many of these objectives apply to broader regulatory issues as well. Here the focus is solely on the objectives as they might apply to design of cost recovery and incentive mechanisms intended to serve the overarching objective stated above; that is whether the treatment of these objectives leads to a policy that effectively incents substantial cost-effective savings. A cost recovery and incentives policy that satisfies each of the design objectives described below, but which does not stimulate utility investment in energy efficiency, would not serve the overarching objective.

3.1.1 Strike an Appropriate Balance of Risk/Reward Between Utilities/Customers

The principal trade-off is between lowering utility risk/enhancing utility returns on the one hand and the magnitude of consumer benefits on the other. Mechanisms that reduce utility risk by, for example, providing timely recovery of lost margins and providing performance incentives, reduce consumer benefit, since consumers will pay for recovery and incentives through rates.[1] However, if the mechanisms are well-designed and implemented, customer benefits will be large enough that sharing some of this benefit as a way to reduce utility risk and strengthen institutional commitment will leave all parties better off than had no investment been made.

3.1.2 Promote Stabilization of Customer Rates and Bills

This objective is common to many regulatory policies and is relevant to energy efficiency cost recovery and incentives policy primarily with respect to recovery of lost margins. The ultimate objective served by a cost recovery and incentives policy implies an overall reduction in the long run costs to serve load, which equate to the total amount paid by customers over time. Therefore, while it is prudent to explore policy designs that, among available options, minimize potential rate volatility, the pursuit of rate stability should be balanced against the broader interest of total customer bill reductions. In fact, there are cases (Questar Gas in Utah, for example) where energy efficiency programs produce benefits for all customers (programs pass the so-called No-Losers test of cost-effectiveness) through reductions in commodity costs (Personal communication with Barry McKay, Questar Gas, July 9, 2007).

Program costs and performance incentives are relatively stable and predictable, or at least subject to caps. Lost margins can grow rapidly, and recovery can have a noticeable impact on customer rates. Decoupling mechanisms can be designed to mitigate this problem through the adoption of annual caps, but there have been isolated cases in which the true-ups have become so large due to factors independent of energy efficiency investment that regulators have balked at allowing full recovery.[2] Therefore, consideration of this objective is important for customers and utilities, as erratic and substantial energy efficiency cost swings can imperil full recovery and increase the risk of efficiency investments for utilities.

3.1.3 Stabilize Utility Revenues

This objective is a companion to stabilization of rates. Aggressive energy efficiency programs will impact utility revenues and full recovery of fixed costs. However, even if cost recovery policy covers program costs, lost margins, and performance incentives, how this recovery takes place can affect the pattern of earnings. Large episodic jumps in earnings (for example, produced by a decision to allow recovery of accrued lost margins in a lump sum), while better than non-recovery, cloud the financial community's ability to discern the true financial performance of the company, and creates the perception of risk that such adjustments might or might not happen again. PG&E views the ability of its decoupling mechanism to smooth earnings as a very important risk mitigation tool (personal communication with Roland Risser, PG&E).

3.1.4 Administrative Simplicity and Managing Regulatory Costs

Simplicity requires that any/all mechanisms be transparent with respect to both calculation of recoverable amounts and overall impact on utility earnings. This, in turn, supports minimizing regulatory costs. Given the workload facing regulatory commissions, adoption of cost recovery and incentive mechanisms that require frequent and complex regulatory review will create a latent barrier to effective implementation of the mechanisms. Every mechanism will impose some incremental cost on all parties, since some regulatory responsibilities are inevitable. The objective, therefore, is to structure mechanisms with several attributes that can establish at least a consistent and more formulaic process.

The mechanism should be supported by prior regulatory review of the proposed efficiency investment plan, and at least general approval of the contours of the plan and budget. In the alternative, policy-makers can establish clear rules prescribing what is considered acceptable/necessary as part of an investment plan, including cost caps. This will reduce the amount of time required for post-implementation review, as the prudence of the investment decision and the reasonableness of costs will have been established.

Use of tariff riders with periodic true-up allows for more clear segregation of investment costs and adjustment for over/under-recovery than simply including costs in a general rate case. However, in some states, the periodic treatment of energy efficiency program costs, fixed cost recovery, and incentives outside of a general rate case could be prohibited as single-issue ratemaking.[3]

Because certain mechanisms require evaluation and verification of program savings as a condition for recovery, very clear specification of the evaluation standards at the front end of the process is important. Millions of dollars are at stake in such evaluations, and failure to prescribe these standards early in the process almost guarantees that evaluation methods will be contested in cost recovery proceedings.

3.2 The Design Context

The need to design mechanisms that match the often unique circumstances of individual jurisdictions is clear, but what are the variables that determine the context for cost recovery and incentive design? Table 3-1 identifies and describes several variables often cited as important influences.

Table 3-1. Cost Recovery and Incentive Design Considerations

Variable	Implication
Related to Industry Structure	
Differences between gas and electric utility policy and operating environments	Wide variety of embedded implications. Gas utility cost structures create greater sensitivity to sales variability and recovery of fixed costs. In addition, as an industry, gas utilities face declining demand per customer.
Differences between investor-, publicly, and cooperatively owned utilities	Significant differences in financing structures. Municipal and cooperative ownership structures might provide greater ratemaking flexibility. Shareholder incentives are not relevant to publicly and cooperatively owned utilities, although management incentives might be.
Differences between bundled and unbundled utilities	Unbundled electric utilities have cost structures with some similarities to gas utilities; may be more susceptible to sales variability and fixed-cost recovery.
Presence of organized wholesale markets	Organized markets may provide an opportunity for utilities to resell "saved" megawatt-hours and megawatts to offset under-recovery of fixed costs.
Related to Regulatory Structure and Process	
Utility cost recovery and ratemaking statutes and rules	Determines permissible types of mechanisms. Prohibitions on single-issue ratemaking could preclude approval of recovery outside of general rate cases. Accounting rules could affect use of balancing and deferred/escrow accounts. Use of deferred accounts creates regulatory assets that are disfavored by Wall Street.
Related legislative mandates such as DSM program funding levels or inclusion of DSM in portfolio standards	Can eliminate decisional prudence issues/reduce utility program cost recovery risk. Does not address fixed-cost recovery or performance incentive issues.

Table 3-1. Cost Recovery and Incentive Design Considerations (continued)

Variable	Implication
Related to Regulatory Structure and Process (continued)	
Frequency of rate cases and the presence of automatic rate adjustment mechanisms	Frequent rate cases reduce the need for specific fixed-cost recovery mechanism, but do not address utility incentives to promote sales growth or disincentives to promote customer energy efficiency. Utility and regulator costs increase with frequency.
Type of test year	Type of test year (historic or future) is relevant mostly in cases in which energy efficiency cost recovery takes place exclusively within a rate case. Test year costs typically must be known, which can pose a problem for energy efficiency programs that are expected to ramp-up significantly. This applies particularly to the initiation or significant ramp-up of energy efficiency programs combined with a historic test year.
Performance-based ratemaking elements	Initiating an energy efficiency investment program within the context of an existing performance-based ratemaking (PBR) structure can be complicated, requiring both adjustments in so-called "Z factors"4 and performance metrics. However, revenue-cap PBR can be consistent with decoupling.
Rate structure	The larger the share of fixed costs allocated to fixed charges, the lower the sensitivity of fixed-cost recovery to sales reductions. Price cap systems pose particular issues, since costs incurred for programs implemented subsequent to the cap but prior to its expiration must be carried as regulatory assets with all of the associated implications for the financial evaluation of the utility and the ultimate change in prices once the cap is lifted.
Regulatory commission/governing board resources	Resource-constrained commissions/governing boards may prefer simpler, self-adjusting mechanisms.
Related to the Operating Environment	
Sales/peak growth and urgency of projected reserve margin shortfalls	Rapid growth may imply growing capacity needs, which will boost avoided costs. Higher avoided costs create a larger potential net benefit for efficiency programs and higher potential utility performance incentive. Growth rate does not affect fixed-cost recovery if the rate has been factored into the calculation of prices.

Table 3-1. Cost Recovery and Incentive Design Considerations (continued)

Variable	Implication
Related to the Operating Environment (continued)	
Volatility in load growth	Unexpected acceleration or slowing of load growth can have a major impact on fixed-cost recovery, an impact that can vary by type of utility. Higher than expected growth can lessen the impact of energy efficiency on fixed cost recovery, while slower growth exacerbates it. On the other hand, if the cost to add a new customer exceeds the embedded cost, higher than expected growth can adversely impact utility finances.
Utility cost structure	Utilities with higher fixed/variable cost structures are more susceptible to the fixed-cost recovery problem.
Structure of the DSM portfolio	Portfolios more heavily weighted toward electric demand response will result in less significant lost margin recovery issues, thus reducing the need for a specific mechanism to address. Moreover, a portfolio weighted toward demand response typically will not offer the same environmental benefits.

3.3 Notes

1. A related concern raised by skeptics of performance incentives is that by providing an incentive to utilities to deliver successful energy efficiency programs, customers might pay more than they otherwise should or would have to achieve the same result if another party delivered the programs, or if the utilities were simply directed to acquire a certain amount of energy savings. Of course, the counter-argument is that in some cases, the level of savings actually achieved by a utility (savings in excess of a goal, for example) are motivated by the opportunity to earn an incentive. In addition, certain third-party models include the opportunity for the administering entity to earn performance incentives.

2. See the discussion of the Maine decoupling mechanism in the National Action Plan for Energy Efficiency, July 2006, Chapter 2, pages 2–5. The examples of this issue are isolated, emerging in early decoupling programs in the electric utility industry. The negative impacts were exacerbated by accounting treatments that deferred recovery of the revenues in the balancing accounts.

3. Single issue ratemaking allows for a cost change in a single item in a utility's cost of service to flow through to consumer rates. A prohibition on single-issue ratemaking occurs because, among the multitude of utility cost items, there will be increases and decreases, and many states find it inappropriate to base a rate change on the movement of any single cost item in isolation. In some states, a fuel adjustment clause is an exception to this rule, justified because the impacts of changes in fuel costs on the total cost of service is high. States that employ an energy efficiency rider justify this exception as a function of the policy importance of energy efficiency and as an important element in creating a stable energy efficiency funding environment.

4. Z factors are factors affecting the price of service over which the utility has no control. PBR programs typically allow rate cap adjustments to accommodate changes in these factors.

4: Program Cost Recovery

This chapter provides a practical overview of alternative cost recovery mechanisms and presents their pros and cons. Detailed case studies are provided for each mechanism.

4.1 Overview

Administration and implementation of energy efficiency programs by utilities or third-party administrators involves the annual expenditure of several million dollars to several hundred million dollars, depending on the jurisdiction. The most basic requirement for elimination of disincentives to customer-funded energy efficiency is establishing a fair, expeditious process for recovery of these costs, which include participant incentives and implementation, administration, and evaluation costs. Failure to recover such costs directly and negatively affects a utility's cash flow, net operating income, and earnings.

Utilities incur two types of costs in the provision of service. Capital costs are associated with the plant and equipment associated with the production and delivery of energy. Expenses typically are the costs of service that are not directly associated with physical plant or other hard assets.[1] The amount of revenue that a utility must earn over a given period to be financially viable must cover the sum of expenses over that period plus the financial cost associated with the utility's physical assets. In simple terms, a utility revenue requirement is equivalent to the cost of owning and operating a home, including the mortgage payment and ongoing expenses. The costs associated with utility energy efficiency programs must be recovered either as expenses or as capital items.

The predominant approach to recovery of program costs is through some type of periodic rate adjustment established and monitored by state utility regulatory commissions or the governing entities for publicly or cooperatively owned utilities. These regulatory mechanisms can take a variety of forms including recovery as expenses in traditional rate cases, recovery as expenses through surcharges or riders that can be adjusted periodically outside of a formal rate case, or recovery via capitalization and amortization. Variations exist within these broad forms of cost recovery as well, through the use of balancing accounts, escrow accounts, test years, and so forth.

The approach applied in any given jurisdiction will often be the product of a variety of local factors such as the frequency of rate cases, the specific forms of cost accounting allowed in a state, the amount and timing of expenditures, and the types of programs being implemented. States will also differ in how costs are distributed across and recovered from different customer classes. Some states, for example, allow large customers to opt-out of efficiency programs administered by utilities,[2] and some states require that costs be recovered only from the classes of customers directly benefiting from specific programs. These variations preclude a single best approach. However, for those utilities and states considering implementation of energy efficiency programs, the variety of approaches offers a variety of options to consider.

4.2 Expensing of Energy Efficiency Program Costs

Most energy efficiency program costs are recovered through "expensing." In the simplest case, if a utility spends $1.00 to fund an energy efficiency program, that $1.00 is passed directly to customers as part of the utility's cost of service. While in principle, the expensing of energy efficiency program costs is straightforward, utilities and state regulatory commissions have employed a wide variety of specific accounting treatments and actual recovery mechanisms to enable recovery of program expenses. This section provides an overview of several of the more common approaches.

4.2.1 Rate Case Recovery

The most straightforward approach to recovery of program costs as expenses involves recovery in base rates as an element of the utility revenue requirement. Energy efficiency program costs are estimated for the relevant period, added to the utility's revenue requirement, and recovered through customer rates that were set based on this revenue requirement and estimated sales. Rate cases typically involve an estimate of known future costs, given that the rates that emerge from the case are applied going forward. For example, a utility and its commission might conduct a rate case in 2007 to establish the rates that will apply beginning in 2008. Therefore, the utility will estimate (and be seeking approval to incur) the costs associated with the energy efficiency program in 2008 and annually thereafter. The approved level of energy efficiency spending will be included in the allowed revenue requirement, and the rates taking effect in 2008 should include an amount that will recover the utility's budgeted program costs over the course of the year based on the level of annual sales estimated in the rate case. Although actual program expenses rarely match the amount of revenue collected for those programs in real-time, in principle, program expenses incurred will match revenue received by the end of the year. This approach works best when annual energy efficiency expenditures are constant on average.

4.2.2 Balancing Accounts with Periodic True-Up

Practice rarely matches principle, however, particularly with respect to energy efficiency program costs. The estimates of program costs used as the basis for setting rates are based in large part on assumed customer participation in the efficiency programs. However, participation is difficult to predict at a level of precision that ensures that annual expenditures will match annual revenue, especially in the early years of programs. Under-recovery of expenses occurs if participation in programs exceeds estimates and actual program costs rise. Regulatory commissions and utilities frequently have implemented various types of balancing mechanisms to ensure that customers do not pay for costs never incurred, and that utilities are not penalized because participation and program costs exceeded estimates. Such approaches also enable utilities to more flexibly ramp program activity (and associated spending) up or down. These mechanisms also often include some type of periodic prudence review to ensure that costs incurred in excess of those estimated in the rate case were prudently incurred.

The mechanics of a balancing account can work in a number of ways. Balances can simply be carried (typically with an associated carrying charge) until the next rate case, at which point they are "trued-up."[3] A positive balance could be used to reduce the level of expenses authorized for recovery in the future period, and a negative balance could be added in full to the authorized revenues for the future period or could be amortized. Alternatively, the balances can be self-adjusting by using a surcharge or tariff rider (discussed below), and some states allow annual true-up outside of general rate case proceedings.[4]

4.2.3 Pros and Cons

Table 4-1 describes general pros and cons associated with the expensing of program costs.

4.2.4 Case Study: Arizona Public Service Company (APS)

In June 2003, APS filed an application for a rate increase and a settlement agreement was signed between APS and the involved parties in August 2004. The settlement addresses DSM and cost recovery, allowing $10 million each year in base rates for eligible expenses, as well as an adjustment mechanism for program expenses beyond $10 million.

- The settlement agreement embodied in Order No. 67744 issued in April of 2005, under Docket No. E-01345A-03-0437[5] includes the following provisions:
- Included in APS' total test year settlement base rate revenue requirement is an annual $10 million base rate DSM allowance for the costs of approved "eligible DSM-related items," defined as the planning, implementation, and evaluation of programs that reduce the use of electricity by means of energy efficiency products, services, or practices. Performance incentives are included as an allowable expense.

Table 4-1. Pros and Cons of Expensing Program Costs

Pros

- Expensing treatment is generally consistent with standard utility cost accounting and recovery rules.
- Avoids the creation of potentially large regulatory assets and associated carrying costs.
- Provides more-or-less immediate recovery of costs and reduces recovery risk.
- The use of balancing mechanisms outside of a general rate case ensures more timely recovery when efficiency program costs are variable and prevents significant over- or under-recovery from being carried forward to the next rate case.

Cons

- A combination of infrequent rate cases and escalating expenditures can lead to under-recovery absent a balancing mechanism.
- Can be viewed as single-issue ratemaking.
- If annual energy efficiency expenditures are large, lump sum recovery can have a measurable short-term impact on rates.
- Some have argued that expensing creates unequal treatment between the supply-side investments (which are rate-based) and the efficiency investments that are intended to substitute for new supply.

- In addition to expending the annual $10 million base rate allowance, APS is obligated to spend, on average, at least another $6 million annually on approved eligible DSM-related items. These additional amounts are to be recovered by means of a DSM adjustment mechanism.
- All DSM programs must be pre-approved before APS may include their costs in any determination of total DSM costs incurred.
- The adjustment mechanism uses an adjustor rate, initially set at zero, which is to be reset on March 1, 2006, and thereafter on March 1 of each subsequent year. The adjustor is used only to recover costs in arrears. APS is required to file its proposal for spending in excess of $10 million prior to the March 1 adjustment. The per-kilowatt-hour charge for the year will be calculated by dividing the account balance by the number of kilowatt-hours used by customers in the previous calendar year.
- General Service customers that are demand-billed will pay a per-kilowatt charge instead of a per-kilowatt-hour charge. The account balance allocated to the General Service class is divided by the kilowatt billing determinant for the demand-billed customers in that class to determine the per-kilowatt DSM adjustor charge. The DSM adjustor applies to all customers taking delivery from the company, including direct access customers.

4.2.5 Case Study: Iowa Energy Efficiency Cost Recovery Surcharge

Until 1997, electric energy efficiency program costs were tracked in deferred accounts with recovery in a rate case via capitalization and amortization. Since then investor-owned utilities in Iowa, pursuant to Iowa Code 2001, Section 476.6,[6] recover energy efficiency program-related costs through an automatic rate pass-through reconciled annually to prevent over- or under-recovery (i.e., costs are expensed and recovered concurrently). Program costs are allocated within the rate classes to which the programs are directed, although certain program costs, such as those associated with low income and research and development programs, are allocated to all customers. The cost recovery surcharge is recalculated annually based on historical collections and expenses and planned budgets. The energy efficiency costs recovered from customers during the previous period are compared to those that were allowed to be recovered at the time of the prior adjustment. Any over- or under-collection, any ongoing costs, and any change in forecast sales, are used to adjust the current energy efficiency cost recovery factors. The statute requires that each utility file, by March 1 of each year, the energy efficiency costs proposed to be recovered in rates for the 12-month recovery period. This period begins at the start of the first utility billing month at least 30 days following Iowa Utility Board approval.

199 Iowa Administrative Code Chapter 35[7] provides the detailed cost recovery mechanism in place in Iowa. These details are summarized in Appendix D.

4.2.6 Case Study: Florida Electric-Rider Surcharge

The Florida Energy Efficiency and Conservation Act (FEECA) was enacted in 1980 and required the Florida Commission to adopt rules requiring electric utilities to implement cost-effective conservation and DSM programs. Florida Administrative Code Rules 25-17.001 through 25-17.015 require all electric utilities to implement cost-effective DSM programs. In June 1993, the commission revised the existing rules and required the establishment of numeric goals for summer and winter demand and annual energy sales reductions.

In order to obtain cost recovery, utilities are required to provide a cost-effectiveness analysis of each program using the ratepayer impact measure, total resource cost, and participant cost tests.

Investor-owned electric utilities are allowed to recover prudent and reasonable commission-approved expenses through the Energy Conservation Cost Recovery (ECCR) clause. The commission conducts ECCR proceedings during November of each year. The commission determines an ECCR factor to be applied to the energy portion of each customer's bill during the next calendar year. These factors are set based on each utility's estimated conservation costs for the next calendar year, along with a true-up for any actual conservation cost under- or over-recovery for the previous year (Florida PSC, 2007).

The procedure for conservation cost recovery is described by Florida Administrative Code Rule 25-17.015(1);[8] details are included in Appendix D. Table 4-2 shows the current cost recovery factors.

Florida Power and Light's (FPL's) recent cost recovery filing provides some insight into the nature of the adjustment process:

> FPL projects total conservation program costs, net of all program revenues, of $175,303,326 for the period January 2007 through December 2007. The net true-up is an over recovery of $4,662,647, which includes the final conservation true-up over recovery for January 2005, through December 2005, of $5,849,271 that

Table 4-2. Current Cost Recovery Factors in Florida

	Residential Conservation Cost Recovery Factor (cents per kWh)	Typical Residential Monthly Bill Impact (based on 1,000 kWh)
FPL	0.169	$1.69
FPUC	0.060	$0.60
Gulf	0.088	$0.88
Progress	0.169	$1.96
TECO	0.073	$0.73

Source: Florida PSC, 2007.

was reported in FPL's Schedule CT-1, filed May 1, 2006. Decreasing the projected costs of $175,303,326 by the net true-up over-recovery of $4,662,647 results in a total of $170,640,679 of conservation costs (plus applicable taxes) to be recovered during the January 2007, through December 2007, period. Total recoverable conservation costs and applicable taxes, net of program revenues and reflecting any applicable over- or under-recoveries are $170,705,441, and the conservation cost recovery factors for which FPL seeks approval are designed to recover this level of costs and taxes.

4.3 Capitalization and Amortization of Energy Efficiency Program Costs

Capitalization as a cost recovery method is typically reserved for the costs of physical assets such as generating plant and transmission lines. However, some states allow the costs of energy efficiency and demand-response programs to be treated as capital items, even though the utility is not acquiring any physical asset. In the case of an investor-owned utility, such capital items are included in the utility's rate base. The utility is allowed to earn a return on this capital, and the investment is depreciated over time, with the depreciation charged as an expense. Depending on precisely how a capitalization mechanism is structured, it can serve as a strict cost-recovery tool or as a utility performance incentive mechanism as well. A principle argument made in favor of capitalizing energy efficiency program costs is that this treatment places demand-and supply-side expenditures on an equal financial footing.[9,10]

Capitalization[11] currently is not a common approach to energy efficiency program cost recovery, although during the peak of the last major cycle of utility energy efficiency investment during the late 1980s and early 1990s many states allowed or required capitalization.[12]

Capitalization of energy efficiency costs as a cost recovery mechanism first appeared in the Pacific Northwest (Reid, 1988). Oregon and Idaho were the first two states to allow capitalization of certain selected costs in the early 1980s. Washington soon followed with statutory authority for ratebasing that included authorization for a higher return on energy efficiency investments. Puget Power1[3] in Washington was allowed to ratebase all of its energy efficiency–related costs using a 10-year recovery period with no carrying charges applied to the costs incurred between rate cases. Montana followed Washington in 1983 and adopted a similar mechanism. In 1986, Wisconsin switched from expensing the conservation expenditures to capitalization and allowed a large amount of direct investment to be capitalized with a 10-year amortization period.

With a very few exceptions, capitalization is no longer the method of choice for energy efficiency cost recovery in these states. The decline in the popularity of this approach can be attributed to a variety of factors, including the general decline in utility energy efficiency investment. However, in several states capitalization was abandoned, in part because the total costs associated with recovery (given the cost of the return on investment) were rising rapidly.

4.3.1 The Mechanics of Capitalization

As a simplified example, suppose that a utility spends $1 million in each of five years for its energy efficiency programs, and it is allowed to capitalize and amortize these investments over a 10-year recovery period uniformly. Table 4-3 illustrates the yearly change in revenue requirements, assuming a 10 percent rate of return on the unrecovered balance.

By the end of the 15-year amortization period, the total amount collected by the utility through rates is $7,250,000. Just as the total cost of purchasing a home will be lower with a shorter mortgage, shorter amortization periods yield a lower total cost for recovery of the energy efficiency program expenditures. Similarly, although the total amount recovered is almost 50 percent higher in this case than the direct cost of the energy efficiency program, the $2,250,000 represents a legitimate cost to the utility which comes from the need to carry an unrecovered balance on its books. Conceptually, a utility will be indifferent to immediate recovery of program costs as an expense and capitalization, as the added cost of capitalization should be equal to the cost to the utility of effectively lending the $5 million to customers. However, in the cases of those states that have allowed utilities to earn a return on energy efficiency investments that exceeds their weighted cost of capital, this added return constitutes an incentive for investment in energy efficiency that goes beyond that provided for traditional capital investments.

4.3.2 Issues

The length of time over which an energy efficiency investment is amortized (essentially the rate of depreciation), and the capital recovery rate or rate-of-return on the unamortized balance of the investment, both affect the total cost to customers of the utility.

Amortization and Depreciation

When an expenditure is capitalized, the recovery of this expenditure is spread over several years, with predetermined amounts recovered in rates each year during the recovery or amortization period. The depreciation or amortization rate is the fraction of unrecovered cost that is recovered each year. Tax law and regulation generally govern the specific rate used for different types of capital investments such as generating or distribution plant and equipment and other physical structures. However, since the costs of energy efficiency programs typically are not considered capital items, there is no universally accepted depreciation rate applied to energy efficiency program costs that are capitalized. An early study (Reid, 1988) of energy efficiency capitalization found that amortization programs for conservation expenditures ranged from three to 10 years. For example, Washington and Wisconsin allowed a 10-year recovery period for amortization.

Table 4-3. Illustration of Energy Efficiency Investment Capitalization

End-of-year	Annual Energy-Efficiency Expenditure	Cumulative Energy-Efficiency Expenditure	Depreciation	Unamortized Balance	Return on Unrecovered Investment	Incremental Revenue Requirements
1	1,000,000	1,000,000	$100,000	$900,000	$90,000	$190,000
2	1,000,000	2,000,000	$200,000	$1,700,000	$170,000	$370,000
3	1,000,000	3,000,000	$300,000	$2,400,000	$240,000	$540,000
4	1,000,000	4,000,000	$400,000	$3,000,000	$300,000	$700,000
5	1,000,000	5,000,000	$500,000	$3,500,000	$350,000	$850,000
6			$500,000	$3,000,000	$300,000	$800,000
7			$500,000	$2,500,000	$250,000	$750,000
8			$500,000	$2,000,000	$200,000	$700,000
9			$500,000	$1,500,000	$150,000	$650,000
10			$500,000	$1,000,000	$100,000	$600,000
11			$400,000	$600,000	$60,000	$460,000
12			$300,000	$300,000	$30,000	$330,000
13			$200,000	$100,000	$10,000	$210,000
14			$100,000	$0	$0	$100,000
15/Total	5,000,000		$5,000,000		$2,250,000	$7,250,000

Massachusetts used the lifetime of the energy efficiency equipment for the recovery period.

Rate of Return[14]

Just as the interest rate on a home mortgage can greatly affect both the monthly payment and the total cost of the home, the rate of return allowed on the unamortized cost of an energy efficiency program can significantly affect the cost of that program to ratepayers. Rates-of-return for investor-owned utilities are set by state regulators based on the relative costs of debt and equity. In the case of publicly and cooperatively owned utilities, the return much more closely mirrors the cost of debt. The ROE, in turn, is based on an assessment of the financial returns that investors in that utility would expect to receive—an expectation that is influenced by the perceived riskiness of the investment. This riskiness is related directly to the perceived likelihood that a utility will, for some reason, not be able to earn enough money to pay off the investment.

Unless the level of energy efficiency program investment is significant relative to a utility's total unamortized capital investment, the relative riskiness of energy efficiency versus supply-side investments is not a major issue. However, if this investment is significant, the relative risk of an energy efficiency investment can become an issue for a variety of reasons, including:

- These resources are not backed by physical assets. While a utility actually owns gas distribution mains or generating plants, it does not own an efficient air conditioner that a customer installs through a utility program. If energy efficiency spending is accrued for future recovery, either by expensing or amortization, this accrual is considered as a "regulatory asset"—an asset created by regulatory policy that is not backed by an actual plant or equipment. Carrying substantial regulatory assets on the balance sheet can hurt a utility's financial rating.
- The investment becomes more susceptible to disallowance. Recovery of a capital investment typically is allowed only for investments deemed prudent and used-and-useful. Because energy efficiency programs are based on customer behavior, and because that behavior is difficult to predict, it is possible that the investment being recovered does not actually produce its intended benefit. This result could lead regulators to conclude that the investment was not prudent or used-and-useful. This risk owes more to the fact that energy efficiency program effectiveness is subject to ex post evaluation. As program design and implementation experience grows, program realization rates (the ratio of actual to expected savings) increases, and this risk diminishes. It is not clear that this risk is any different with respect to its ultimate effect than the risks associated with the construction and operation of a utility plant.
- Potential uncertainty arising from policy changes that govern energy efficiency incentive mechanisms heightens the risk. Although both supply- and demand-side resources are subject to policy risk, the modularity and short lead-times associated with demand-side resources (which is a distinct benefit from a resource planning perspective) also create more opportunities to revisit the policies governing energy efficiency expenditure and cost recovery. The fact that energy efficiency program costs are regulatory assets in theory, means that the regulatory policy underlying those assets can change with changes in the regulatory environment. The pressure to modify policies governing recovery of program costs has increased historically as the size of these assets has grown with increases in program funding.

4.3.3 Pros and Cons

Based on experience to date, capitalization and amortization carries pros and cons as illustrated in Table 4-4.

4.3.4 Case Study: Nevada Electric Capitalization with ROE Bonus

Nevada is the only state currently that allows recovery of energy efficiency program costs using capitalization *as well as* a bonus return on those costs. Development and administration of energy efficiency programs by Nevada's regulated electric utilities takes place within the context of an integrated resource planning process combined with a resource portfolio standard that allows energy efficiency programs to fulfill up to 25 percent of the utilities' portfolio requirements. Over the past several years spending on energy efficiency programs has risen substantially, both as a response to rapid growth in electricity demand and as Nevada Power and Sierra Pacific Power have attempted to maximize the contribution of energy efficiency to portfolio requirements as those requirements grow.

All prudently incurred costs associated with energy efficiency programs are recoverable pursuant to the Nevada Administrative Code 704.9523. A utility may seek to recover any costs associated with approved programs for conservation and DSM, including labor, overhead, materials, incentives paid to customer, advertising, and program monitoring and evaluation.

Mechanically, the Nevada mechanism works as follows for those approved programs not already included in a utility's rate base:

- The utility tracks all program costs monthly in a separate account.
- A carrying cost equal to 1/12 of the utility's annual allowed rate of return is applied to the balance in the account.
- At the time of the next rate case, the balance in the account (including program costs and carrying costs) is cleared from the tracking account and moved into the utility's rate base.
- The commission sets an appropriate amortization period for the account balance based on its determination of the life of the investment.
- The utility applies a rate of return to the unamortized balances equal to the authorized rate of return plus 5 percent (for example a 10.0 percent return becomes 10.5 percent).

Nevada's current cost recovery/incentive structure has been in place since 2001. However, with the recent rapid rise in utility energy efficiency program spending, concerns also have arisen with respect to the structure of the mechanism and its effect on the utilities' investment incentives. These concerns prompted the Nevada Public Service Commission to open an investigatory docket in late 2006. In its Revised Order in Docket Nos. 06-0651 and 07-07010 on January 30, 2007, the commission wrote that:

Table 4-4. Pros and Cons of Capitalization and Amortization

Pros

- Places energy efficiency investments on more of an equal footing with supply-side investment with respect to cost recovery
- Capitalization can help make up for the decline in utility generation and transmission and distribution assets expected to occur, as energy efficiency defers the need for new supply-side investment.
- As part of this equalization, enables the utility to earn a financial return on efficiency investments.
- Smoothes the rate impacts of large swings in annual energy efficiency spending.

Cons

- Treats what is arguably an expense as a capital item.
- Creates a regulatory asset that can grow substantially over time; because this asset is not tangible or owned by utility, it tends to be viewed as more risky by the financial community.
- Delays full recovery and boosts recovery risk.
- To the extent that the return on the energy efficiency program investment is intended to provide a financial incentive for the utility, this incentive is not tied to program performance.
- Raises the total dollar cost of the efficiency programs.

> [We] believe that appropriate incentives for utility DSM programs are necessary. The exact nature and form of incentives that should be offered for such programs involve a number of factors, including the regulatory and statutory environment. The current incentives for DSM were implemented in 2001 when the companies had few, if any, incentives to implement DSM programs. The enactment of A.B. 3 changed both the regulatory and statutory context. Utilities now have incentives to implement DSM to meet portions of their respective renewable portfolio standard requirements. Nevada Power Company's expenditures will increase almost four times compared to pre A.B. 3 during this action plan. Given these changes, it is now time to reexamine the mandatory package of incentives provided to DSM programs. This includes the types and categories of costs eligible for expense treatment, as well as prescribed incentives. The commission therefore directs its secretary to open an investigation and rulemaking into the appropriateness of DSM cost recovery mechanisms and incentives.

In early 2007, the commission asked all interested parties to comment on four specific issues, as identified below:

- What are the public policy objectives of an incentive structure? i.e., Should only the most cost-effective programs be incented? Should only the most strategic programs be incented?
- Does the current incentive structure provide the appropriate incentives to fulfill each public policy objective?
- Are there alternative incentive structures that the commission should consider? If so, what are these incentives and how would each further the goals identified above?
- How should the current incentive structure be redesigned? i.e., what expenses should be included in the incentive mechanism? What should be the basis for determining incentives?

Commission staff have argued that the underlying rationale for utility energy efficiency investments is found in the integrated resource planning process. Staff noted that utilities should be inclined to pursue those programs that contribute to the least-cost resource mix. The addition of the resource portfolio requirement and the ability to meet up to 25 percent of that requirement provides further incentive to pursue energy efficiency investment. At the same time, staff argued that the current cost recovery mechanism, with the addition of the five percentage point rate of return bonus, provided no incentive for effective program performance and in fact, simply encouraged additional spending with no consideration for the implementation outcome—an argument echoed by the Attorney General's Bureau of Consumer Protection. Staff recommended that the ideal solution is to tie incentives to program performance and to share program net benefits with ratepayers.

Nevada Power Company and Sierra Pacific Power Company have endorsed the existing mechanism as providing appropriate incentives to fulfill the public policy objective of achieving a net benefit for customers while providing a stable and motivating incentive for the utility. According to the companies, the current incentive scheme with the bonus rate of return recognizes the increased risks associated with DSM investments compared to the supply-side investments, and they argue that changing the existing incentive structure will create uncertainty and therefore, increase the perceived risk associated with energy efficiency investments. They further argue that the integrated resource plan review process ensures that program budgets are given detailed review.

4.4 Notes

1. Depreciation of capital equipment is, however, treated as an expense.
2. An "opt-out" allows a customer, typically a large customer, to elect to not participate in a utility program and to avoid paying associated program costs. Some states do not allow opt-outs, but will allow large customers to spend the monies that otherwise would be collected from them by utilities for efficiency projects in their own facilities. This often is called "self-direction."
3. Wisconsin investor-owned utilities use "escrow accounting" as a form of a balancing account. Should the Public Service

Commission authorize a utility to incur specific program costs during a period between rate cases, these costs are recorded in an escrow account. Carrying charges are applied to the balance. The balance of the escrow account is cleared into the revenue requirement at the time of the next rate case (typically every two years).

4. As discussed elsewhere in this paper, addressing recovery of program costs as a separate matter apart from all other utility cost changes could be considered single-issue ratemaking which can be prohibited.

5. Order No. 67744, *In the Matter of the Application of the Arizona Public Service Company for a Hearing to Determine the Fair Value of the Utility Property of the Company for Ratemaking Purposes, to Fix a Just and Reasonable Rate of Return Thereon, to Approve Rate Schedules Designed to Develop such Return, and for Approval of Purchased Power Contract,* Docket No. E-01345-A-03-0437, accessed at <www.azcc.gov/divisions/utilities/electric/APS-FinalOrder.pdf>.

6. Iowa Code 2001: Section 476.6, accessed at <www.legis.state.ia.us/IACODE/2001/476/6.html>.

7. 199 Iowa Administrative Code Chapter 35, accessed at <www.legis.state.ia.us/Rules/Current/iac/199iac/19935/19935.pdf>.

8. Florida Administrative Code Rule 25-17.015(1), accessed at <www.flrules.org/gateway/RuleNo.asp?ID=25-17.015>.

9. Some have argued that capitalization and amortization of energy efficiency program costs provides an incentive to utilities to invest in energy efficiency without regard to the performance of the programs. See the Nevada case study below for a broader treatment of this issue.

10. From a narrow theoretical perspective, there should be no significant financial difference between expensing and capitalization. The return on capital is intended to compensate a utility for the cost of money used to fund an activity. For investor-owned utilities, this compensation includes payment to equity investors. However, if program expenses are immediately expensed—that is, if the utility can immediately recover each dollar it expends on a program—the utility does not need to "advance" capital to fund the programs, and therefore, there is no cost incurred by the utility.

11. This Report uses the generic term "capitalization" as opposed to "ratebasing," since, in some states, energy efficiency program costs technically are not included in a utility's rate base but are treated in a similar fashion via capitalization.

12. The following states either have used in the past or continue to use some form of capitalization of energy efficiency costs: Oregon, Idaho, Washington, Montana, Texas, Wisconsin, Nevada, Oklahoma, Connecticut, Maine, Massachusetts, Vermont, and Iowa. With the exception of Nevada, most of these states are no longer using capitalization, though it remains an option. See Reid, M. (1988). *Ratebasing of Utility Conservation and Load Management Programs. The Alliance to Save Energy.*

13. Puget Power is now known as Puget Sound Energy.

14. "Rate of return" is used in this context to refer to the rate applied to an unamortized balance that is used to represent the cost of money to the utility. In the case of investor-owned utilities, this rate is usually a weighted average of the interest rate on debt and the allowed return on equity.

5: Lost Margin Recovery

This chapter provides a practical overview of alternative mechanisms to address the recovery of lost margins and presents their pros and cons. Detailed case studies are provided for each mechanism.

5.1 Overview

Chapter 2 of the Action Plan provides a concise explanation of the throughput incentive and a summary of options to mitigate the incentive. This incentive has been identified by many as the primary barrier to aggressive utility investment in energy efficiency. Policy expectations that utilities aggressively pursue the implementation of energy efficiency programs create a conflict of interest for utilities in that they cannot fulfill their obligations to their shareholders while simultaneously encouraging energy efficiency efforts of their customers, which will reduce their sales and margins in the presence of the throughput incentive.

Any approach aiming to eliminate, or at least neutralize, the impact of the throughput incentive on effective implementation of energy efficiency programs must address the issue of lost margins due to successful energy efficiency programs. Two major cost recovery approaches have been tried since the 1980s with this objective in mind; *decoupling* and *lost revenue* recovery.[1] A third approach, known generically as *straight fixed-variable* (SFV) ratemaking, conceptually provides a solution to the problem by allocating most or all fixed costs to a fixed (non-volumetric) charge. Under such a rate design, reductions in the volume of sales do not affect recovery of fixed costs. While conceptually appealing, this approach carries with it complex implementation issues associated with the transition from a structure that recovers fixed costs via volumetric charges to a SFV structure. It also can reduce the financial incentive for end-users to pursue energy efficiency investments by reducing the value that consumers realize by reducing the volume of consumption—an issue more likely to impact electricity consumers than gas customers, since commodity cost represents a larger share of a consumer's total gas bill. While it has seen application in the natural gas industry, SFV ratemaking is uncommon in the electric industry (see American Gas Association, 2007).

5.2 Decoupling

The term "decoupling" is used generically to represent a variety of methods for severing the link between revenue recovery and sales. These methods vary widely in scope, and it is rare that a mechanism fully decouples sales and revenues. Some approaches provide for limited true-ups in attempts to ensure that utilities continue to bear the risks for sales changes unrelated to energy efficiency programs. Some focus on preserving recovery of lost margins. This focus recognizes that a sales reduction will be accompanied by some cost reduction, and therefore, the total revenue requirement will be lower. Truing up total revenue would, in such cases, boost utility earnings.

In recent years, decoupling has re-emerged as an approach to address the margin recovery issue facing utilities implementing substantial energy efficiency program investments. Decoupling can be defined generally as a separation of revenues and profits from the volume of energy sold and, in theory, makes a utility indifferent to sales fluctuations. Mechanically, decoupling trues-up revenues via a price adjustment when actual sales are different than the projected or test year levels.

Decoupling mechanisms appear under various names including the following listed by the National Regulatory Research Institute (Costello, 2006): Conservation Margin Tracker; Conservation-Enabling Tariff; Conservation Tariff; Conservation Rider; Conservation and Usage Adjustment

(CUA) Tariff; Conservation Tracker Allowance; Incentive Equalizer; Delivery Margin Normalization; Usage per Customer Tracker; Fixed Cost Recovery Mechanism; and Customer Utilization Tracker. Although often cited as a solution to the throughput issue raised by energy efficiency programs, decoupling is also a mechanism that often is generally suggested as a way to smooth earnings in the face of sales volatility. Natural gas utilities have been among the strongest advocates of decoupling because of its ability to moderate the impacts of abnormal weather and declining usage per customer, in addition to its ability to mitigate the under-recovery of fixed costs caused by energy efficiency programs (see American Gas Association, 2006a).

A decoupling mechanism will sometimes include a balancing account in order to ensure the exact collection of the revenue requirement, although this approach typically is used only if there is an extended period between rate adjustments. If revenues collected deviate from allowed revenues, the difference is collected from or returned to customers through periodic adjustments or reconciliation mechanisms. If a successful energy efficiency program reduces sales, there will not be any loss in revenue resulting from these energy efficiency programs. If sales turn out to be higher than the projected, the excess revenue is returned to the ratepayer.

There are two major forms of revenue decoupling—those linked to total revenue and those focused on revenue per customer: the revenue a utility is allowed to earn is capped in the former, and the revenue per customer is capped in the latter. The primary advantage of a revenue-per-customer model is that it recognizes the link between a utility's revenue requirement and its number of customers. For example, if a decoupling mechanism caps total revenue, and if the utility experiences a net increase in customers, all else being equal, the allowed level of revenue will fall short of the cost of serving the additional customers, leading to a drop in earnings. A revenue-per-customer mechanism allows total revenue to grow (or fall) as the number of customers and associated costs rise (fall).

Table 5-1 shows a simple example (constructed similarly to the example in Eto et al., 1994) illustrating the basic decoupling mechanism with a balancing account.

For year 1, the revenue requirement of $100 is authorized through the general rate case. Given projected sales of 1,000 therms, the price is determined to be 10

Table 5-1. Illustration of Revenue Decoupling

		A	B	C (A÷B)	D	E (D÷B)	F	G (E×F)	H (G–A)	I (D–G)
	Year	Revenue Requirements	Expected Sales (Therms)	Price Set in the Rate Case (Therms)	Allowed to Collect	Actual Price ($/Therm)	Actual Sales (Therms)	Actual Revenue	Changes Between Revenue Requirement and Actual Revenue	Balance Account
Rate Case 1	1	$100.00	1,000	0.100	$100.00	0.100	1,100	$110.00	$10.00	-$10.00
	2	$100.00	1,000	0.100	$90.00	0.090	990	$89.10	-$10.90	$0.90
Rate Case 2	3	$111.10	1,010	0.110	$112.00	0.111	1,010	$112.00	$0.90	$0.00

cents/therm. If actual sales are 1,100 therms, then at the rate of 0.1 $/therm, the actual realized revenue is $110. The utility places the $10 difference between the actual revenue and the allowed revenue in a balancing account. The next year, the utility needs to collect only $90 to reach the $100 authorized revenue and the price per therm is set at 9 cents. If the sales were indeed 1,000 therms, the utility would make $90, and with the $10 in the balancing account, it would exactly meet the authorized revenue. However, in this example, the sales are 990 therms, and utility revenue is $89.10 at 9 cents/therm. The utility needs to collect 90 cents from the ratepayers.

Suppose that the revenue requirement is reset to $111.10 at the projected sales level of 1,010 therms. The utility needs to collect the balance in the balancing account and its authorized revenue of $111.10, a total of $112. At the projected sales level of 1,010, the price needs to be set at 11.1 cents per therm to recover $112. Suppose that the utility's sales are actually equal to the projected sales of 1,010. The utility recovers exactly $112 and there is a zero balance left in the balancing account.

Under the revenue-per-customer cap approach, the actual revenues collected *per customer* are compared to the authorized revenues *per customer,* and the balancing account maintains the over- or under-earnings. A simple example of the revenue cap-per-customer approach is illustrated in Table 5-2.

In this example, the revenue per customer to be collected is fixed or capped. Assuming monthly adjustments, actual revenues collected per customer are compared

Performance-Based Ratemaking and Decoupling

Performance-Based Ratemaking (PBR) is an alternative to traditional return on rate base regulation that attempts to forego frequent rate cases by allowing rates or revenues to fluctuate as a function of specified utility performance against a set of benchmarks. One form of PBR embodies a revenue cap mechanism that functions very much like a decoupling, wherein price is allowed to fluctuate as a way to true-up actual revenues to allowed revenues. The revenue-cap PBR mechanism can be more complex, incorporating a variety of specific adjustments to both price and revenue. In most cases, if a utility operates under revenue-cap PBR, sales and revenues are decoupled for purposes of energy efficiency investment, although specific adjustments may be required to allow prices to be adjusted for changes in actual program costs as well as changes in margins.

Table 5-2. Illustration of Revenue per Customer Decoupling

A		Revenue requirements ($)	100
B		Expected sales (therms)	1,000
C	**(A÷B)**	Price set in the rate case ($/therm)	0.1
D		Number of customers	100
E	**(A÷D)**	Allowed revenue per customer ($/therm)	1
F		Actual sales (therms)	950
G	**(C×F)**	Actual revenue ($)	95
H		Actual number of customers	101
I		Allowed revenue ($)	101
J	**(I–G)**	Revenue adjustment ($)	6

to the allowed revenue per customer for that month. The difference is recorded in a balancing account and reconciled periodically. In this case, because of customer growth, the utility is allowed to collect $6 more than the initial revenue requirement.

Revenue decoupling has been a part of gas ratemaking for over two decades, with revenue cap-per-customer the more commonly encountered approach.[2] Interest has increased over the past several years due to increased customer conservation in response to high gas prices and utility-funded energy efficiency initiatives. In addition, natural gas usage per household has declined more than 20 percent since the 1980s and is projected to continue to decline in the future in many jurisdictions (Costello, 2006). In such cases, decoupling provides an automatic adjustment mechanism that allows the utility to be revenue neutral and can help defer otherwise needed rate cases.

Early experience with decoupling, as recounted in Chapter 2 of the Action Plan, provides important lessons.[3] In 1991, the Maine PUC adopted a revenue decoupling mechanism in the form of revenue-per-customer cap for Central Maine Power (CMP) on a three-year trial basis. The utility's allowed revenue was determined through a rate case and adjusted annually in accordance with changes in the number of customers. CMP was allowed to file a rate case at any time to adjust its authorized revenues. With the economic downturn Maine experienced around the time the mechanism was in place, sales dipped significantly leading to a large unrecovered balance ($52 million by the end of 1992) that needed to be charged to the ratepayers. In fact, the portion of the energy efficiency-related drop in the sales was very small. Nevertheless, the program in its entirety was terminated in 1993.

Currently, a number of jurisdictions are investigating the advantages and disadvantages of decoupling, including Arizona, Colorado, Delaware, the District of Columbia, Delaware, Hawaii, Kentucky, Maryland, Michigan, New Hampshire, New Mexico, Pennsylvania, Tennessee, and Virginia. Sixteen states have adopted either gas or electric decoupling programs for at least one utility. Arkansas, New York, Utah, Oregon, Washington, Idaho, and Minnesota are among the states recently adopting decoupling programs.[4]

Table 5-3 suggests the possible pros and cons of decoupling. The specific nature of the decoupling mechanism and, in particular, the nature of adjustments for factors such as weather and economic growth, will determine the extent to which the link between sales and profits is affected.

5.2.1 Case Study: Idaho's Fixed Cost Recovery Pilot Program

The mechanism adopted in Idaho to address the impacts of efficiency program-induced changes in sales should not be viewed as decoupling in the broadest sense of that term. While it contains a number of the elements found in decoupling plans, it is focused specifically on recovery of lost fixed-cost revenues. The Idaho Public Utilities Commission initiated Case No. IPC-04-15 in August 2004, to investigate financial disincentives to investment in energy efficiency by Idaho Power Company. A series of workshops was conducted, and a written report was filed with the commission in early 2005. The report pointed to two action items:

1. The development of a true-up simulation to track what might have occurred if a decoupling or true-up mechanism had been implemented for Idaho Power at the time of the last general rate case.
2. The filing of a pilot energy efficiency program that would incorporate both performance incentives and fixed-cost recovery.

During the investigation, the parties agreed that there were disincentives preventing higher energy efficiency investment by Idaho Power, but no agreement was reached on whether or not the return of lost fixed-cost revenues would result in removing the disincentives. The parties agreed to conduct a simulation of the proposed mechanism, the results of which indicated that lost fixed-cost revenues, in fact, produced barriers to energy efficiency investments and, therefore, a three-year pilot mechanism to allow recovery of fixed-cost revenue losses should be approved.

Table 5-3. Pros and Cons of Revenue Decoupling

Pros

- Revenue decoupling weakens the link between sales and margin recovery of a utility, reducing utility reluctance to promote energy efficiency, including building codes, appliance standards, and other efficiency policies.
- Through decoupling, the utility's revenues are stabilized and shielded from fluctuations in sales. Some have argued that this, in turn, might lower its cost of capital.[5] (For a discussion of this issue, see Hansen, 2007, and Delaware PSC, 2007). The degree of stabilization is a function of adjustments made for weather, economic growth, and other factors (some mechanisms do not adjust revenues for weather or economic growth-induced changes in sales).[6]
- Decoupling does not require an energy efficiency program measurement and evaluation process to determine the level of under-recovery of fixed costs.[7]
- Decoupling has a low administrative cost relative to specific lost revenue recovery mechanisms.
- Decoupling reduces the need for frequent rate cases and corresponding regulatory costs.

Cons

- Rates (and in the case of gas utilities, non-gas customer rates) can be more volatile between rate cases, although annual caps can be instituted.
- Where carrying charges are applied to balancing accounts, the accruals can grow quickly.
- The need for frequent balancing or true-up requires regulatory resources; may be a lesser commitment than required for frequent rate cases.

Idaho Power filed an application with the Idaho Public Utilities Commission in January of 2006, and requested authority to implement a fixed cost adjustment (FCA) decoupling or true-up mechanism for its residential and small General Service customers. The commission staff, the NW Energy Coalition, and Idaho Power negotiated a settlement agreement, and the commission approved a Joint Motion for Approval of Stipulation in December 2006.

The commission issued Order No. 30267 (Idaho PUC, 2007) approving the FCA as a three-year pilot program, noting that either staff or Idaho Power can request discontinuance of the pilot. Program implementation began on January 1, 2007, and will last through December 31, 2009, plus any carryover. The first rate adjustment will occur June 1, 2008, and subsequent rate adjustments will occur on June 1 of each year during the term of the pilot.

The proposed FCA is applicable to residential service and small General Service customers because, as the company noted, these two classes present the most fixed-cost exposure for the company. The FCA is designed to provide symmetric rate adjustment (up or down) when fixed-cost recovery per customer varies above or below a commission-established level. While this approach fits the conventional description of a decoupling mechanism, Idaho Power noted that a more accurate description of the mechanism is a "true-up." The fixed-cost portion of the revenue requirement would be established for residential and small General Service customers at the time of a general rate case. Thereafter, the FCA would provide the mechanism to true-up the collection of fixed costs per customer to recover the difference between the fixed costs actually recovered through rates and the fixed costs authorized for recovery in the company's most recent general rate case. The FCA mechanism incorporates a 3 percent cap on annual increases, with carryover of unrecovered deferred costs to subsequent years.

The actual number of customers in the adjustment year for each customer class to which the mechanism applies is multiplied by the assumed fixed cost per customer, which is determined by dividing the total fixed costs by the total number of customers from the last general rate case. This allowed fixed-cost recovery amount is compared with the amount of fixed costs actually recovered by the Idaho Power. The actual fixed-cost recovery is determined by multiplying the weather-normalized sales for each class by the fixed-cost per kilowatt-hour rate also determined in the general rate case. The difference between the allowed and the actual fixed-cost recovered amounts is the fixed-cost adjustment for each class.

For customer billing purposes only, the commission-approved FCA adjustment is combined with the conservation program funding charge.

While recognizing the potential value of the true-up mechanism, parties have taken a cautious approach that allows the company and the commission to gain experience in implementing, monitoring, and evaluating the program. And, since the program is a pilot, program corrections or cessation will take place if it is found unsuccessful or if unintended consequences develop. From the commission's perspective, the company must demonstrate an "enhanced commitment" to energy efficiency investment resulting from implementation of the FCA, including making efficiency and load management programs widely available, supporting building code improvement activity, pursuing appliance standards, and expanding of DSM programs.

Despite the approval of the pilot, the commission staff raised a number of the technical issues related to the relationship between energy efficiency program implementation and the application of the true-up mechanism. Given that the success of the mechanism is being determined in part by how it affects the company's investment in energy efficiency, several issues were raised regarding how that commitment was to be measured and, specifically, how evidence of that commitment could be distinguished from factors affecting sales per customer unrelated to the company's energy efficiency efforts. The commission noted that FCA will require close monitoring, and the development of proper metrics to evaluate the company's performance remains an issue.

5.2.2 Case Study: New Jersey Gas Decoupling

A relatively novel decoupling mechanism has recently been approved in New Jersey. In late 2005, New Jersey Natural Gas (NJNG) and South Jersey Gas (SJG) jointly filed proposals with the New Jersey Board of Public Utilities to implement a CUA clause in a five-year pilot program. The CUA was proposed as a way to *"[s]eparate the companies' margin recoveries from throughput and to adjust margin recoveries for variances in customer usage, enabling the companies to aggressively promote conservation and energy efficiency by their customers"* (New Jersey BPU, 2006).

The companies, the New Jersey Utility Board Staff, and the Department of the Public Advocate reached a settlement agreement that was approved by the New Jersey Commission in October 2006. Through the settlement, the proposed CUA was modified and implemented on a three-year pilot basis and renamed as the Conservation Incentive Program (CIP). The CIP replaced the Weather Normalization Clause, which helped cover weather-related fluctuations. The CIP is an incentive-based program that:

- Requires the companies to implement shareholder-funded conservation programs designed to aid customers in reducing their costs of natural gas and to reduce each utility's peak winter and design day system demand.
- Requires the companies to reduce gas supply related costs.
- Allows the companies to recover from customers certain non-weather margin revenue losses limited to the level of gas supply cost savings achieved.

The companies are required to make annual CIP filings, based on seven months of actual data and five months of projected data, with a June 1 filing date. The filings are to document actual results, perform the required

CIP collection test, and propose the new CIP rate. Any variances from the annual filings will be trued up in the subsequent year. The board has reserved the right to review any aspect of the companies' programs, including, but not limited to, the sufficiency of program funding.

The CIP tariffs include ROE limitations on recoveries from customers for both the weather and non-weather-related components. In the case of South Jersey Gas, the ROE was set at the level of the company's most recent general rate case. The ROE for New Jersey Natural Gas was set at 10.5 percent (compared to its most recently authorized rate of 11.5 percent).

The most significant element of the CIP tariff is its requirement that, as a condition for decoupling, the utilities must reduce gas supply costs—the so-called Basic Gas Supply Service (BGSS) savings—such that consumers see no net change in costs.

The methodology employed to calculate the non-weather-related CIP surcharge, if any, is delineated in paragraph 33(a) of the stipulation. If the non-weather-related CIP recovery is less than or equal to the level of available gas cost savings, the amount will be eligible for recovery through the CIP tariffs. Any portion of the non-weather CIP value that exceeds the available gas cost savings will not be recovered in the current period, will be deferred up to three years, and will be subject to an eligibility test in the subsequent period. Deferred CIP surcharges may be recovered in a future period to the extent that available gas cost savings are available to offset the deferred amount. If the pilot is terminated after the initial period, any remaining deferred CIP surcharges will not be recovered. The value of any BGSS savings during one year in excess of the non-weather CIP value cannot be carried forward for use in future year calculations.

NJNG will provide $2 million for program costs and SJG will provide $400,000 for each year of the pilot program, all of which will come from shareholders. The companies are required to provide the full cost of the programs, even if the program costs exceed the budgeted levels.

In approving the stipulation, the commission concluded with the following:

> With the CIP and the possible recovery of non-weather-related margin losses, the utilities have represented that they will actively promote conservation and energy efficiency by their customers through programs funded by their shareholders. The programs are not to replicate existing CEP programs and are to include, among other things, customized customer communications and outreach built upon the utilities' relationships with their customers. While not replicating existing CEP programs, the CIP programs include initiatives that promote customers' use of CEP programs through consistent messaging with the CEP programs. At the same time, by limiting non-weather-related CIP recovery by gas supply cost reductions, in addition to an earnings cap, the CIP gives recognition to the nexus between reductions in long-term usage and reductions in gas supply capacity requirements. By limiting any non-weather CIP recovery to offsetting gas supply cost reductions, the CIP does not just provide the utilities with a mechanism for rate recovery but ensures that the CIP results in an appropriate, concomitant reduction in gas supply costs borne by customers. In this way, customers taking BGSS will not incur any overall net rate increases arising from non-weather related load losses.
>
> (New Jersey BPU, 2006)

New Jersey Resources (NJR) recently reported its experience with the CIP. NJNG, NJR's largest subsidiary, realized 6.6 percent increase in its first-quarter earnings over last year due primarily to the impact of the recently approved CIP. The company states in a recent press release that:

> [Our] conservation Incentive Program has performed as intended, and has resulted in lower gas costs for customers and improved financial results for our shareowners. This innovative program is another example of working in partnership with our regulators to help all our stakeholders.
>
> For the three months ended December 31, 2006, NJR earned $28.1 million, or $1.01 per basic share,

compared with $34.3 million, or $1.24 per basic share, last year. The decrease in earnings was due primarily to lower earnings at NJR's unregulated wholesale energy services subsidiary, NJR Energy Services (NJRES), partially offset by improved results at NJNG. NJNG earned $19.9 million in the quarter, compared with $18.7 million last year. The increase in earnings was due to the impact of the CIP and continued customer growth. Gross margin at NJNG included $11.3 million accrued for future collection from customers under the CIP.

Weather in the first fiscal quarter was 18.3 percent warmer than normal and 18.2 percent warmer than last year. "Normal" weather is based on 20-year average temperatures. As with the weather normalization clause which preceded it, the impact of weather is significantly offset by the recently approved CIP, which is designed to smooth out year-to-year fluctuations on both gross margin and customers' bills that may result from changing weather and usage patterns. Included in the CIP accrual was $8 million associated with the warmer-than-normal weather and $3.3 million associated with non-weather factors. However, customers will realize annual savings of $10.6 million in fixed cost reductions and commodity cost savings of approximately $15 million through the first fiscal quarter.

(NJR, 2007)

5.2.3 Case Study: Baltimore Gas and Electric

Baltimore Gas and Electric (BGE) has had a form of a revenue-per-customer decoupling mechanism in place since 1998 for its natural gas business. The Maryland PSC allowed BGE to implement a monthly adjustment mechanism that accounts for the effect of abnormal weather patterns on sales.

Commission Order 80460 describes Rider 8[8] as follows:

Rider 8 is a tariff provision that serves as a "weather/ number of customers adjustment clause." That is, when the weather is warmer, Rider 8 will increase BGE's revenues because gas demand is lower than normal. However, when the weather is colder than normal and gas demand is high, Rider 8 decreases BGE's revenues.

(Maryland PSC, 2005)

The mechanism is implemented through the Tariff Rider 8 or Monthly Rate Adjustment. The following explains the mechanism.

- The delivery price for residential service and for general service is adjusted to reflect test year base rate revenues established in the latest base rate proceeding, after adjustment to recognize the change in the number of customers from the test year level.
- The change in revenues associated with the customer charge is the change in number of customers multiplied by the customer charge for the rate schedule.
- The change in revenues associated with throughput is the test year average use per customer multiplied by the net number of customers added since the like-month during the test year, and multiplying that product by the delivery price for the rate schedule.
- The change in revenues associated with customer charge and throughput is added to test year revenue to restate test year revenues for the month to include the revised values.
- Actual revenues collected for the month are compared to the restated test year revenues and any difference is divided by estimated sales for the second succeeding month to obtain the adjustment to the applicable delivery price.
- Any difference between actual and estimated sales is reconciled in the determination of the adjustment for a future month.

5.2.4 Case Study: Questar Gas Conservation Enabling Tariff

On December 16, 2005, Questar Gas, the Division of Public Utilities, and Utah Clean Energy (UCE) filed an application seeking approval of a three-year (pilot) Conservation Enabling Tariff (CET) and DSM Pilot Program. On September 13, 2006, Questar Gas, the Division, UCE, and the committee filed the Settlement Stipulation. The settlement was approved by the commission in October 2006 (Utah PSC, 2006). The approval of the settlement put in place the CET (Questar Gas, n.d., Section 2.11, pages 2–17), which represents the authorized revenue-per-customer amount Questar is allowed to collect from General Service customer classes.

Questar's allowed revenue for a given month is equal to the allowed distribution non-gas (DNG) revenue per customer for that month multiplied by the actual number of customers. The difference between the actual billed General Services DNG revenue[9] and the allowed revenue for that month is the monthly accrual for that month. The formula to calculate the monthly accrual is shown below.

allowed revenue (for each month) =

allowed revenue per customer for that month × actual general services customers

monthly accrual = allowed revenue – actual general services DNG revenue

The accrual could be positive or negative.

For illustrative purposes, Table 5-4 shows the currently allowed DNG revenue per customer for each month of 2007.

For the purpose of keeping track of over- or under-recovery amounts on a monthly basis, the CET Deferred Account (Account 191.9) was established. At least twice a year, Questar will file with the commission a request for approval for the amortization of the amount accumulated in this account subject to the above formula. The amortization will be over a year, and the impacted customer class volumetric DNG rates will be adjusted by a uniform percentage increase or decrease. The balance in the account is subject to 6 percent annual interest rate or carrying charge applied monthly (0.5 percent each month).

The settlement states that there would be a 1-year review of the CET mechanism, and a technical workshop would be held in April 2007 commencing the 1-year evaluation process. The parties submitted testimony either supporting the continuation of the current CET mechanism beyond its first year of implementation, offering modifications or alternatives, or supporting discontinuation of the mechanism on June 1, 2007.

Table 5-4. Questar Gas DNG Revenue per Customer per Month

Month	DNG Revenue per Customer
January	$42.45
February	$34.03
March	$26.42
April	$20.34
May	$13.28
June	$10.25
July	$10.03
August	$9.44
September	$10.83
October	$15.48
November	$26.47
December	$36.51

Source: Questar Gas, n.d.

In testimony[10] filed by Questar supporting the continuation of the CET, the company stated the following benefits of the mechanism:

- CET allows Questar to collect the commission-allowed DNG revenue. During the first year before energy efficiency programs were in place, usage per customer increased, and over $1.7 million was credited back to customers.
- CET allows Questar to aggressively promote energy efficiency, and in 2007 the company launched six energy efficiency programs with a budget of about $7 million.
- CET aligns the interests of Questar and regulators for the benefit of customers.

Questar believes that the CET has been working as expected during its first year of implementation. The Utah Committee of Consumer Services filed testimony[11] on June 1, 2007, urging the discontinuation of the CET. The primary reason driving this recommendation is the alleged sales risk shift to consumers with little or no offsetting benefits for ratepayers assuming those risks.

As of the writing of this white paper, the proceeding is still in process and the commission is expected to reach a decision by October of 2007.

5.3 Lost Revenue Recovery Mechanisms

Lost revenue recovery mechanisms[12] are designed to recover lost margins that result as sales fall below test year levels due to the success of energy efficiency programs. They differ from decoupling mechanisms in that they do not attempt to decouple revenues from sales, but rather try to isolate the amount of under-recovery of margin revenues due to the programs. Simply put, the margin loss resulting from reductions in sales through the implementation of a successful energy efficiency program is calculated as the product of program-induced sales reductions and the amount of margin allocated per therm or kilowatt-hour in a utility's most recent rate case. In this sense, the shortfall in revenue recovery is treated as a cost to be recovered.

Although the disincentive to invest in successful efficiency programs might be removed, lost revenue recovery mechanisms do not remove a utility's disincentive to promote/support other energy saving policies, such as building codes and appliance standards, or their incentive to see sales increase generally, since the utility still earns more profit with additional sales.

One of the most important characteristics of a lost revenue recovery mechanism is that actual savings achieved from a successful energy efficiency program must be estimated correctly. Overestimates of savings will enable a utility to over-collect, and underestimates lead to under-collection of revenue. Unfortunately, reliance on evaluation creates two complications:

- While at its most rigorous, program evaluation produces a statistically valid estimate of actual savings. Rigorous evaluation can be expensive and, in any case, will not always be recognized as such by all parties.
- Because evaluation can only occur after an action has occurred, a process built on evaluation is one with potentially significant lags built in. It is possible to conduct rolling or real-time evaluations, albeit at considerable cost. In its least defensible applications, such mechanisms are applied with little or no independent evaluation and verification.

Despite these issues, several states have implemented lost revenue recovery mechanisms in lieu of decoupling as a way to address this barrier. For example, in January 2007, the Indiana Utility Regulatory Commission granted Vectren South's application for approval of a DSM lost margin adjustment factor for electric service.[13] Order Nos. 39201 and 40322 accepted the utility's request for a lost margin tracking mechanism. Recovery is done on a customer class and cost causation basis. Vectren South's total demand-side-related lost margin to be recovered through rates during the period February to April 2007 was $577,591.[14]

Perceived advantages and disadvantages of the lost revenue recovery mechanism are summarized in Table 5-5.

5.3.1 Case Study: Kentucky Comprehensive Cost Recovery Mechanism[15]

Kentucky currently allows lost revenue recovery for both electric and gas DSM programs as part of a comprehensive hybrid cost recovery mechanism. Under Kentucky Revised Statute 278.190, Kentucky's Public Service Commission determines the reasonableness of DSM plans that include components for program cost recovery, lost revenue recovery, and utility incentives for cost-effectiveness. The cost recovery mechanism can be reviewed as part of a rate proceeding, or as part of a separate, limited proceeding.

The DSM Cost Recovery Mechanism currently in effect for Louisville Gas and Electric Company (LG&E) is composed of factors for DSM program cost recovery (DCR), DSM revenue from lost sales (DRLS), DSM incentive (DSMI), and DSM balance adjustment (DBA). The monthly amount computed under each of the rate schedules to which this DSM Cost Recovery Mechanism applies is adjusted by the DSM Cost Recovery Component (DSMRC) at a rate per kilowatt-hour of monthly consumption in accordance with the following formula:

Table 5-5. Pros and Cons of Lost Revenue Recovery Mechanisms

Pros

- Removes disincentive to energy efficiency investment in approved programs caused by under-recovery of allowed revenues.
- May be more acceptable to parties uncomfortable with decoupling.

Cons

- Does not remove the throughput incentive to increase sales.
- Does not remove the disincentive to support other energy saving policies.
- Can be complex to implement given the need for precise evaluation, and will increase regulatory costs if it is closely monitored.
- Proper recovery (no over- or under-recovery) depends on precise evaluation of program savings

DSMRC = DCR + DRLS + DSMI + DBA

The DCR includes all expected costs approved by the commission for each 12-month period for DSM programs, including costs for planning, developing, implementing, monitoring, and evaluating DSM programs. Only those customer classes to which the programs are offered are subject to the DCR. The cost of approved programs is divided by the expected kilowatt-hour sales for the next 12-month period to determine the DCR for a given rate class.

- For each upcoming 12-month period, the estimated reduction in customer usage (in kilowatt-hours) as determined for the approved programs shall be multiplied by the nonvariable revenue requirement per kilowatt-hour for purposes of determining the lost revenue to be recovered hereunder from each customer class.
- The nonvariable revenue requirement for the Residential and General Service customer class is defined as the weighted average price per kilowatt-hour of expected billings under the energy charges contained in the rate RS, VFD, RPM, and General Services rate schedules in the upcoming 12-month period, after deducting the variable costs included in such energy charges.
- The nonvariable revenue requirement for each of the customer classes that are billed under demand and energy rates (rates STOD, LC, LC-TOD, LP, and LP TOD) is defined as the weighted average price per kilowatt-hour represented by the composite of the expected billings under the respective demand and energy charges in the upcoming 12-month period, after deducting the variable costs included in the energy charges.
- The lost revenues for each customer class shall then be divided by the estimated class sales (in kilowatt-hour) for the upcoming 12-month period to determine the applicable DRLS surcharge.
- Recovery of revenue from lost sales calculated for a 12-month period shall be included in the DRLS for 36 months or until implementation of new rates pursuant to a general rate case, whichever comes first.
- Revenues from lost sales will be assigned for recovery purposes to the rate classes whose programs resulted in the lost sales.
- Revenues collected under the mechanism are based on engineering estimates of energy savings, expected program participation and estimated sales for the upcoming 12-month period. At the end of each such period, any difference between the lost revenues actually collected hereunder, and the lost revenues determined after any revisions of the engineering estimates and actual program participation are accounted for, shall be reconciled in future billings under the DBA component.

DSMI is calculated by multiplying the net resource savings expected from the approved programs expected to be installed during the next 12-month period by 15 percent, not to exceed 5 percent of program expenditures. Net resource savings are equal to program benefits minus utility program costs and participant costs. Program benefits are calculated based on the present value of LG&E's avoided costs over the expected program life and includes capacity and energy savings.

The DBA is calculated for each calendar year and is used to reconcile the difference between the amount of revenues actually billed through the DCR, DRLS, DSMI, and previous application of the DBA. The balance adjustment (BA) amounts include interest applied to the bill amount calculated as the average of the "3-month commercial paper rate" for the immediately preceding 12-month period. The total of the BA amounts is divided by the expected kilowatt-hour sales to determine the DBA for each rate class. DBA amounts are assigned to the rate classes with under- or over-recoveries of DSM amounts.

The levels of the various DSM cost recovery components effective April 3, 2007, for LG&E's residential customers are shown in the Table 5-6.

5.4 Alternative Rate Structures

The lost margin issue arises because some or all of a utility's current fixed costs are recovered through volumetric charges. The most straightforward resolution to the issue is to design and implement rate structures that allocate a larger share of fixed costs to customer fixed charges. SFV rate structures allocate all current fixed costs to a per customer charge that does not vary with consumption. Alternatives to the SFV design employ a consumption block structure, which allocates costs across several blocks of commodity consumption and typically places most or all of the fixed costs within the initial block. This block is designed such that most customers will always consume more than this amount and, therefore, fixed costs will be recovered regardless of the level of sales in higher blocks (American Gas Association, 2006b). This produces a declining block rate structure.

Table 5-6. Louisville Gas and Electric Company DSM Cost Recovery Rates

DSM cost recovery component (DCR)	0.085 ¢/kilowatt-hour
DSM revenues from lost sales (DRLS)	0.005 ¢/kilowatt-hour
DSM incentive (DSMI)	0.004 ¢/kilowatt-hour
DSM balance adjustment (DBA)	(0.010)¢/kilowatt-hour
DSMRC rates	0.084 ¢/kilowatt-hour

Source: LG&E, 2004.

Such a rate design provides significant earnings stability for the utility in the short run, making it indifferent from a net revenue perspective to the customer's usage at any time. In this way, these alternative rate structures are similar to revenue decoupling; a utility has neither a disincentive to promote energy efficiency nor an incentive to promote increased sales. SFV and similar rate designs also are viewed by some as adhering more closely to a theoretically correct approach to cost allocation that sees fixed costs as a function of the number of customers or the level of customer demand.

This approach is most commonly discussed in the context of natural gas distribution companies, where fixed costs represent the costs to build out and maintain a distribution system. These costs tend to vary more as a function of the number of customers than of system throughput (American Gas Association, 2006c).[16] These alternative rate designs are more problematic when applied to integrated electric utilities, because fixed costs are in some cases related to the volume of electricity consumed. For example, the need for baseload capacity is driven by the level of energy consumption as much or more than by the level of peak demand. Practically, it is more difficult to allocate all fixed costs to a fixed customer charge, simply because such costs can be very

Table 5-7. Pros and Cons of Alternative Rate Structures

Pros
• Removes the utility's incentive to promote increased sales. • May align better with principles of cost-causation.
Cons
• May not align with cost causation principles for integrated utilities, especially in the long run. • Can create issues of income equity. • Movement to a SFV design can significantly reduce customer incentives to reduce consumption by lowering variable charges (applies more to electric than gas utilities).

high, and allocation to a fixed charge would impose serious ability-to-pay issues on lower income customers. Nevertheless, improvements in rate structures that better align energy charges with the marginal costs of energy will help reduce the throughput disincentive.

Given the overarching objective of capturing the net economic and environmental benefits of energy efficiency investments, SFV designs can significantly reduce a customer's incentive to undertake efficiency improvements because of the associated reduction in variable charges.

5.5 Notes

1. Also known as lost revenue or lost margin recovery.
2. The National Action Plan for Energy Efficiency.
3. Also see Chapter 6, "Utility Planning and Incentive Structures," in the *EPA Clean Energy-Environment Guide to Action.*
4. The Idaho Public Utilities Commission adopted a three-year decoupling pilot in March 2007, and in April 2007, the New York Public Service Commission ordered electric and natural gas utilities to file decoupling plans within the context of ongoing and new rate cases. The Minnesota legislature recently (spring 2007) enacted legislation authorizing decoupling. List of states is taken from the Natural Resources Defense Council's map of *Gas and Electric Decoupling in the US, June 2007.*
5. The design of the decoupling mechanism can address risk-shifting through the nature of the adjustments that are included. Some states have explicitly not included weather-related fluctuations in the decoupling mechanism (the utility continues to bear weather risk). In addition, recognizing that utility shareholder risk decreases with decoupling, some decoupling plans include provisions for capturing some of the risk reduction benefits for consumers. For example, PEPCO proposed (and subsequently withdrew a proposal for a 0.25 percent reduction in its ROE to reflect lower risk. The issue is under consideration by the Delaware Commission in a generic decoupling proceeding. The Oregon Public Utilities Commission reduced the threshold above which Cascade Natural Gas must share earnings from baseline ROE plus 300 basis points, to baseline ROE plus 175 basis points.
6. The impact of decoupling in eliminating the throughput incentives is lessened as the scope of the decoupling mechanism shrinks.
7. Note, however, that as the various determinants of sales, such as weather and economic activity, are excluded from the mechanism, the need for complex adjustment and evaluation methods increases. In any case, an evaluation process should nevertheless be part of the broader energy efficiency investment process.
8. <www.bge.com/vcmfiles/BGE/Files/Rates%20and%20Tariffs/Gas%20Service%2 Tariff/Brdr_3.doc>.
9. Customers' bills include a real-time, customer-specific Weather Normalization Adjustment (see Section 2.08 of Questar Gas, n.d.) to eliminate the impact of warmer or colder than normal weather on the DNG portion of the bill.
10. Direct Testimony of Barrie L. McKay to Support the Continuation of the Conservation Enabling Tariff for Questar Gas Company, Docket No. 05-057-T01, June 1, 2007, accessed at <www.psc.utah.gov/gas/05docs/05057T01/535586-1-07DitTestBarrieMcKay.doc>.
11. Direct Testimony of David E. Dismukes, Ph.D., on Behalf of the Utah Committee of Consumer Services, Docket No. 05-057-T01, June 1, 2007, accessed at <www.psc.utah.gov/gas/05docs/05057T01/6-1-0753584DirTestDavidDismukesPh.D.doc>.

12. Also known as lost revenue or lost margin recovery mechanisms.

13. Order issued in Cause No. 39453 DSM 59 on January 31, 2007, accessed at <www.in.gov/iurc/portal/Modules/Ecms/Cases/Docketed_Cases/ViewDocumentaspx?DocID=0900b631800c5033>.

14. Energy efficiency traditionally has been defined as an overall reduction in energy use due to use of more efficiency equipment and practices, while load management, as a subset of demand response has been defined as reductions or shifts in demand with minor declines and sometimes increases in energy use.

15. This description quotes extensively from LG&E, 2004.

16. Even in a gas distribution system, fixed costs do vary partly as a function of individual customer demand. The SFV rate used by Atlanta Gas Light, for example, estimates the fixed charge as a function of the maximum daily demand for gas imposed by each premise.

6: Performance Incentives

This chapter provides a practical overview of alternative performance incentive mechanisms and presents their pros and cons. Detailed case studies are provided for each mechanism.

6.1 Overview

The final financial effect is represented by incentives provided to utility shareholders for the performance of a utility's energy efficiency programs. Even if regulatory policy enables recovery of program costs and addresses the issue of lost margins, at best, two major disincentives to promotion of energy efficiency are removed. Financially, demand- and supply-side investments are still not equivalent, as the supply-side investment will generate greater earnings. However, the availability of performance incentives can establish financial equivalence and creates a clear utility financial interest in the success of efficiency programs.

Three major types of performance mechanisms have been most prevalent:

- Performance target incentives
- Shared savings incentives
- Rate of return incentives

Table 6-1 illustrates the various forms of performance incentives in effect today.

Table 6-1. Examples of Utility Performance Incentive Mechanisms

State	Type of Utility Performance Incentive Mechanism	Details
AZ	Shared savings	Share of net economic benefits up to 10 percent of total DSM spending.
CT	Performance target Savings and other programs goals	Management fee of 1 to 8 percent of program costs (before tax) for meeting or exceeding predetermined targets. One percent incentive is given to meet at least 70 percent of the target, 5 percent for meeting the target, and 8 percent for 130 percent of the target.
GA	Shared savings	15 percent of the net benefits of the Power Credit Single Family Home program.
HI	Shared savings	Hawaiian Electric must meet four energy efficiency targets to be eligible for incentives calculated based on net system benefits up to 5 percent.

Table 6-1. Examples of Utility Performance Incentive Mechanisms (continued)

State	Type of Utility Performance Incentive Mechanism	Details
IN	Shared savings/rate of return (utility-specific)	Southern Indiana Gas and Electric Company may earn up to 2 percent added ROE on its DSM investments if performance targets are met with one percent penalty otherwise.
KS	Rate of return incentives	2 percent additional ROE for energy efficiency investments possible.
MA	Performance target Multi-factor performance targets, savings, value, and performance	5 percent of program costs are given to the distribution utilities if savings targets are met on a program-by-program basis.
MN	Shared savings Energy savings goal	Specific share of net benefits based on cost-effectiveness test is given back to the utilities. At 150 percent of savings target, 30 percent of the conservation expenditure budget can be earned.
MT	Rate of return incentives	2 percent added ROE on capitalized demand response programs possible.
NV	Rate of return incentives	5 percent additional ROE for energy efficiency investments.
NH	Shared savings Savings and cost- effectiveness goals	Performance incentive of up to 8 to 12 percent of total program budgets for meeting cost-effectiveness and savings goals.
RI	Performance targets Savings and cost- effectiveness goals	Five performance-based metrics and savings targets by sector. Incentives from at least 60 percent of savings target up to 125 percent.
SC	N/A	Utility-specific incentives for DSM programs allowed.

Notes: For AZ, CT, MA, MN, NV, NH, and RI, see Kushler, York, and Witte, 2006.

For IN, KS, and SC, see Michigan PUC, 2003.

For HI, see Hawaii PUC, 2007. Note that in a prior order the Hawaii Commission eliminated specific shareholder incentives and fixed-cost recovery. However, in the instant case, the commission was persuaded to provide a shared savings incentive.

Vermont uses an efficiency utility, Efficiency Vermont, to administer energy efficiency programs. While not a utility in a conventional sense, Efficiency Vermont is eligible to receive performance incentives.

6.2 Performance Targets

Mechanisms that allow utilities to capture some portion of net benefits typically include savings performance targets. Incentives are not paid unless a utility achieves some minimum fraction of proposed savings, and incentives are capped at some level above projected savings.[1] Several states have designed multi-objective performance mechanisms. Utilities in Connecticut, for example, are eligible for "performance management fees" tied to performance goals such as lifetime energy savings, demand savings, and other measures. Incentives are available for a range of outcomes from 70 to 130 percent of pre-determined goals. A utility is not entitled to the management fee unless it achieves at least 70 percent of the targets. After 130 percent of the goals have been reached, no added incentive is provided. Over the incentive-eligible range of 70 to 130 percent, the utilities can earn 2 to 8 percent of total energy efficiency program expenditures.

6.2.1 Case Study: Massachusetts

The Massachusetts Department of Telecommunications and Energy Order in Docket 98-100 (February 2000)[2] allows for performance-based performance incentives where a distribution company achieves its "design" performance level (i.e., the energy efficiency program performance level that the distribution company expects to achieve). The performance tiers are defined as follows:

1. The design performance level represents the level of performance that the distribution utility expects to achieve from the implementation of the energy efficiency programs included in its proposed plan. The design performance level is expressed in terms of levels of savings in energy, commodity, and capacity, and in other measures of performance as appropriate.

2. The threshold performance level (the minimum level that must be achieved for a utility to be eligible for an incentive) represents 75 percent of the utility's design performance level.

3. The exemplary performance level represents 125 percent of the utility's design performance level.

For the distribution utilities that achieve their design performance levels, the after-tax performance incentive is calculated as the product of:[3]

1. The average yield of the 3-month United States Treasury bill calculated as the arithmetic average of the yields of the 3-month United States Treasury bills issued during the most recent 12-month period, or as the arithmetic average of the 3-month United States Treasury bill's 12-month high and 12-month low, and

2. The direct program implementation costs.

A distribution utility calculates its after-tax performance incentive as the product of:

1. The percentage of the design performance level achieved, and

2. The design performance incentive level, provided that the utility will earn no incentive if its actual performance is below its threshold performance level, and will earn no more than its exemplary performance level incentive even if its actual performance is beyond its exemplary performance level.

In May 2007, the Massachusetts Department of Public Utilities issued an order approving NSTAR Electric's Energy Efficiency Plan for calendar year 2006, filed with the department in April 2006.[4] NSTAR Electric's utility performance incentive proposal contains performance categories based on savings, value, and performance determinants and allocates specific weights to each category. For its residential programs, NSTAR Electric allocates the weights for its savings, value, and performance determinants as follows: 45 percent, 35 percent, and 20 percent, respectively. For its low-income programs, the weights are 30 percent, 10 percent, and 60 percent, respectively. And for its commercial and industrial programs, NSTAR sets the weights at 45 percent, 35 percent, and 20 percent, respectively.[5]

NSTAR proposed an incentive rate equal to 5 percent (after tax) of net benefits, as opposed to the pre-approved

3-Month Treasury rate, and also requested that the exemplary performance level be set at 110 percent of design level for 2006 rather than the 125 percent threshold set by the department. The department accepted both changes. With regard to the latter, the department noted that the precision of performance measurements had improved to the point that performance could be forecast more accurately. Based on these parameters, the company estimated its annual incentive would be $2.4 million.[6]

6.3 Shared Savings

With a shared savings mechanism, utilities share the net benefits resulting from successful implementation of energy efficiency programs with ratepayers. Implicitly, net benefits are tied to the utility's avoided costs, as these costs determine the level of economic benefit achieved. Therefore, the potential upside to a utility from use of a shared savings mechanism will be greater in jurisdictions with higher avoided costs.[7] Key elements in fashioning a shared savings mechanism include:

- The degree of sharing (the percentage of net benefits retained by a utility).
- The amount to be shared (maximum dollar amount of the incentive irrespective of the sharing percentage).
- The extent to which there are penalties for failing to reach performance targets.
- The manner in which avoided costs are determined for purposes of calculating net benefits.
- The threshold values above which the sharing will begin.

6.3.1 Case Study: Minnesota

Minnesota Statute § 216B.241[8] requires Minnesota's energy utilities to invest in energy conservation improvement programs (CIP) authorized by the Minnesota Department of Commerce. Utilities are allowed to recover their costs annually. Part of the CIP cost recovery is achieved through a conservation cost recovery charge (CCRC). If a utility's CIP costs differ from the amount recovered through the CCRC, the utility can adjust its rates annually through the conservation cost recovery adjustment (CCRA). Utilities record CIP costs in a "tracker" account. The Minnesota Public Utilities Commission reviews these accounts before the utilities are authorized to make adjustments to their rates. The statute also authorizes the commission to provide an incentive rate of return, a shared savings incentive, and lost margin/fixed cost recovery.

The legislation describes the requirements of an incentive plan as follows:

> Subd. 6c. Incentive plan for energy conservation improvement.
>
> (a) The commission may order public utilities to develop and submit for commission approval incentive plans that describe the method of recovery and accounting for utility conservation expenditures and savings. In developing the incentive plans the commission shall ensure the effective involvement of interested parties.
>
> (b) In approving incentive plans, the commission shall consider:
>
> (1) Whether the plan is likely to increase utility investment in cost-effective energy conservation.
>
> (2) Whether the plan is compatible with the interest of utility ratepayers and other interested parties.
>
> (3) Whether the plan links the incentive to the utility's performance in achieving cost-effective conservation.
>
> (4) Whether the plan is in conflict with other provisions of this chapter.

As explained in the Order Approving DSM Financial Incentive Plans under Docket E, G-999/CI-98-1759,[9] issued in April 2000, Minnesota Public Utilities Commission convened a round table in December 1998 to assess gas and electric DSM efforts *"to identify other DSM programs and methodologies that effectively conserve energy, to revaluate the need for gas and electric DSM financial incentives and make recommendations for elimination or redesign."*

In November 1999, a joint proposal for a shared savings DSM financial incentive plan was filed with the commission. In the same month, each of the utilities filed their proposed DSMI plans for 1999 and beyond.

The jointly proposed DSM financial incentive plan, which formed the basis for individual utility plans, was intended to replace the then current incentive plans. A primary characteristic of the proposed plan was the method for determining a utility's target energy savings used to calculate incentives. Each utility was subject to the same following formula in determining the energy savings goal:

$$(\text{approved energy savings goal} \div \text{approved budget}) \times \text{statutory minimum spending level}$$

where the statutory spending requirement is 1 percent for electric IOUs (Xcel at 2 percent) and 0.5 percent for gas utilities.

The utilities were required to show that their expenditures resulted in net ratepayer benefits (utility program costs netted against avoided supply-side costs). The net benefits of achieving the specific percentage of energy savings goals were calculated by determining the utilities' avoided costs resulting from their actual CIP achievement, then subtracting the CIP costs. A portion of these benefits was given to the shareholders as an incentive. The size of the incentive depended on the percentage of the net benefits achieved. This percentage increased as the percentage of the goal reached increased. At 90 percent of the goal, the utility received no incentive. At 91 percent of the goal, a small percentage of its net benefits were given to the utility. Net benefits, as mentioned, depended on the utility's avoided costs, which varied from utility to utility. In order to treat all utilities equally, the percentage values were calculated such that at 150 percent of the goals, the utility's incentive was capped at 30 percent of its statutory spending requirement.

In the April 7, 2000 order, the commission found that the plan was likely to increase investment in cost-effective energy conservation. The incentive grew for each incremental block of energy savings. No significant incentive was provided unless a utility met or exceeded its expected energy savings at minimum spending requirements.[10] The mechanism was designed such that if a utility's program was not cost-effective (i.e., there were no net benefits), no incentives were paid. As the cost-effectiveness increased, net benefits and incentives increased accordingly.

The utilities make compliance filings on February 1 of each year to demonstrate the application of the incentive mechanism to a utility's budget and energy savings target.

The 2007 compliance filing[11] of Northern States Power Company (NSP), a wholly owned subsidiary of Xcel Energy, offers useful insight into application of the electric and gas incentive mechanism, in this case incorporating goals and budgets approved in November 2006. Table 6-2 shows the basic calculation of net benefits, and Table 6-3 shows the incentive amount earned by NSP at different levels of program savings.

6.3.2 Case Study: Hawaiian Electric Company (HECO)

In Order No. 23258, the Hawaii Public Utilities Commission approved HECO's proposed energy efficiency incentive mechanism. The order sets four energy efficiency goals that HECO must meet before being entitled to any incentive based on net system benefits (less program costs). Only positive incentives are allowed; in other words, once HECO meets and exceeds the energy efficiency goals, it is entitled to the incentive, but if it cannot achieve the goal, no penalties will apply.

The order details the approach as follows:

> The DSM Utility Incentive Mechanism will be calculated based on net system benefits (less program costs), limited to no more than the utility earnings opportunities foregone by implementing DSM programs in lieu of supply-side rate based investments, capped at $4 million, subject to the following performance requirements and incentive schedule. As indicated in section III.E.l.c., supra, the commission is not requiring negative incentives. In order to encourage high achievement, HECO must meet or exceed the megawatt-hour and megawatt Energy Efficiency goals for both the

Table 6-2. Northern States Power Net Benefit Calculation

2007 Inputs	Electric	Gas
Approved CIP energy (kWh/MCF)	238,213,749	729,086
Approved CIP budget ($)	45,504,799	5,239,557
Minimum spending[a] ($)	42,147,472	3,718,065
Energy savings @ 100% of goal[b] (kWh/MCF)	220,638,428	517,370
Estimated net benefits[c] ($)	180,402,782	65,813,455
Net benefits @ 100% of goal[d] ($)	167,092,732	46,702,175

(a) Statutory requirement. Electric: 2 percent of gross operating revenue. Gas: 0.5 percent.

(b) Energy savings at 100 percent of goal: (Minimum Spending × Goal Energy Savings) ÷ Goal Spending.

(c) Estimated net benefits are calculated from the approved cost-benefit analysis in the 2007/2008/2009 CIP Triennial Plan. For electric, estimated net benefits are equal to the sum of each program's total avoided costs minus spending. For gas, the estimated net benefit is equal to total gas CIP revenue requirements test NPV for 2007 as first and only year.

(d) Net benefits at 100 percent of goal = (Minimum Spending × Goal Net Benefits) ÷ Goal Spending.

Table 6-3. Northern States Power 2007 Electric Incentive Calculation

Electric	Kilowatt-Hour	Percent of Base	Estimated Benefits Achieved	Estimated Incentive
90% of goal	198,574,585	0.00%	150,383,459	0
100% of goal	220,638,428	0.8408%	167,092,732	1,404,916
110% of goal	242,702,270	1.6816%	183,802,005	3,090,815
120% of goal	264,766,113	2.5224%	200,511,278	5,057,697
130% of goal	286,829,956	3.3632%	217,220,552	7,305,562
140% of goal	308,893,799	4.2040%	233,929,825	9,834,410
150% of goal	330,957,641	5.0448%	250,639,098	12,644,241

Source: Xcel Energy, 2006.

commercial and industrial sector, and the residential sector, established in section III.A., supra, for HECO to be eligible for a DSM utility incentive. If HECO fails to meet one or more of its four Energy Efficiency goals, see supra section III.A.8., HECO will not be eligible to receive a DSM utility incentive. Upon a determination that HECO is eligible for a DSM utility incentive, the next step will be to calculate the percentage by which HECO's actual performance meets or exceeds each of its Energy Efficiency goals. Then, these four percentages will be averaged to determine HECO's "Averaged Actual Performance Above Goals."

(Hawaii PUC, 2007)

The incentive allowed HECO (as a percentage of net benefits) is a function of the extent to which the company exceeds its savings goals, as illustrated by Table 6-4.

The commission also provided the following example to illustrate how the mechanism works.

Assume that HECO's 2007 actual total gross commercial and industrial energy savings is 100,893 megawatt-hours, HECO's 2007 actual total gross residential energy savings is 50,553 megawatt-hours, HECO's 2007 actual total gross commercial and industrial demand savings is 13.416 megawatts, and HECO's 2007 actual total gross residential energy savings is 14.016 megawatts.

(Hawaii PUC, 2007)

Table 6-4. Hawaiian Electric Company Shared Savings Incentive Structure

Averaged Actual Performance Above Goals	DSM Utility Incentive (% of Net System Benefits)
Meets goal	1%
Exceeds goal by 2.5%	2%
Exceeds goal by 5%	3%
Exceeds goal by 7.5%	4%
Exceeds goal by 10.0% or more	5%

Source: Hawaii PUC, 2007.

6.3.3 Case Study: The California Utilities

In September 2007, CPUC adopted a far-reaching utility performance incentives plan that creates both the potential for significant additions to utility earnings for superior performance, and significant penalties for inadequate performance.

Under the plan, shareholder incentives are tied to utilities' independently verified achievement of CPUC-established savings goals for each three-year program cycle *and* to the level of verified net benefits. Savings goals have been established for kilowatt-hours, kilowatts, and therms. To be eligible for an incentive, utilities must achieve at least 80 percent of each applicable savings goal.[12] If utilities achieve 85 percent and up to 100 percent of the simple average of all applicable goals, shareholders will receive a reward of 9 percent of verified net benefits.[13] Achievement of over 100 percent or more of the goal will yield a performance payment of 12 percent of verified net benefits, with a statewide cap of $450 million over each three-year program cycle. Failure to achieve at least 65 percent of goal will result in performance penalties. Penalties are calculated as the greater of a charge per unit (kilowatt-hour, kilowatt, or therm) for shortfalls at or below 65 percent of goal, or a dollar-for-dollar payback to ratepayers of any negative net benefits. Total penalties also are capped statewide at $500 million. A performance dead-band of between 65 percent and 85 percent of goal produces no performance reward or penalty. Figure 6-1 and Table 6-6 illustrate the incentive structure.

For example, if utilities achieve the threshold 85 percent of goal for the current 2006-2008 program period, and total verified net benefits equal the estimated value of $1.9 billion on a statewide basis, the utilities would

Table 6-5. Illustration of HECO Shared Savings Calculation

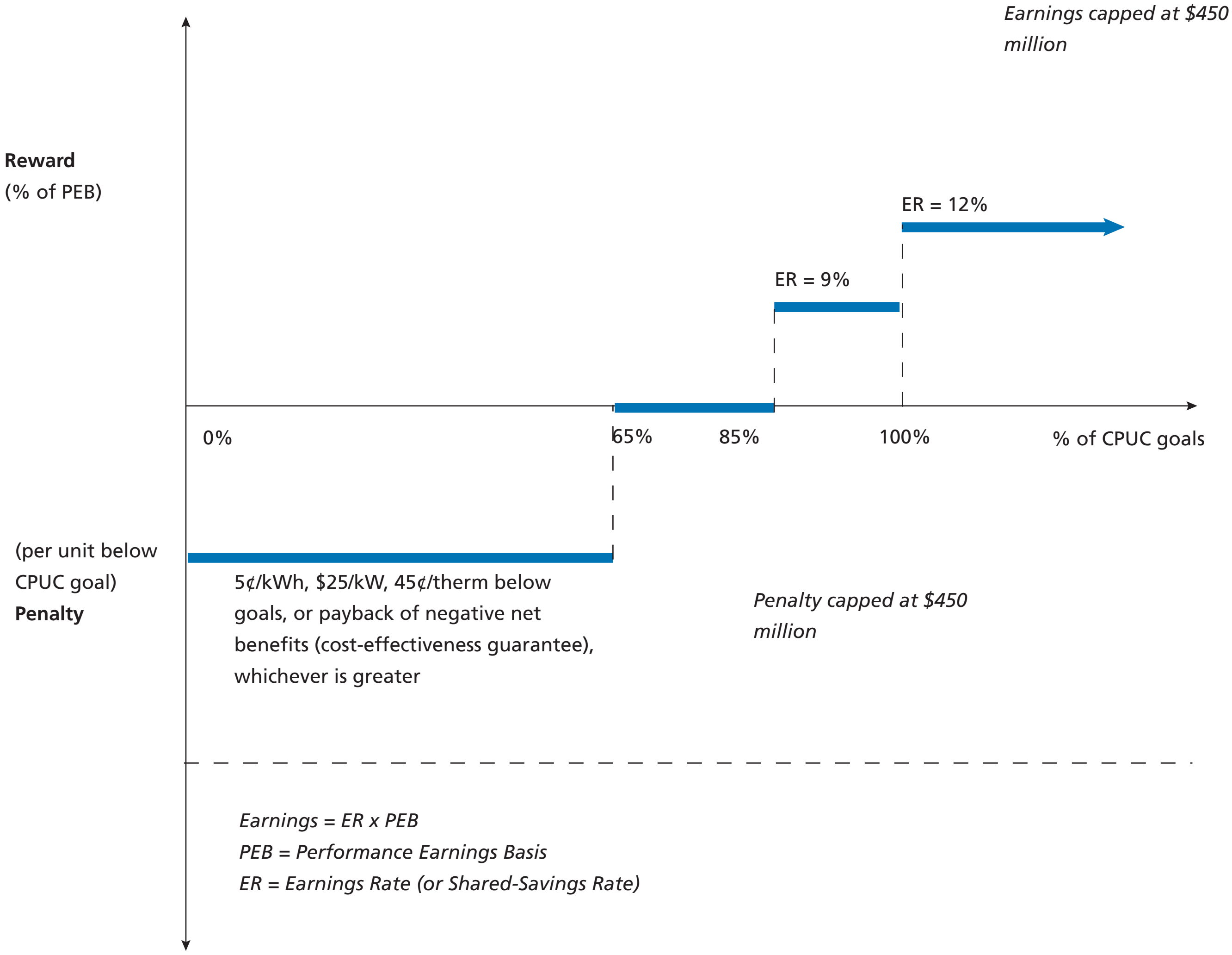
Energy Efficiency Energy Savings (MWh)	2007 Goal (MWh)	2007 Actual Performance (MWh)	Energy Efficiency Goal Met?	*Actual Performance Above 2007 Goal (%)*
Commercial and industrial				
Total gross energy savings	91,549	100,893	10.21%	Yes
Residential				
Total gross energy savings	50,553	50,553	Yes	0%
Commercial and industrial				
Total gross demand savings	13.041	13.416	Yes	*2.88%*
Residential				
Total gross demand savings	13.336	14.016	Yes	*5.10%*
Averaged actual performance above goals	4.55%			
DSM utility incentive (% of net system benefits)	2%			

Source: Hawaii PUC, 2007.

receive 9 percent of that amount, or $175 million. If the utilities each met 100 percent of the savings goals, and the estimated verified net benefit of $2.7 billion is realized, the earnings bonus would equal $323 million.

Rewards or penalties may be collected in three installments for each three-year program cycle. Two interim reward claims or penalty assessments will be made based on estimated performance and net benefits. The third payment—a "true-up claim"—will be made after the program cycle is complete and savings and net benefits have been independently verified. Thirty percent of each interim reward payment is withheld to cover potential errors in estimated earnings calculations. Verified savings will be based on independent measurement and evaluation studies managed by CPUC.

Figure 6-1. California Performance Incentive Mechanism Earnings/Penalty Curve



Source: CPUC, 2007.

CPUC also adjusted the basic cost-effectiveness calculations for purposes of determining net benefits. The estimated value of the performance incentives must be treated as a cost in the net benefit calculation, both during the program planning process to determine the overall cost-effectiveness of the utilities' energy efficiency portfolios, and when the value of net benefits is calculated for purposes of reward determinations subsequent to program implementation.

The commission devoted a significant portion of its order to the fundamental issues surrounding utility performance incentives—whether and why a utility should earn rewards for what are essential expenditures of ratepayer funds; the basis for determining the magnitude of the shareholder rewards; and the relationship between relative reward levels and performance. CPUC ultimately concluded that incentives were appropriate and necessary to achieve the ambitious energy efficiency goals the utilities had been given. The rewards at high levels of goal attainment were set to be generally reflective of earnings from supply-side investments foregone due to implementation of the energy efficiency programs.

Table 6-6. Ratepayer and Shareholder Benefits Under California's Shareholder Incentive Mechanism (Based on 2006–2008 Program Cycle Estimates)

Verified Savings % of Goals	Total Verified Net Benefits	Shareholder Earnings		Ratepayers' Savings
125%	$2,919	$450	cap	$3,469
120%	$3,673	$441		$3,232
115%	$3,427	$411		$3,016
110%	$3,181	$382		$2,799
105%	$2,935	$352		$2,583
100%	$2,689	$323		$2,366
95%	$2,443	$220		$2,223
90%	$2,197	$198		$1,999
85%	$1,951	$176		$1,775
80%	$1,705	$0		$1,705
75%	$1,459	$0		$1,459
70%	$1,213	$0		$1,213
65%	$967	($144)		$1,111
60%	$721	($168)		$889
55%	$475	($199)		$674
50%	$228	($239)		$467
45%	($18)	($276)		$258
40%	($264)	($378)		$114
35%	($510)	($450)	cap	($60)

Source: CPUC, 2007.

Finally, the structure of what the commission termed the "earnings curve," showing the relationship between goal achievement and reward and penalty levels, was fashioned to achieve a reasonable balance between opportunity for reward and risk for penalty. And although potential penalties are significant, even in cases in which programs deliver a net benefit (but fail to meet goal), CPUC found that utilities have sufficient ability to manage these risks, such that penalties can reasonably be associated with nonperformance as opposed to uncontrollable circumstances. This last point has been contested. Utilities are subject to substantial evaluation risk in the final true-up claim. An evaluator's finding that per-unit measure savings or net-to-gross ratios[14] were significantly lower than those estimated ex ante (thus significantly lowering system net benefits) could result in utilities having to refund interim performance payments, which are based on estimates of net benefits. While utilities have some control over net-to-gross ratios through program design, there is considerable debate over the reliability of net-to-gross calculations, and even if utilities attempt to monitor the level of free ridership in a program, the final findings of an independent evaluator are unpredictable.

6.4 Enhanced Rate of Return

Under the bonus rate of return mechanism, utilities are allowed an increased return on investment for energy efficiency investments or offered a bonus return on total equity investment for superior performance. A number of states allowed an increased rate of return on energy efficiency–related investments starting in the 1980s. In fact, the majority of the states that allowed or required ratebasing or capitalization also allowed an increased rate of return for such investments. For example, Washington and Montana allowed an additional 2 percent return for energy efficiency investments, while Wisconsin adopted a mechanism where each additional 125 MW of capacity saved with energy efficiency yielded an additional 1 percent ROE. Connecticut authorized a 1 to 5 percent additional return (Reid, 1988).

Although a bonus rate of return remains an option "on the books" in a number of states, it is seldom used, largely because capitalization of efficiency investments has fallen from favor. The most often-cited current example of a bonus return mechanism, and the only one applied to a utility with significant efficiency spending, is found in Nevada. The Nevada approach, described earlier, allows a bonus rate of return for DSM that is 5 percent higher than authorized rates of return for supply investments. The earlier discussion cited the concerns raised by some that this mechanism does not provide an incentive for superior performance.

6.5 Pros and Cons of Utility Performance Incentive Mechanisms

Shared savings and performance target incentive mechanisms are similar, in that both tie an incentive to achievement of some target level of performance. The two differ in the specific nature of the target and the base upon which the incentive is calculated. The application of each mechanism will differ based on regulators' decisions regarding the specific performance target levels; the relative share of incentive base available as an incentive; the maximum amount of the incentive; and whether performance penalties can be imposed (as opposed to simply failing to earn a performance incentive). Whether an incentive mechanism is implemented will depend on how regulators balance the value of the mechanism in incenting exemplary performance against the cost to ratepayers and arguments that customers should not have to pay for a utility that simply complies with statutory or regulatory mandates. A bonus rate of return mechanism also can include performance measures (those applied in the late 1980s and early 1990s often did), but may not, as in the Nevada example. Table 6-7 summarizes the major pros and cons of performance incentive mechanisms as a whole.

Table 6-7. Pros and Cons of Utility Performance Incentive Mechanisms

Pros

- Provide positive incentives for utility investment in energy efficiency programs.
- Policy-makers can influence the types of program investments and the manner in which they are implemented through the design of specific performance features.

Cons

- Typically requires post-implementation evaluation, which entails the same issues as cited with respect to fixed-cost recovery mechanisms.
- Mechanisms without performance targets can reward utilities simply for spending, as opposed to realizing savings.
- Mechanisms without penalty provisions send mixed signals regarding the importance of performance.
- Incentives will raise the total program costs borne by customers and reduce the net benefit that they otherwise would capture.

6.6 Notes

1. Performance targets can include metrics beyond energy and demand savings; installations of eligible equipment or market share achieved for certain products such as those bearing the ENERGY STAR™ label.

2. *Department of Telecommunications and Energy on Its Own Motion to Establish Methods and Procedures to Evaluate and Approve Energy Efficiency Programs, Pursuant to G.L. c. 25, § 19 and c. 25A, § 11G,* found at, <www.mass.gov/Eoca/docs/dte/electric/98-100/finalguidelinesorder.pdf>.

3. The following is quoted from Investigation by the Department of Telecommunications and Energy on its own motion to establish methods and procedures to evaluate and approve energy efficiency programs, pursuant to G.L. c. 25, § 19 and c. 25A, § 11G, found at <www.mass.gov/Eoca/docs/dte/electric/98-100/finalguidelinesorder.pdf>.

4. *Final Order in D.T.E./D.P.U Docket 06-45, Petition of Boston Edison Company, Cambridge Electric Light Company, and Commonwealth Electric Company, d/b/a NSTAR Electric, Pursuant to G.L. c. 25, § 19 and G.L. c. 25A, § 11G, for Approval of Its 2006 Energy Efficiency Plan.* Found at <www.mass.gov/Eoca/docs/dte/electric/06-45/5807dpuorder.pdf>.

5. Ibid, page 9.

6. Ibid, page 10.

7. Avoided costs are the costs that would otherwise be incurred by a utility to serve the load that is avoided due to an energy efficiency program. Historically, these costs were determined administratively according to specified procedures approved by regulators. This is still the predominant approach, although some jurisdictions now use wholesale market costs to represent avoided costs. This Report will not address the derivation of these costs in detail, but note that the level of avoided costs is extremely important in determining energy efficiency program cost-effectiveness and can be the subject of substantial debate.

8. Minnesota Statute 216B.241, 2006, found at <www.revisor.leg.state.mn.us/bin/getpub.php?type=s&year=current&num=216B.241>.

9. *Order Approving Demand-Side Management Financial Incentive Plans,* Docket No. E,G-999/CI-98-1759, April 7, 2000, accessed at <https://www.edockets.state.mn.us/EFiling/ShowFile.do?DocNumber=822257>.

10. Ibid, page 16.

11. *Xcel Energy Compliance Filing 2007 Electric and Gas CIP Incentive Mechanisms,* Docket E,G-999/CI-98-1759, February 1, 2007, accessed at <https://www.edockets.state.mn.us/EFiling/ShowFile.do?DocNumber=3761385>.

12. PG&E and SDG&E must meet therm, kilowatt-hour, and kilowatt goals; SCE must meet kilowatt-hour and kilowatt goals; and Southern California Gas faces only a therm goal.

13. Southern California Gas need only meet the 80 percent minimum therm savings threshold to be eligible for an incentive.

14. The net-to-gross ratio is a measurement of program free ridership. Free riders are program participants who would have taken the program's intended action, even in the absence of the program.

7: Emerging Models

This chapter examines two new models currently being explored to address the basic financial effects associated with utility energy efficiency investment. The first model has been proposed as an alternative comprehensive cost recovery and performance incentive mechanism. The second represents a fundamentally different approach to funding energy efficiency within a utility resource planning and procurement framework.

7.1 Introduction

Although the details of the policies and mechanisms described above for addressing the three financial effects continue to evolve in jurisdictions across the country, the basic classes of mechanisms have been understood, applied, and debated for more than two decades. Most jurisdictions currently considering policies to remove financial disincentives to utility investment in energy efficiency are considering one or more of the mechanisms described earlier. However, new models that do not fit easily within the traditional classes of mechanisms are now being considered.

7.2 Duke Energy's Proposed Save-a-Watt Model

The persistent and sometimes acrimonious nature of the debate over the proper approach to removing disincentives, combined with a sense that the energy efficiency investment environment is on the threshold of fundamental change, has led some to search for a new way to address the investment disincentive. Although no approach has yet been adopted, an intriguing proposal has emerged from Duke Energy in an energy efficiency proceeding in North Carolina.[1] Duke's energy efficiency investment plan includes an energy efficiency rider that encapsulates program cost recovery, recovery of lost margins, and shareholder incentives into one conceptually simple mechanism keyed to the utility's avoided cost. The approach is an attempt to improve upon previous methods with a more streamlined and comprehensive mechanism.

The energy efficiency rider supporting Duke's proposal is based on the notion that if energy efficiency is to be viewed from the utility's perspective as equivalent to a supply resource, the utility should be compensated for its investment in energy efficiency by an amount roughly equal to what it would otherwise spend to build the new capacity that is to be avoided. Thus, the Duke proposal would authorize the company "to recover the amortization of and a return on 90% of the costs avoided by producing save-a-watts" (Duke Energy, 2007, p. 2). There is no explicit program cost recovery mechanism, no lost margin recovery mechanism and no shareholder incentive mechanism—all such costs and incentives would be recovered under the 90 percent of avoided cost plan. According to Duke, this structure creates an explicit incentive to design and deliver programs efficiently, as doing so will minimize the program costs and maximize the financial incentive received by the company. This mechanism would apply to the full Duke demand-side portfolio, including demand-response programs.

The Duke proposal includes one element that is often not addressed explicitly in other cost recovery and incentive mechanisms, but has significant implications. A number of states have, for a variety of reasons, excluded demand response from incentive mechanisms. This becomes an issue insofar as demand response programs typically cost considerably less on a per-kilowatt basis than energy efficiency, and thus could yield substantial margins for the company under a cost recovery and incentive mechanism that pays on the basis of avoided cost. Currently available information on the proposal does not provide a basis for evaluating how significant an issue this might be (e.g., what portion of the total portfolio's impacts is due to demand response programs contained therein).

The proposed rider is to be implemented with a balancing mechanism, including annual adjustments for changes in avoided costs going forward, and to ensure that the company is compensated only for actual energy and capacity savings as determined by ex post evaluation. However, the rider is set initially based on the company's estimate of savings, and the company acknowledges that meaningful evaluation cannot occur until implementation has been underway for some time. For example, at least one year's worth of program data is required to enable valid samples to be drawn. Drawing the samples, performing data collection, and conducting analysis and report preparation can then take another six months or more. Duke's filing suggests that true-up results may lag by about three years (Duke Energy, 2007, note 4, p. 12).

The basic mechanics of the energy efficiency rider are as follows. The calculations are performed by customer class, consistent with many recovery mechanisms that, for equity reasons, allocate costs to the classes that benefit directly from the investments. The nomenclature for the class allocation has been omitted here for simplicity.

$$EEA = (AC + BA) \div \text{sales}$$

Where:

EEA = Energy efficiency adjustment, expressed in $/kWh

AC = Avoided cost revenue requirement

BA = Balance adjustment (true-up amount)

$$AC = (ACC + ACE) \times 0.90$$

Where:

ACC = Avoided capacity cost revenue requirement

AEC = Avoided energy cost revenue requirement

$$ACC = DC + (ROE \times ACI) \text{ summed over each vintage year, measure/program}$$

Where:

ACI = Present value of the sum of annual avoided capacity cost (AACT), less depreciation

DC = Depreciation of the avoided cost investment

ROE = Weighted return on equity/1-effective tax rate

$$AACT = PD_{kw} \times AAC_{\$/kW/year} \text{ (for each vintage year)}$$

Where:

PD = Projected demand impacts for each measure/program by vintage year

AAC = Annual avoided costs per year, including avoided transmission costs

ACE = DE + (ROE × AEI)

Where:

DE = Depreciation of the avoided energy investment

AEI = Present value of the sum of annual avoided energy costs (AAET), less accumulated depreciation

$AAET = PE_{kWh} \times AEC_{\$/kWh/year}$ (for each vintage year)

Where:

PE = Projected energy impacts by measure/program by year

AEC = Annual energy avoided costs, calculated as the difference between system energy costs with and without the portfolio of energy efficiency programs.

The mechanism's adjustment factor (BA from the first equation) addresses the true-up and is calculated as follows:

BA = AREP – RREP

Where:

AREP = Actual revenues from the evaluation period collected by the mechanism (90 percent of avoided cost)

RREP = Revenue requirements for the energy efficiency programs for the same period

All variables apply to and all calculations are performed over the "evaluation period" which is the time period to which the evaluation results apply.

AREP = EE × AKWH × RREP

Where:

EE = The rider charge expressed in cents/kWh

AKWH = Actual sales for the evaluation period by class

RREP = 90% × [(ACC × (AD/PD)] + [AEC × (AE/PE)]

Where:

ACC = Avoided capacity revenue requirement for the evaluation period

AD = Actual demand reduction for the period based on evaluation results

PD = Projected demand reduction for the same period

AEC = Avoided energy revenue requirement for the period

AE = Actual energy reduction for the period based on evaluation results

PE = Projected energy reduction for the period.

If evaluated savings (in kilowatt-hours and kilowatts) equal planned savings over the relevant period, then there is no adjustment.

Avoided costs are administratively determined in accordance with North Carolina rules, where avoided costs (both capacity and energy) are calculated based on the peaker methodology and are approved by the North Carolina Utilities Commission on a biannual basis (personal communication with Raiford Smith, Duke Energy, May 25, 2007).

It is important to emphasize that Duke's energy efficiency rider has only recently been filed as of this writing, and the regulatory review has only just begun. The proposal clearly represents an innovation in thinking regarding elimination of financial disincentives for utilities, and it has intuitive appeal for its conceptual simplicity. The Save-a-Watt rider *does* represent a distinct departure from cost recovery and shareholder incentives convention. In its attempt to address the range of financial effects described above in a single mechanism, the rider requires a number of detailed calculations, and estimating the amount of money to be recovered is complicated.

7.3 ISO New England's Market-Based Approach to Energy Efficiency Procurement

The development of organized wholesale markets that allow participation from providers of load reduction creates both an alternative source of funding for energy efficiency projects and a source of revenue that potentially could be used to provide financial incentives for energy efficiency performance.

ISO New England, New England's electricity system operator and wholesale market administrator, is implementing a new capacity market, known as the forward capacity market (FCM). The FCM will, for the first time, permit all demand resources to participate in the wholesale capacity market on a comparable basis with traditional generation resources. Demand resources, as defined by ISO New England's market rules, include energy efficiency, load management, real-time demand response, and distributed generation. An annual forward capacity auction would be held to procure capacity three years in advance of delivery. This three-year window provides developers with sufficient time to construct/complete auction-clearing projects and to reduce the risk of developing new capacity. All capacity providers receive payments during the annual commitment period based upon a single clearing price set in the forward capacity auction. In return, the providers commit to providing capacity for the duration of the commitment period by producing power (if a generator) or by reducing demand (if a demand resource) during specific performance hours (typically peak load hours and shortage hours—hours in which reserves needed for reliable system operation are being depleted) (Yoshimura, 2007, pp. 1–2).

This system creates two revenue pathways. First, non-utility providers of demand reduction, such as energy service companies, municipalities, and retail customers (perhaps through aggregators), could receive a stream of revenues that could help finance incremental energy efficiency projects. Second, utilities in the region could bid the demand reduction associated with energy efficiency programs that they are implementing. The revenues received by utilities from winning bids could be handled in a variety of ways depending on the policy of their state regulators. Traditionally, any revenues earned from these programs would be credited against the utilities' jurisdictional revenue requirement. This approach assumes the programs were funded by ratepayers and therefore, that the benefits from these programs should accrue to ratepayers. However, several alternatives exist to this approach:[2]

- Allow revenues earned from winning bids to be retained by the utilities as financial incentives. Rather than having ratepayers directly fund a performance incentive program, as is typically done, state regulators could allow utilities to retain some or all of the funds received from the capacity auction as a reward for performance and inducement to implement effective programs that reduce system peak load.

- Require that some or all of the revenues earned be applied to the expansion of existing programs or development of new programs.
- Require that the jurisdictional costs of energy efficiency programs be offset by revenues earned from the auction, resulting in a rate decrease for jurisdictional customers.

The ISO New England forward capacity auction is in its very early stages. The initial "show-of-interest" solicitation produced almost 2,500 MW of additional demand reduction potential, of which almost half was in the form of some type of energy efficiency. About 80 percent of the capacity was proposed by non-utility entities (Yoshimura, 2007, p. 4).

While this model represents a new source of revenue to fund energy efficiency investments, it also presents a novel way to capture value from energy efficiency programs by virtue of their ability to reduce wholesale power costs. Increasing the supply of capacity that is bid into the auction, particularly from lower-cost energy efficiency, would likely result in a lower market clearing price for capacity resources, which would lower overall regional capacity costs.

However, whether this model becomes a significant source of revenue to support utility energy efficiency programs is not yet known at this time. Successful implementation of an FCM that allows energy efficiency resources to participate requires that the control area responsible for resource adequacy develop rigorous and complex rules to ensure that the impacts of energy efficiency programs on capability responsibility are real and are not double-counted. Additionally, using a regional capacity market to fund energy efficiency results in all consumers of electricity within the region paying for energy efficiency programs implemented in the region. Accordingly, policy-makers in the region must be prepared for the potential shifting of energy efficiency program cost recovery from jurisdictional ratepayers to all ratepayers in the region. State regulatory policy with respect to the treatment of revenues earned in wholesale markets may or may not provide an incentive for utilities to increase the amount of energy efficiency in response to these markets. Finally, the model works only where there are organized wholesale markets that include a capacity market. Currently, much of the country operates without a capacity market.

7.4 Notes

1. The information in this chapter is drawn largely from the Application of Duke Energy Carolinas, LLC for Approval of Save-a-Watt Approach, Energy Efficiency Rider and Portfolio of Energy Efficiency Programs.

2. Note that these alternatives are not mutually exclusive.

8: Final Thoughts—Getting Started

This final chapter provides seven lessons for policy makers to consider as they begin the process of better aligning utility incentives with investment in energy efficiency.

8.1 Lessons for Policy-Makers

The previous four chapters described a variety of options for addressing the barriers to efficiency investment through program cost recovery, lost margin recovery and performance incentive mechanisms. Chapter 2 underscored the principle that it is the combined effect of cost and incentive recovery that matters in the elimination of financial disincentives. There is no single optimal solution for every utility and jurisdiction. Context matters very much, and it is less important that a jurisdiction address each financial effect than that it crafts a solution that leaves utility earnings at least at pre–energy efficiency program implementation levels and perhaps higher.

The history of utility energy efficiency investment is rich with examples of how regulatory commissions and the governing bodies of publicly and cooperatively owned utilities have explored their cost recovery policy options. As these options are reconsidered and reconfigured in light of the trend toward higher utility investment in energy efficiency, this experience yields several lessons with respect to process.

1. **Set cost recovery and incentive policy based on the direction of the market's evolution.** No policy-maker sets a course by looking over his or her shoulder. Nevertheless, there is a natural tendency to project onto the future what seems most comfortable today. The rapid development of technology, the likely integration of energy efficiency and demand response, the continuing evolution of utility industry structure, the likelihood of broader action on climate change, and a wide range of other uncertainties argue for cost recovery and incentive policies that can work with intended effect under a variety of possible futures.

2. **Apply cost recovery mechanisms and utility performance incentives in a broad policy context.** The policies that affect utility investment in energy efficiency are many and varied, and each will control, to some extent, the nature of financial incentives and disincentives that a utility faces. Policies that could impact the design of cost recovery and incentive mechanisms include those having to do with rate design (PBR, dynamic pricing, SFV designs, etc.); non-CO_2 environmental controls such as NO_X cap-and-trade initiatives; broader clean energy and distributed energy development; and the development of more liquid wholesale markets for load reduction programs.

3. **Test prospective policies.** Cost recovery and incentive discussions have tended toward the conceptual. What is appropriate to award and allow? Is it the utilities' responsibility to invest in energy efficiency, and do they need to be rewarded for doing so? Should revenues be decoupled from sales? All questions are appropriate and yet at the end of the day, the answers tell policy-makers very little about how a mechanism will impact rates and earnings. This answer can only come from running the numbers—test driving the policy—and not simply under the standard business-as-usual scenario. Business is never "as usual," and a sustainable, durable policy requires that it generate acceptable outcomes under unusual circumstances. Complex mechanisms that have many moving parts cannot easily be understood absent simulation of the mechanisms under a wide range of conditions. This is particularly true of mechanisms that rely on projections of avoided costs, prices, or program impacts.

4. **Policy rules must be clear.** Earlier chapters of this Report described the relationship between perceived financial risk and utility disincentives to invest in energy efficiency. This risk is mitigated in part by having cost recovery and incentive mechanisms in place, but the effectiveness of these mechanisms depends very much on the rules governing their application. For example, review and approval of energy efficiency program budgets by regulators prior to implementation provides utilities with greater assurance of subsequent cost recovery. Alternatively, spelling out what is considered prudent in terms of planning and investment can help allay concerns over post-implementation disallowances. Similarly, the criteria/methods to be applied when reviewing costs, recovery of lost margins, and claimed incentives should be as specific as possible, recognizing the need to preserve regulatory flexibility. Where possible, the values of key cost recovery and incentive variables, such as avoided costs, should be determined in other appropriate proceedings, rather than argued in cost recovery dockets. Although this clear separation of issues will not always be possible, the principal focus of cost recovery proceedings should be on (1) whether a utility adhered to an approved plan and, if not, whether it was prudent in diverging, and (2) whether costs and incentives proposed for recovery are properly calculated.

5. **Collaboration has value.** Like every issue involving utility costs of service, recovering the costs associated with program implementation, recovering lost margins/fixed costs, and providing performance incentives will involve determinations of who should pay how much. These decisions invariably will draw active participation from a variety of stakeholders. Key among these are utilities, consumer advocates, environmental groups, energy efficiency proponents, and representatives of large energy consumers. Fashioning a cost recovery and incentives policy will be challenging. The most successful and sustainable cost recovery and incentive policies are those that (1) were based on a consultative process that includes broad agreement on the general aims of the energy efficiency investment policy, and (2) are based on legislative enactment of clear regulatory authority to implement the policy.

6. **Flexibility is essential.** Most of the states that have had significant efficiency investment and cost recovery policies in place for more than a few years have found compelling reasons to modify these policies at some point. Rather than indicating policy inconsistency, these changes most often reflect an institutional capacity to acknowledge either weaknesses in existing approaches or broader contextual changes that render prior approaches ineffective. Minnesota developed and subsequently abandoned a lost margin recovery mechanism after finding that its costs were too high, but the state replaced the mechanism with a utility performance incentive policy that appears to be effective in addressing barriers to investment. California adopted, abandoned, and is now set to again adopt performance incentive mechanisms as it responds to broader changes in energy market structure and the role of utilities in promoting efficiency. Nevada adopted a bonus rate of return for utility efficiency investments and is now reconsidering that policy in the context of the state's aggressive resource portfolio standard. Policy stability is desirable, and changes that suggest significant impacts on earnings or prices can be particularly challenging, but it is the stability of impact rather than adherence to a particular model that is important in addressing financial disincentives to invest.

7. **Culture matters.** One important test of a cost recovery and incentives policy is its impact on corporate culture. A policy providing cost recovery is an essential first step in removing financial disincentives associated with energy efficiency investment, but it will not change a utility's core business model. Earnings are still created by investing in supply-side assets and selling more energy. Cost recovery, plus a policy enabling recovery of lost margins might make a utility indifferent to selling or saving a kilowatt-hour or therm, but still will not make the business case for aggressive pursuit of energy efficiency. A full comple-

ment of cost recovery, lost margin recovery, and performance incentive mechanisms can change this model, and likely will be needed to secure sustainable funding for energy efficiency at levels necessary to fundamentally change resource mix.

As utility spending on energy efficiency programs rises to historic levels, attention increasingly falls on the policies in place to recover program costs, recover potential lost margins, and provide performance incentives. These policies take on even greater importance if utilities are expected to go beyond current spending mandates and adopt investment in customer energy efficiency as a fundamental element of their business strategy. The financial implications of utility energy efficiency spending can be significant, and failure to address them ensures that at best, utilities will comply with policies requiring their involvement in energy efficiency, and at worst, it could lead to ineffective programs and lost opportunities.

This paper has outlined the financial implications surrounding utility funding for energy efficiency and the mechanisms available for addressing them, with the intent of supporting policies that align utility financial incentives with investment in cost-effective energy efficiency. The variety of policy options is testament to the creativity of state policy-makers and utilities, but as pressure for higher efficiency spending levels increases, the volume of the debate surrounding these options also increases. To a great extent, the debates revolve around the basic tenets of utility regulation. Some efficiency cost recovery, margin recovery, and performance incentive mechanisms imply changes in the approach to utility regulation and ratemaking.

Building the consensus necessary to support significant increases in utility administration of energy efficiency will require that these tenants be revisited. If state and federal policy-makers conclude that utilities should play an increasingly aggressive role in promoting energy efficiency, adaptations to these tenants to accommodate this role will need to be explored. An important first step may be building a common understanding around the financial implications of utility spending for efficiency, including development of a consistent cost accounting framework and terminology.

Appendix A: National Action Plan for Energy Efficiency Leadership Group

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Appendix B: Glossary

Decoupling: A mechanism that weakens or eliminates the relationship between sales and revenue (or more narrowly the revenue collected to cover fixed costs) by allowing a utility to adjust rates to recover authorized revenues independent of the level of sales.

Energy efficiency: The use of less energy to provide the same or an improved level of service to the energy consumer in an economically efficient way. "Energy conservation" is a term that has also been used, but it has the connotation of doing without in order to save energy rather than using less energy to perform the same or better function.

Fixed costs: Expenses incurred by the utility that do not change in proportion to the volume of sales within a relevant time period.

Lost margin: The reduction in revenue to cover fixed costs, including earnings or profits in the case of investor-owned utilities. Similar to lost revenue, but concerned only with fixed cost recovery, or with the opportunity costs of lost margins that would have been added to net income or created a cash buffer in excess of that reflected in the last rate case.

Lost revenue adjustment mechanisms: Mechanisms that attempt to estimate the amount of fixed cost or margin revenue that is "lost" as a result of reduced sales. The estimated lost revenue is then recovered through an adjustment to rates.

Performance-based ratemaking: An alternative to traditional return on rate base regulation that attempts to forego frequent rate cases by allowing rates or revenues to fluctuate as a function of specified utility performance against a set of benchmarks.

Program cost recovery: Recovery of the direct costs associated with program administration (including evaluation), implementation, and incentives to program participants.

Shared savings: Mechanisms that give utilities the opportunity to share the net benefits from successful implementation of energy efficiency programs with ratepayers.

Return on equity: Based on an assessment of the financial returns that investors in that utility would expect to receive, an expectation that is influenced by the perceived riskiness of the investment.

Straight fixed-variable: A rate structure that allocates all current fixed costs to a per customer charge that does not vary with consumption.

System benefits charge: A surcharge dictated by statute that is added to ratepayers' bills to pay for energy efficiency programs that may be administered by utilities or other entities.

Throughput incentive: The incentive for utilities to promote sales growth that is created when fixed costs are recovered through volumetric charges. Many have identified the throughput incentive as the primary barrier to aggressive utility investment in energy efficiency.

Appendix C: Sources for Policy Status Table

This appendix provides specific sources by state for the status of energy efficiency cost recovery and incentive mechanisms provided in Tables ES-1 and 1-2.

Table C-1. Policy Status Table

States	Sources
Arizona	Arizona Corporation Commission, Decision Nos. 67744 and 69662 in docket E-01345A-05-0816
California	2001 California Public Utilities Code 739.10. D.04-01-048, D.04-03-23, D.04-07-022, D.05-03-023, D.04-05-055, D.05-05-055
Colorado	House Bill 1037 (2007) authorizes cost recovery and performance incentives for both gas and electric utilities
Connecticut	2005 Energy Independence Act, Section 21
District of Columbia	Code 34-3514
Florida	Florida Administrative Code Rule 25-17.015(1)
Hawaii	Docket No. 05-0069, Decision and Order No. 23258
Idaho	Idaho PUC Case numbers IPC-E-04-15 and IPC-E-06-32
Illinois	Illinois Statutes 20-687.606
Indiana	Case-by-case
Iowa	Iowa Code 2001: Section 476.6; 199 Iowa Administrative Code Chapter 35
Kentucky	Kentucky Revised Statute 278.190
Maine	Maine Statue Title 35-A

Table C-1. Policy Status Table (continued)

States	Sources
Massachusetts	D.T.E. 04-11 Order on 8/19/2004
Minnesota	Statutes 2005, 216B.24 1
Montana	Montana Code Annotated 69.8.402
Nevada	Nevada Administrative Code 704.9523
New Hampshire	Order 23-574, 2000. Statues Chapter 374-F:3
New Jersey	N.J.S.A. 46:3-60
New Mexico	New Mexico Statues Chapter 62-17-6
New York	Case 05-M-0900, In the Matter of the System Benefits Charge III, Order Continuing the System Benefits Charge (SBC)
North Carolina	Order on November 3, 2005 Docket G-21 Sub 461
Ohio	Case-by-case
Oregon	Order 02-634
Rhode Island	Rhode Island Code 39-2-1.2
Utah	<www.raponline.org/showpdf.asp?PDF_URL=%22/pubs/irpsurvey/irput2.pdf%22 and Questar Order>
Washington	Case-by-case
Wisconsin	Wisconsin Statute 16.957.4

Appendix D: Case Study Detail

This appendix provides additional detail on the Iowa and Florida case studies discussed in this Report.

D.1 Iowa

199 Iowa Administrative Code Chapter 35[1] specifies the application of the cost recovery rider.

Energy efficiency cost recovery (ECR) factors, must be calculated separately for each customer or group classification. ECR factors are calculated using the following formula:

$$\text{ECR factor} = ((PAC) + (ADPC \times 12) + (ECE) + A)/ASU$$

where:

- The ECR factor is the recovery amount per unit of sales over the 12-month recovery period.
- PAC is the annual amount of previously approved costs from earlier ECR proceedings, until the previously approved costs are fully recovered.
- ECE is the estimated contemporaneous expenditures to be incurred during the 12-month recovery period.
- "A" is the adjustment factor equal to over-collections or under-collections determined in the annual reconciliation, and for adjustments ordered by the board in prudence reviews.
- ASU is the annual sales units estimated for the 12-month recovery period.
- ADPC is amortized deferred past cost. It is calculated as the levelized monthly payment needed to provide a return of and on the utility's deferred past costs (DPC). ADPC is calculated as:

$$ADPC = DPC\,[r(1+r)n] \div [(1+r)n - 1]$$

where:

- DPC is deferred past costs, including carrying charges that have not previously been approved for recovery, until the deferred past costs are fully recovered.
- n is the length of the utility's plan in months.
- r is the applicable monthly rate of return calculated as:

$$r = (1+R)^{1/12} - 1 \text{ or}$$

$$r = R/12 \text{ if previously approved}$$

- R is the pretax overall rate of return the board held just and reasonable in the utility's most recent general rate case involving the same type of utility service. If the board has not rendered a decision in an applicable rate case for a utility, the average of the weighted average cost rates for each of the capital structure components allowed in general rate cases within the preceding 24 months for Iowa utilities providing the same type of utility service will be used to determine the applicable pretax overall rate of return.

D.2 Florida

The procedure for conservation cost recovery described by Florida Administrative Code Rule 25-17.015(1)[2] includes the following elements:

- Utilities submit an annual final true-up filing showing the actual common costs, individual program costs and revenues, and actual total ECCR revenues for the most recent 12-month historical period from January 1 through December 31 that ends prior to the annual ECCR proceedings. As part of this filing a utility must include:

- A summary comparison of the actual total costs and revenues reported, to the estimated total costs and revenues previously reported for the same period covered by the filing. The filing shall also include the final over- or under-recovery of total conservation costs for the final true-up period.
  - Eight months of actual and four months of projected common costs, individual program costs, and any revenues collected. Actual costs and revenues should begin January 1, immediately following the period described in paragraph (1)(a). The filing shall also include the estimated/actual over- or under-recovery of total conservation costs for the estimated/actual true-up period.
  - An annual projection filing showing 12 months of projected common costs and program costs for the period beginning January 1, following the annual hearing.
  - An annual petition setting forth proposed ECCR factors to be effective for the 12-month period beginning January 1, following the hearing.
- Within the 90 days that immediately follow the first six months of the reporting period, each utility must report the actual results for that period.
- Each utility must establish separate accounts or sub-accounts for each conservation program for the purposes of recording the costs incurred for that program. Each utility must also establish separate sub-accounts for any revenues derived from specific customer charges associated with specific programs.
- New programs or program modifications must be approved prior to a utility seeking cost recovery. Specifically, any incentives or rebates associated with new or modified programs may not be recovered if paid before approval. However, if a utility incurs prudent implementation costs before a new program or modification has been approved by the commission, a utility may seek recovery of these expenditures.

Advertising expense recovered through ECCR must be directly related to an approved conservation program, shall not mention a competing energy source, and shall not be company image-enhancing.

D.3 Notes

1. 199 Iowa Administrative Code Chapter 35, accessed at <http://www.legis.state.ia.us/Rules/Current/iac/199iac/19935/19935.pdf>.
2. Florida Administrative Code Rule 25-17.015(1), accessed at <http://www.flrules.org/gateway/RuleNo.asp?ID=25-17.015>.

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STATE ELECTRIC EFFICIENCY REGULATORY FRAMEWORKS

IEE Report
July 2013

IEE | INNOVATION ELECTRICITY EFFICIENCY
An Institute of The Edison Foundation

EXECUTIVE SUMMARY: STATE ELECTRIC EFFICIENCY REGULATORY FRAMEWORKS

This report summarizes ongoing and recent policy developments that support utility investments in electric efficiency programs, including program cost recovery, fixed cost recovery, and performance incentives for electric utilities on a state-by-state basis.

Supportive regulatory frameworks are the key to expanding the electric power industry's already large commitment to energy efficiency even further. Through them, the power industry can fully and seamlessly integrate electric efficiency programs into their long-term financial and system planning. And through these regulatory frameworks, the nation's homes and businesses will be able to continue to benefit from electric efficiency far into the future.

Since the last IEE update (July 2012), several states have expanded the business environment to support investments in efficiency programs by electric utilities.

- In total, 32 states have approved fixed cost recovery mechanisms – 14 with revenue decoupling and 18 with lost revenue adjustment mechanisms. This is up from 27 states in 2012. Three additional states have open cases that await a decision by their respective regulators.
- 18 states have lost revenue adjustment mechanisms, including Missouri and Louisiana, which received approval recently. Two additional states – Mississippi and Virginia – await regulatory approval of lost revenue adjustment mechanisms.
- 14 states have electric decoupling mechanisms, including Washington, which received approval recently. Delaware awaits a decision on its proposed decoupling mechanism.
- In total, 28 states currently have performance incentives in place. This is up from 23 states in 2012. The states with recently approved performance incentives include Alabama, the District of Columbia, Louisiana, Missouri, and South Dakota. An additional three states – Mississippi, Montana, and West Virginia – are evaluating performance incentives.

Table 1. Summary of State Regulatory Frameworks: July 2013*

Summary of State Regulatory Frameworks: July 2013*			
Energy Efficiency Incentive Mechanism		Number of States	Pending
Fixed-Cost Recovery Mechanisms	Lost Revenue Recovery	18	2
	Revenue Decoupling	14	1
Performance Incentives		28	3

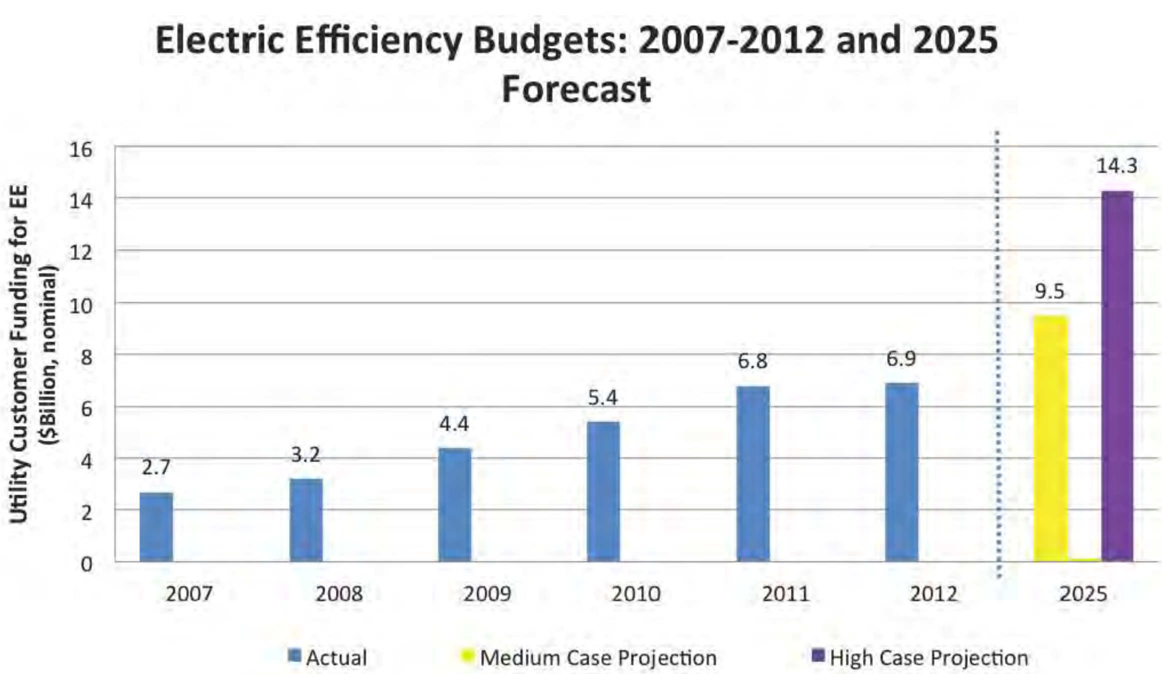
* To avoid double-counting, Ohio is included as an approved decoupling state.

For utilities to treat electric efficiency programs as equivalent to supply-side investments from a financial perspective, three types of regulatory mechanisms are critical: direct cost recovery, fixed cost recovery, and performance incentives.

- **Direct Cost Recovery** refers to regulator-approved mechanisms for the recovery of costs related to the administration of the efficiency program by the administrator, implementation costs such as marketing, and the actual cost of product rebates and mid-stream product buy-downs. Such costs are recovered through rate cases, system benefits charges, and tariff rider/surcharges.
- **Fixed Cost Recovery** refers to decoupling and lost revenue adjustment mechanisms that assist the utility in recovering the marginal revenue associated with fixed operating costs. Rate making practices tie the recovery of fixed costs to volumetric consumption charges with rates set upon an assumed level of energy sales. The purpose of electric efficiency programs is to reduce the consumption of electricity; decoupling and lost revenue mechanisms allow for timely recovery of fixed costs.
- **Performance Incentives** are mechanisms that reward utilities for reaching certain electric efficiency program goals, and, in some cases, impose a penalty for performance below the agreed-upon goals. Performance incentives allow for utilities to earn a return on their investment in electric efficiency, typically similar to the return on supply-side investments.

Spending and budgets for customer-funded, utility electric efficiency programs continue to grow, due in part to the evolution of state policies that allow utilities to pursue efficiency as a sustainable business. In fact, according to a recent IEE report, utility company electric efficiency budgets in 2012 totaled $6.9 billion, a 27 percent increase above 2010 levels. By 2025, IEE predicts that electric efficiency budgets will exceed $14 billion.

Figure 1. U.S. Electric Efficiency Budgets (2007-2012) and 2025 Forecast



Source: IEE, Summary of Ratepayer-Funded Electric Efficiency Impacts, Budgets, and Expenditures (2011-2012), March 2013.

Since the last issue of IEE's State Electric Efficiency Regulatory Frameworks (July 2012), the following categorical clarifications occurred:

- Florida's pending performance incentive has been dropped.
- Idaho's pending performance incentive has been dropped.
- Kansas' pending performance incentive has been dropped.
- Michigan's decoupling status has been dropped.
- Minnesota's pending decoupling status has been dropped.
- New Hampshire's pending decoupling status has been dropped.
- New Mexico's pending decoupling mechanism has been clarified as an approved lost revenue adjustment mechanism.
- Utah's pending decoupling, lost revenue adjustment mechanism, and performance incentive have been dropped.

The remainder of this report provides detailed state-by-state information on regulatory decisions that support customer-funded electric efficiency, current as of July 2013.

For inquiries, please contact Adam Cooper, Research Manager, at acooper@edisonfoundation.net. For further information, please visit http://www.edisonfoundation.net/IEE.

State Regulatory Framework Summary Table

State	Direct Cost Recovery			Fixed Cost Recovery		Performance Incentives
	Rate Case	System Benefits Charge	Tariff Rider/ Surcharge	Decoupling	Lost Revenue Adjustment Mechanism	
Alabama	Yes		Yes		Yes	Yes
Alaska						
Arizona		Yes	Yes		Yes	Yes
Arkansas			Yes		Yes	Yes
California	Yes	Yes	Yes	Yes		Yes
Colorado	Yes		Yes		Yes	Yes
Connecticut		Yes		Yes		Yes
Delaware	Yes		Yes	Pending		
District of Columbia		Yes	Yes	Yes		Yes
Florida			Yes			
Georgia	Yes		Yes		Yes	Yes
Hawaii	Yes	Yes		Yes		Yes
Idaho			Yes	Yes		
Illinois			Yes			
Indiana			Yes		Yes	Yes
Iowa			Yes			
Kansas			Yes		Yes	
Kentucky			Yes		Yes	Yes
Louisiana	Yes				Yes	Yes
Maine		Yes				
Maryland			Yes	Yes		
Massachusetts		Yes		Yes		Yes
Michigan			Yes			Yes
Minnesota	Yes		Yes			Yes
Mississippi	Yes		Yes		Pending	Pending
Missouri	Yes				Yes	Yes
Montana		Yes	Yes		Yes	Pending
Nebraska						
Nevada			Yes		Yes	
New Hampshire	Yes	Yes				Yes
New Jersey	Yes	Yes	Yes			

State	Direct Cost Recovery			Fixed Cost Recovery		Performance Incentives
	Rate Case	System Benefits Charge	Tariff Rider/ Surcharge	Decoupling	Lost Revenue Adjustment Mechanism	
New Mexico			Yes		Yes	Yes
New York		Yes		Yes		Yes
North Carolina			Yes		Yes	Yes
North Dakota						
Ohio			Yes	Yes	Yes	Yes
Oklahoma			Yes		Yes	Yes
Oregon		Yes		Yes		
Pennsylvania	Yes		Yes			
Rhode Island		Yes		Yes		Yes
South Carolina		Yes			Yes	Yes
South Dakota			Yes		Yes	Yes
Tennessee						
Texas	Yes		Yes			Yes
Utah	Yes		Yes			
Vermont		Yes		Yes		Yes
Virginia			Yes		Pending	
Washington		Yes	Yes	Yes		
West Virginia						Pending
Wisconsin	Yes		Yes	Yes		Yes
Wyoming			Yes		Yes	

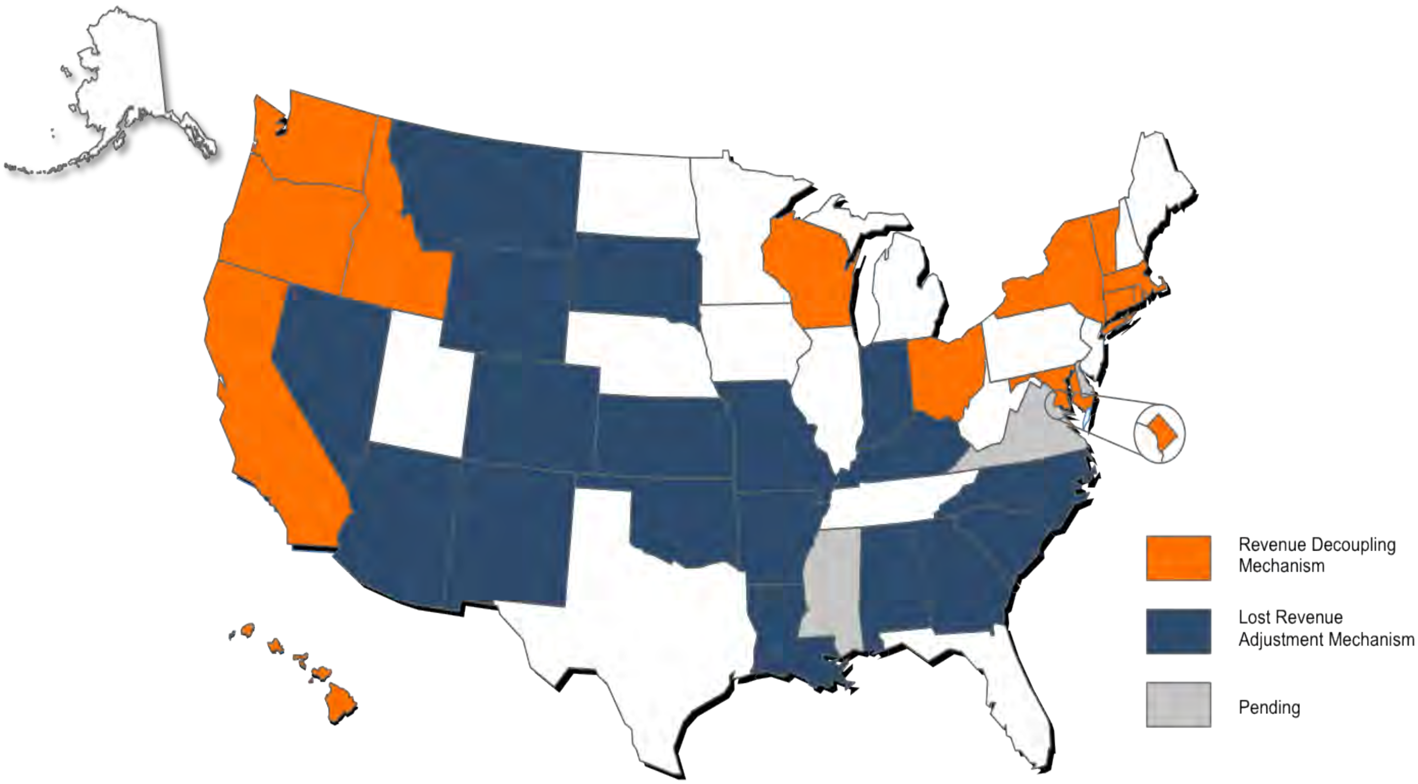
Summary of State Regulatory Frameworks: July 2013*			
Energy Efficiency Incentive Mechanism		Number of States	Pending
Fixed-Cost Recovery Mechanisms	Lost Revenue Recovery	18	2
	Revenue Decoupling	14	1
Performance Incentives		28	3

* To avoid double-counting, Ohio is included as an approved decoupling state.

Please note that although information in this document was compiled from primary sources, readers are encouraged to verify the most recent developments by contacting the appropriate commission or regulatory agency.

For inquiries, please contact Adam Cooper, Research Manager, at acooper@edisonfoundation.net. For further information, please visit www.edisonfoundation.net/IEE.

Lost Revenue Adjustment & Revenue Decoupling Mechanisms for Electric Utilities by State



State	Description	Status	Codes, Orders & Resources
Alabama (LR)	Lost revenue due to efficiency programs can be recovered through a rate rider. Rates can also be set annually to allow for recovery of energy efficiency, through a Rate RSE.	Approved	Docket 31045
Arizona (LR)	In May 2012, a lost-fixed-cost recovery (LFCR) was approved, as part of a rate case filed by APS. Lost revenues can be recovered starting July 1, 2012. Utilities can recover a portion of transmission and distribution costs related to sales reduced by efficiency or distributed generation. Recovered revenue can be adjusted annually. The LFCR can be modified by the Commission up to the next APS rate case in 2015. There is a residential opt-out clause to the LFCR, if residents choose the optional Basic Service Charge (BSC) instead.	Approved (2012)	DocketsE-01345A-11-0224; E-01345A-12-0232; Decision #73183

State	Description	Status	Codes, Orders & Resources
Arkanasas (LR)	In 2008 the Arkanasas Public Service Commission opened a docket "for the purpose of exploring and considering possible innovative approaches to traditional ratebase rate of return regulation". This docket includes examination of decoupling/ lost revenues that result from decreases in power usage based on successful energy efficiency and demand response efforts. In December 2010, the Arkanasas Public Service Commission issued Order #14 in Docket 08-137-U approving a proposal by utilities, alllowing them to submit applications within the annual EE tariff filing process to collect "lost contributions to fixed costs" (LCFC) contemporaneously with program implementation. LCFC is based on the best available data, which may include deemed savings, to be followed by an annual EM&V true-up calculation. The LCFC is eligible to be collected upon starting in 2011.	Approved (2010)	Docket 08-137-U, Order No. 14
California	California has had some form of decoupling since 1982. The current "decoupling plus" program is a revenue decoupling program combined with performance incentives for meeting or exceeding energy efficiency targets (performance-based rates). Revenue requirements are adjusted for customer growth, productivity, weather, and inflation on an annual basis with rate cases every three or four years (varies by utility). The incentive structure caps penalties/earnings for energy efficiency programs at $450M.	Approved (Decoupling "Plus" approved in 2007)	Code Sec. 9 Section 739(3) and Sec. 10 Section 739.10 as amended by A.B. XI 29; Decisions 98-03-063 & 07-09-043
Colorado (LR)	A conditional portion of the performance incentive mechanism in Colorado (see p. 12) allows for Xcel to recover a $2M after-tax, "disincentive offset" payment for achieving greater than 80% of the annual energy savings goal.	Approved (2007)	HB-07-1037; Decision C08-560, Docket 07A-420E
Connecticut	As of 2007, all electric and gas utilities must include a decoupling proposal as a part of their individual rate cases. The type of decoupling is assigned on a utility-by-utility basis. United Illuminating is using a full decoupling mechanism, adjusted annually as a pilot. with a $1 million under/over-recovery bandwidth. Connecticut Light & Power was denied a full decoupling mechanism in its last rate case and will continue decoupling through rate design.	Approved (2007)	Public Act No. 07-242; Docket No.08-07-04RE02; Docket No. 09-12-05
Delaware	The Delaware Commission has recognized decoupling as a possible solution for promoting energy efficiency, but no plans have been approved for utilities. Delmarva Power submitted its decoupling plan in its 2009 rate case. The proposed decoupling method was a fixed variable rate design. Docket 09-276T was folded into Docket 09-414T and the docket remains open. Rate design implementation workshops occurred in October 2011, but negative press since has prevented any additional developments.	Pending	Docket 59; Docket 09-276T; Docket 09-414T
District of Columbia	The DC Public Service Commission approved PEPCO's Bill Stabilization Adjustment (BSA) in October 2009. Like the BSA approved for Maryland, an RPC mechanism is employed which adjusts quarterly.	Approved (2009)	PSC Order 1053-E-549

State	Description	Status	Codes, Orders & Resources
Georgia (LR)	Electric utilities are authorized to request a lost revenue adjustment mechanisms through the Georgia Code. This rate for recovery can include programmatic costs plus an "additional sum" for approved efficiency programs.	Approved	Georgia Code 46-3A-9
Hawaii	The Hawaii PUC approved decoupling as a policy in February 2010, but a final order is pending. The utilities have submitted a proposed mechanism which allows for decoupling of revenues from sales, rate base adjustments for O&M costs and planned capital additions, and a mechanism for sharing earnings with rate payers should a company exceed their allowed ROE. True-ups occur annually.	Approved - Pending Final Order	Docket 2008-0274
Idaho	After a five year pilot the Commission approved Idaho Power Company's request to convert Schedule 54, a fixed-cost adjustment (FCA) mechanism from a pilot to an ongoing, permanent schedule. The FCA uses a fixed cost per customer approach. Sales are adjusted for weather and the FCA rate increases are capped at 3% over the previous year. The mechanism is only applied to residential and small general service customers.	Approved (Pilot 2007-2009, extended 2010-2011)	Case No. IPC-E-04-15, Order No. 30267; Case No. IPC-E-09-28, Order No. 31063; Case No. IPC-E-11-19, Order No. 32505, Order No. 32731
Indiana (LR)	The Utility Regulatory Commission approved Duke Energy Indiana and Indiana Michigan Power Company's request to recover lost revenues due to the implementation of a DSM program. Northern Indiana Power & Light, and Indianapolis Power & Light have lost margin recovery mechanisms proposals pending before the Commission.	Approved	Cause No. 43827; Cause No. 43955; Cause No. 43912; Cause No. 43960
Kansas (LR)	Kansas Corporate Commission allows lost revenue adjustment in certain cases. In Docket No: 10-WSEE-775-TAR, Westar was granted a shared savings mechanism, which is similar to lost revenue recovery. The Commission does not favor lost revenue recovery, but will consider it if it achieves established energy efficiency goals.	Approved	Docket No: 10-WSEE-775-TAR; Docket No: 12-GIMX-337-GIV
Kentucky (LR)	Lost revenue recovery mechanisms are determined on a case-by-case basis, but all electric utilities in Kentucky have DSM proposals in place that include similar lost revenue (LR) recovery due to DSM programs. For these utilities, LR is calculated using the marginal rate, net of variable costs, times the estimated kWh savings from a DSM measure over a three-year period.	Approved (2006)	Statute Ch. 278, Title 285; Docket 2007-00477; 2008-00473; 2009-00444; 2010-00445; 2011-00448
Louisiana (LR)	In December 2012, the Louisiana Public Service Commission (PSC) approved a plan to give utilities a year to develop energy efficiency programs for their ratepayers. The Commission reversed its decision in February 2013, but again agreed to revisit the initiative in May 2013 after several consumer and environmental groups filed suit. In June 2013, the PSC voted to reinstate the initiative.	Approved (2013)	Docket R-31106
Maryland	A plan to employ revenue decoupling for Maryland utilities under an RPC mechanism was approved in 2007, which adjusts quarterly. The mechanism is similar to the BSA approved for Washington, DC.	Approved (2007)	PSC Case No. 9093; Order 81518; Case No. 9154

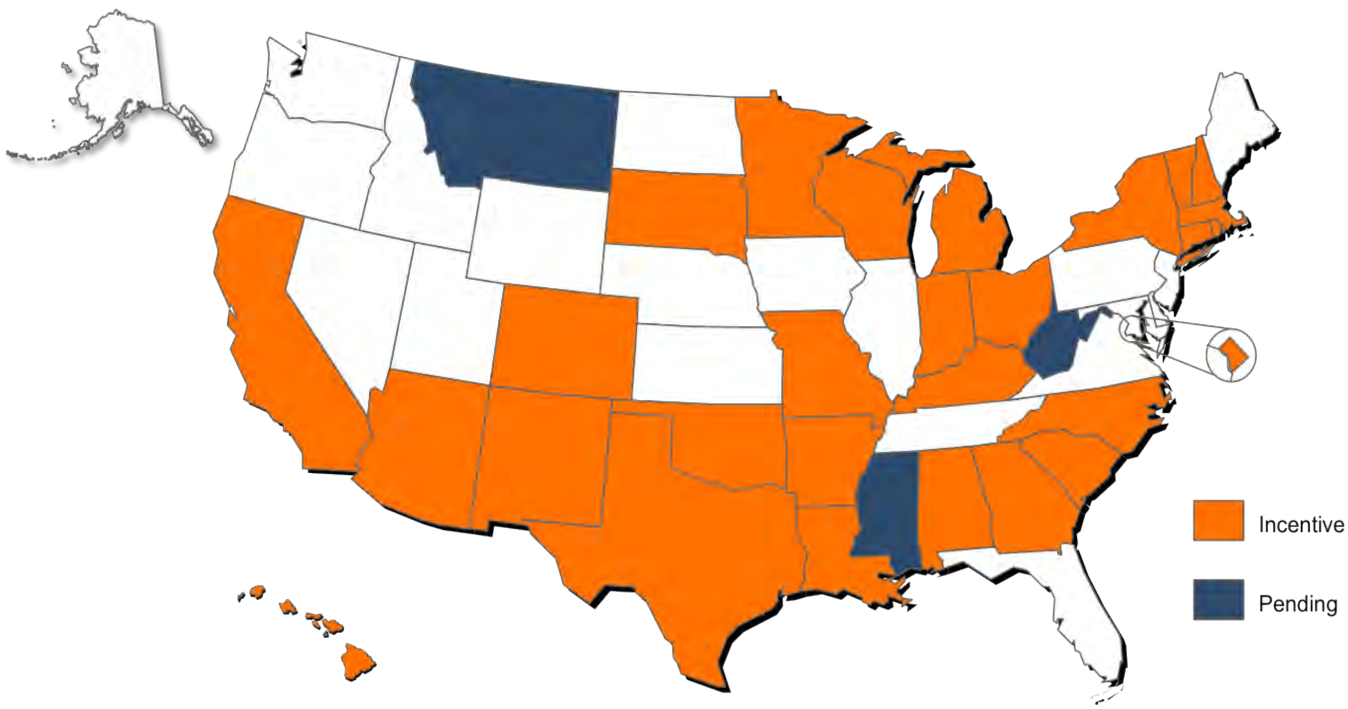
State	Description	Status	Codes, Orders & Resources
Massachusetts	Gas and electric utilities in Massachusetts must include a decoupling proposal in their next rate case. Target revenues are determined on a utility-wide basis (full decoupling) and can be adjusted for inflation or capital spending requirements if necessary. The Massachusetts DPU expects that all utilities will have fully operational decoupling plans by 2012. In May 2009, National Grid was the first utility to submit a revenue decoupling ratemaking plan (RDR), which proposes an RPC mechanism that adjusts annually.	Approved (2008), full implementation by 2012	Docket 07-50; Docket 09-39
Mississippi (LR)	In July 2013, the Mississippi Public Service Commission issued a final order in Docket No. 2010-AD-2, adding Rule 29, related to the Conservation and Energy Efficiency Programs. Section 106 in Rule 29 defines energy efficiency program costs as the incremental program costs that are not already included in the then-current utiity rates and the lost contribution to fixed costs associated with approved energy efficiency programs. Cost recovery shall include full and timely recovery of incremental program costs and the lost contribution to fixed cost.	Pending	Docket No. 2010-AD-2
Missouri (LR)	In 2011, the Missouri Energy Efficiency Investment Act authorized utilities to file plans to recover a portion of the net benefits of demand-side energy efficiency programs. Ameren Missouri and KCP&L GMO LR rate cases were approved in late 2012. Two other cases - Kansas City Power & Light Company and The Empire District Electric Company - were withdrawn in 2012, and is likely they will refile by 2014.	Approved (2012)	SB376; Case No. EO 2012-0142; Case No. EO 2012-0166; Case No. EO-2012-0009; Case No. EO-2012-0175
Montana (LR)	In December 2005, the MT PSC approved Northwestern Energy's petition for a lost transmission and distribution revenue recovery mechanism. Under the mechanism, lost revenues due to DSM acquisition efforts are factored into rates monthly as part of Northwestern's default supply cost tracker. The estimated lost T&D revenue amount is then trued-up annually based on actual program activity following a comprehensive program evaluation and independent verification of actual savings, which must be filed with the Commission. NWE must consult with its advisory committee on the selection of an independent contractor to evaluate DSM programs and the scope of work. In December 2010, the Commission granted NorthWestern Corp. a decoupling mechanism as part of its electric rate case. NorthWestern filed a motion for reconsideration, leaving the docket open and the implementation of decoupling pending further action.	Approved (LR, 2005)	Dockets D2004.6.90 and D2010.5.50 Docket D2009.9.129
Nevada (LR)	In June 2010, the Nevada PUC approved NV Energy's proposal for a lost revenue recovery mechanism. Approved to implement the legislative directives of S.B. 358 (section 11.3), the mechanism calls for monthly lost revenue trackers with an annual true-up subject to measurement and verification of effects on utility revenue caused or created by energy efficiency and conservation programs.	Approved (2010)	Docket 09-07016; Docket 10-10024; Docket 10-10025; and S.B. 358

State	Description	Status	Codes, Orders & Resources
New Mexico	HB 305, the Energy Efficiency Bill, was signed into law in 2008, requiring that all utilities to include cost-effective energy efficiency and load management portfolios and to remove regulatory disincentives for these programs. As a result, in 2010, the NM Public Regulation Commission instituted an adder for all utilities. The adder comprised of a lost revenue adjustment and a performance premium, combined into a single payment. In July 2011, the New Mexico Supreme Court vacated the adder, stating that it must be cost-based and that each utility must file individually. In November, 2011, the Commission issued orders that PNM and El Paso Electric are authorized to continue collecting the adder. Southwestern Power Service did not file for an adder in its 2011 energy efficiency program filing. HB 267, which becomes effective July 1, 2013, amends HB 305 and includes a fixed tariff rider (3% of revenues) to help fund efficiency programs. The bill also switched the cost-benefit test from Total Resource Cost (TRC) to the Utility Cost (UC) model. Finally, the bill reduced the requirement for energy savings by 2020 from 10% to 8% of 2005 retail sales following a compromise between the Commission, utilities, and interest groups.	Approved (2011)	HB 305 (2008); Dockets 08-00024-UT, 10-00086-UT, 10-00280-UT, 11-00047-UT, 12-00317-UT; SEC 10K Sept 30, 2012 PNM filing
New York	Following an April 2007 order, electric and gas utilities must file proposals for true-up based decoupling mechanisms in ongoing and new rate cases. Proposals have been approved for Consolidated Edison and Orange & Rockland utilities, both for revenue-per-class mechanisms. True-ups occur annually.	Approved (2007)	Cases 03-E-0640, 07-E-0949, & 07-E-0523
North Carolina (LR)	The Commission approved a proposed lost revenue adjustment mechanism for Progress Energy Carolinas as part of their cost recovery mechanism. Net lost revenues for each annual period are recovered over 3 years and determined by multiplying lost sales by a net lost revenue rate, which is the difference between the average retail rate applicable to the customer class impacted by the measure and (1) the related customer charge component of that rate, (2) the fuel component of the rate, and (3) the incremental variable O&M rate. True-ups occur annually. The Commission also approved a similar mechanism for Duke Energy Carolinas in December 2009 for energy efficiency measures only, coinciding with the approval of the utility's virtual power plant mechanism.	Approved (2009)	Docket E-2, Sub 931; Docket E-7, Sub 831

State	Description	Status	Codes, Orders & Resources
Ohio (D, LR)	Lost revenue recovery mechanisms are determined on a case-by-case basis. Duke Energy Ohio recovers lost revenues resulting from their portfolio of EE programs through the DSM rider. LR is calculated as the amount of kWh sales lost due to the DSM programs times the energy charge for the applicable rate schedule, less variable costs, divided by the expected kilowatt-hour sales for the upcoming 12 month period. They are collected over a 36 month period. The Commission ordered AEP Ohio to develop a 3 year decoupling pilot program for 2012-2014. In this pilot there shall be no cap of annual rate decreases to customers; however, annual increases attributable to the pilot shall be capped at 3 percent of the total annual distribution revenues for a customer class. Duke Energy Ohio has a distribution revenue adjustment mechanism for large non-residential customers and distribution revenue decoupling for residential and small non-residential customers.	Approved (2007)	ORC §4928.143(B)(2)(h); 06-0091-EL-UNC; Case No. 11-3549-EL-SSO Case No. 11-0351-EL-AIR
Oklahoma (LR)	OG&E has direct lost revenue adjustment ("Class Lost Revenue Factor") built in to the approved demand program rider (DPR) structure, which includes a shared savings mechanism (see p. 15). As the name implies, LR amounts are examined by customer class.	Approved (2009)	Cause No. PUD 200800059, Order 556179
Oregon	Portland General Electric was approved for a two year pilot employing an RPC decoupling mechanism. True-ups will occur annually.	Approved - Pilot (2009)	Order 09-020
Rhode Island	May 2010, the Rhode Island passed the Decoupling Act (R.I.G.L. §39-1-27.7.1), mandating that Narragansett Electric Co., a subsidiary of National Grid Group Plc., decouple its revenues from sales. In October 2010, National Grid filed a request with the Rhode Island Public Utilities Commission to implement revenue decoupling mechansims for its electric and gas operations. In May 2012, order 20745 was issued approving National Grid's RDM proposal. It is retroactive to April 2011 and an adjustment factor is to be annually.	Approved (2012)	(R.I.G.L. §39-1-27.7.1) Docket No. 4206, Order 20745
South Carolina (LR)	The Commission approved a proposed lost revenue adjustment mechanism for Progress Energy Carolinas as part of their cost recovery mechanism. Net lost revenues for each annual period are recovered over 3 years and determined by multiplying lost sales by a net lost revenue rate, which is the difference between the average retail rate applicable to the customer class impacted by the measure and (1) the related customer charge component of that rate, (2) the fuel component of the rate, and (3) the incremental variable O&M rate. True-ups occur annually.	Approved (2009)	Docket 200-251-E

State	Description	Status	Codes, Orders & Resources
South Dakota (LR)	Beginning in 2010, the SD utilities switched from receiving performance incentives to receiving a fixed percentage of lost revenues. MidAmerican and OtterTail Power converted in 2010 and 2011, respectively. Black Hills and Xcel Energy began recovering in 2011 as well. NorthWestern Energy is expected to file a lost revenue mechanism in the near future. All programs are still in the pilot phase and have not been incorporated into the base rate cases yet. They all allow for riders with annual true-ups for the recovery of lost revenues.	Approved (2010)	Dockets EL11-012; GE10-001; EL11-002; EL11-013; GE12-001
Vermont	An RPC decoupling program was approved for Green Mountain Power under the Alternative Regulation Plan. Rates can be adjusted up to four times per year with an annual reconciliation on allowed earnings. Changes in base rates cannot exceed ~2% per year. CVPS was also approved for decoupling in 2008.	Approved (2007)	Dockets 7175, 7176 & 7336
Virginia (LR)	Virginia Code Section 56-585.1 allows for revenue recovery related to energy efficiency programs. In 2010 and 2011, Dominion Virginia Power applied for lost revenue recovery but was denied both times. The Comission did not find the calculation of lost revenues specific enough and lacked adequate evidence linking these lost revenues back to energy efficiency programs	Pending (2010)	Docket: PUE-2010-00084; Docket: PUE-2011-00093
Washington	The Washington Utilities and Transportation Commission (WUTC) approved decoupling mechanisms for PSE on June 25, 2013. The commission will allow PSE to increase rates by 3.34% this year, and over the next 3-4 years, a maximum of 3% of its revenue with any excess amounts above the 3% recovered in the following year.	Approved (2013)	Docket UE-121373
Wisconsin	Decoupling was approved for WPSC in December 2008 (specified as a "Revenue Stabilization Mechanism"), allowing the utility to pursue a four-year pilot program. WPSC is required to pursue three community-based pilots, which will be regularly reviewed (at 2, 12, 24, and 30 months). True-ups occur annually and over- or under-collection is capped at approximately $14 million.	Approved - Pilot (2008)	Dockets 6680-UR-116 (WPL) & 6690-UR-119 (WPSC)
Wyoming (LR)	A tracking adjustment mechanism that includes direct lost revenue recovery was approved for a small service territory covered by Montana Dakota Utilities. The adjustment applies to all MDU customers to recover costs and lost revenues for load management programs only.	Approved (2007)	Docket No. 20004-65-ET-06

EE Performance Incentives for Electric Efficiency Providers by State



State	Performance Incentive Description	Status	Relevant Statute, Code or Order
Alabama	Alabama Power is able to recover a "reasonable rate of return" on efficiency program spending through a rate rider.	Approved	Docket 31045
Arizona	Arizona Public Service (APS), Tucson Electric Power (TEP), and UniSource all have have performance incentives in place under a shared savings mechanism, set at a percentage of DSM program net economic benefits and capped at a percentage of total DSM expenditures. The percentages are dependent on achievemnt relative to energy efficiency goals. Each incentive is independently determined based on the utility's rate case.	Approved (2005)	Decision 67744, Docket E-01345A-05-0816, et al
Arkansas	In 2010, the Commission issued Order No. 15, approving performance incentives through a shared savings of net benefits approach. 10% of net benefits will be awared to a utility for achievement above 80% of the savings goal. Total incentive rewards are capped at 5% of proposed budget for achievement between 80% and 100% of goal; 7% of budget for achievement between 100% and 110% of goal. Net benefits shall be based on a TRC test. EE program portfolio goals as a percentage of 2010 energy sales are: 2011: 0.25%, 2012: 0.50%, 2013: 0.75%	Approved (2010)	Docket 08-137-U, Order No. 15

State	Performance Incentive Description	Status	Relevant Statute, Code or Order
California	California utilities earn an incentive on energy efficiency programs under a shared savings mechanism called an energy efficiency risk-reward incentive mechanism. Revenue from eligible energy efficiency programs is the product of the Earnings Rate (ER) and net benefits. The ER is 12% if the utility achievement towards CPUC goals is greater than 100%, 9% if the goal achievement is between 85 and 100% and 0% if the goal achievement is between 65 and 85%; if the achievement of goals is less than 65%, the utility pays a penalty. Net benefits are calculated as two-thirds of the TRC Net Benefit and one-third of the PAC Net Benefit. In January 2009, the CPUC instituted a rulemaking (09-01-019) to examine and reform the EE incentive mechanism. Examination and proposed reform of California's risk-reward incentive mechanism continues in the rulemaking 12-01-0005. Currently, no decision has been made as to whether incentive payments will be made related to 2010-2012 EE program activities.	Approved (2007)	R.06-04-010; R.09-01-019; R.12-01-005
Colorado	HB 07-1037 (C.R.S. §40-3.2-104) requires investor-owned electric utilities to achieve at least 5% percent reduction of retail energy sales and capacity savings by 2018, based on 2006 sales. The law further states that the Commission shall allow electric DSM investments an opportunity to be more profitable to the utility than any other utility investment that is not already subject to an incentive. The Commission approved the following incentive package to Public Service Colorado: ■ A "disincentive offset" of $5m/year (pre-tax) for each year approved DSM plan implemented to offset lost margins, if the Company meets or exceeds 100% of its savings goals. Public Service will receive a pre-tax offset of $3.2m for performance relative to its savings goals between 80% and 99%. ■ Performance incentives for surpassing "modest" goals; for each 5% increase of achieved savings above 80% of goal, the company can earn an additional 1% of net economic benefits, up to 15% at 150% goal attainment. ■ Incentives are allowed via annually trued up DSM Cost Adjustment and are capped at $30 million. The Colorado PUC is revisiting the goals and incentive mechanisms in Docket 13A-0686EG.	Approved (2007)	HB-07-1037; Decision C08-560, Dockets 07A-420E, 10A-554EG, and 13A-0686EG
Connecticut	The CT PUC requires annual hearings for utilities, where the past year's results for energy savings are reviewed and a performance incentive is determined, which ranges from 1% to 8% of program costs. The minimum threshold of 70% of goals earns the minimum (1%) incentive. Reaching 100% of goals earns 5%, and for reaching 130% of goals earns 8%.	Approved (first in 1988, mechanism changes over time)	Dockets 07-10-03; 08-10-03; 09-10-03

State	Performance Incentive Description	Status	Relevant Statute, Code or Order
District of Columbia	Section 202 of the DC Clean and Affordable Energy Acot of 2008 authorizes the District's Department of the Environment to award "performanced based" and "financial" incentives to the operator of DC's Sustainable Energy Utility, VEIC, for meeting or exceeding specific performance benchmarks established in its contract. The contract with the Department of the Environment also includes financial penalties should the utility fail to meet the performance benchmarks	Approved (2008)	Section 202 of the DC Clean and Affordable Energy Act of 2008
Georgia	Georgia Power will receive an additional sum of 10% of the NPV of the actual net benefits of gross kWh savings (as determined by the Program Administrator test) from certified DSM programs, if they achieve annual incremental kWh savings of more than 50% of projections. If programs achieve less than 50% of projected kWh savings, the additional sum is 0.5% of NPV of net benefits for demand response measures and 3% of NPV of net benefits for energy efficiency measures. There is no cap to the incentive payments, however, if the incentive sum exceeds program costs, the portion of the total that exceeds the program cost is 5% of NPV of actual net benefits of gross kWh savings from the certified DSM programs (as detemined by the Program Administrator test).	Approved (2010)	Order Docket 31082
Hawaii	As part of the state's transition plan to establish a third-party administrator for efficiency programs, the HECO companies are responsible for administering their own DSM programs until the transition date. HECO may earn a shared percentage of savings of 1%-5% with an incentive cap of $2M.	Approved (2008)	Docket & Order 23258, Docket 2007-0323
Indiana	The state statute allows for either shared savings or adjusted/bonus ROE mechanisms as DSM incentives. To meet mandatory energy efficiency goals, Indiana utilities have developed "Core Plus" DSM programs. Duke Energy, Indianapolis Power & Light and Southern Indiana Gas & Electric Company received approval for a tiered structure shareholder performance incentives, and Indiana Michigan Power Company received approval for a shared benefits approach. Other cases currently pending before the Commission related to energy efficiency programs and performance incentives include No. 43938 (Vectren Energy Indiana), No. 43912 (Northern Indiana Public Service Company), and No. 43960 (Indianapolis Power and Light).	Approved (2010)	Administrative Code, Title 170, Art. 4; Cause No. 43374; Cause No. 43427; Cause No. 43618; Cause 43623; Cause No.43827; Cause No. 43938; Cause No. 43912; Cause No. 43960; Cause No. 43955
Kentucky	Performance incentives can be collected for three types of energy efficiency programs: programs for those who have difficulty participating in energy efficiency due to financial circumstances, programs aimed at residential housing, programs with long-run potential reduction in energy use."	Approved (2007)	Rev. Stat. 278.285(1)(c); Docket 2008-00473; 2007-00477

State	Performance Incentive Description	Status	Relevant Statute, Code or Order
Louisiana	In December 2012, the Louisiana Public Service Commission (PSC) approved a plan to give utilities a year to develop energy efficiency programs for their ratepayers. The Commission reversed its decision in February 2013, but again agreed to revisit the initiative in May 2013 after several consumer and environmental groups filed suit. In June 2013, the PSC voted to reinstate the initiative. The type of performance incentive mechanism has yet to be determined.	Approved (2013)	Docket R-31106
Massachusetts	The incentive allows utilities to earn about 5% of program costs for energy efficiency programs that meet established program goals. The incentive structure is determined on a program-by-program basis but generally utilizes a three-tiered structure. The first "design performance" level is defined as performance that a Program Administrator expects to achieve in implementing its energy efficiency programs. The second "threshold performance" level is 75% of the design level. The third "exemplary performance" level is 125% of the design level. Incentives are awarded only if a program achieves the threshold level or above.	Approved (2000)	Docket 04-11; Order 98-100
Michigan	The Commission approved DTE's energy optimization plan in 2009, which includes an incentive mechanism that allows the utility to earn up to 15% of program spending (a cap mandated by PA 295) if they reach 125% of their savings goals. An incentive payment is applied only if DTE exceeds its savings goal. PA 295 contains two provisions authorizing utilities to receive an economic incentive for energy efficiency programs. To be eligible, utilities must request that appropriate energy efficiency program costs be capitalized and earn a normal rate of return. Utilities can request a performance incentive mechanism to provide additional earnings to shareholders if they exceed the annual energy savings target. Incentives are capped at 15% of the total program cost.	Approved (2009)	PA 295 (2008); U-15806
Minnesota	The PUC revised the performance incentive originally approved in 1999. Under the new agreement, utilities retain a portion of net benefits based on the level of achievement, measured as a percent of retail sales. The award scale for this modified shared savings mechanism is calibrated to award $0.09/kWh at 1.5% of sales (e.g. if a utility achieves savings equal to 1.5% of sales, it will receive $0.09 for every kWh saved. The order was approved in January 2010.	Approved (1999); Revised mechanism (2010)	Docket CI-08-133, Statute 216B.241
Mississippi	In July 2013, the Mississippi Public Service Commission issued a final order in Docket No. 2010-AD-2, adding Rule 29, related to the Conservation and Energy Efficiency Programs. Section 106 in Rule 29 states that the utility may propose an approach to earn a return on energy efficiency investments through a shared savings or other performance based incentive mechanism to make these investments more like other investments on which utilities earn a return.	Pending	Docket No. 2010-AD-2

State	Performance Incentive Description	Status	Relevant Statute, Code or Order
Missouri	The Missouri PSC approved Ameren Missouri and KCP&L GMO's requests for performance incentives using a shared net benefits approach. The Ameren agreement allows $80 million in annual revenue requirement in Ameren Missouri's recent general rate case (Case No. ER-2012-0166) for recovery of demand-side programs' costs and recovery of fixed operating costs. The KCP&L GMO agreement allows $18 million in annual revenue requirement in GMO's recent general rate case (Case No. ER-2012-0175) for recovery of demand-side programs' costs and recovery of fixed operating costs (to overcome the through-put disincentive) and which will allow the Company to earn a future performance incentive award based on after-the-fact verified 3-year program energy savings and demand savings.	Approved (2012)	Case No. EO-2012-0166; Case No. ER-2012-0175
Montana	MT statute allows for the Public Service Commission to add 2% to the authorized rate of return for DSM investments. It has not yet been approved for a specific utility.	Pending. Passed into law, but not implemented by utility	Code 69-3-712
New Hampshire	The PUC is currently re-evaluating its performance incentive mechanism as it regards electric and natural gas savings and fuel-blind savings. There are two separate incentives in NH. The cost-effectiveness incentive is awarded for programs that achieve a cost effectiveness ratio of 1.0 or higher. The incentive is calculated as 4% of the planned EE budget times the ratio of actual to planned cost effectiveness. The energy savings incentive is awarded when actual lifetime kWh savings are greater than or equal to 65% of projected savings. The incentive is 4% of the planned EE budget times the ratio of actual to planned energy savings. Target incentive amounts are calculated separately for residential and commercial/industrial sectors and are capped at 12% of the planned sector budgets.	Approved (2000)	Docket DE 12-262; Order No. 25,462
New Mexico	In April 2010, the PSC approved a rule making that allows utilities to receive an incentive of between $.01 and $.005 per kWh saved and $10 per kW saved for EE. Utilities must file rate designs and ratemaking methods to remove regulatory disincentives to energy efficiency acquisition by July 2010. May 2011 stipulated agreement for El Paso Electric is pending before the Commission. Terms of the agreement include payment of $0.0045 per kWh saved and $20 per annual kW saved. Payments are calculated on a calendar year basis using projected savings for EPE's programs, subject to true up. Additionally, HB 305 was passed in 2008 which requires all utilities to "include all cost-effective energy efficiency and load management programs in the energy resource portfolios, and that regulatory disincentives to public utility development of cost-effective energy efficiency and load management be removed."	Approved (2010)	Case 08-00024-UT; Case 10-00266-UT; CASE 10-00280-UT; NM HB 305

State	Performance Incentive Description	Status	Relevant Statute, Code or Order
New York	The first phase of performance incentives were eligible to be collected for the 2011 year. The order caps the aggregate incentives at $40M per year statewide and target megawatt-hours will be set for each year at the time of review for the EE plans. Utilities could be rewarded or penalized for energy efficiency performance. As of June 2012, these incentives were being accounted for and will be paid out to the utilities upon completion. Phase 2 of the performance incentives will span 2012-2015. Incentives will total $36 million statewide over the three years - 2/3 of the amount can be earned by each utility independently, 1/3 of the amount will be distributed if the utilities reach a statewide goal. Utilities can only be positively rewarded in Phase 2. The proposal is still awaiting finalization.	Approved (2011)	Case 07-M-0548; Commission Opinion No. 89-29
North Carolina	North Carolina state law states that a utility may propose incentives for demand side management or energy efficiency programs to the Commission for consideration. The commission approved Progress Energy Carolina's incentive mechanism that allows for an incentive of 8% of NPV of benefits from DSM programs and 13% of NPV from EE programs. The Commission is considering an avoided cost recovery mechanism submitted by Duke Energy. The Commission issued a notice of decision approving Duke Energy Carolinas' Save-a-Watt program in December 2009 with a full decision to follow in January 2010. The program is similar to that in Ohio, where Duke will receive 50% of the net present value (NPV) of the avoided costs for conservation and 75% of the NPV for demand response.	Approved - Progress Energy Carolinas (2009), Duke Energy (2009)	Docket E-2, sub 931; Docket E-7, Sub 831
Ohio	Duke Energy received approval in December of 2008 for its proposed "Save-a-Watt" program, where the utility will receive 50% of the NPV of the avoided costs for energy conservation and 75% of the NPV of the avoided costs for demand response. Demand response programs are viewed by the parties as having a useful life of 1 year, while energy conservation programs have useful lives of up to 15 years. This mechanism was approved through December 31, 2011. Duke Energy Ohio has filed for a new recovery mechanism of Shared Savings. This is at a tiered level dependent upon impacts achieved. Duke Energy Ohio has also filed a decoupling mechanism to account for LR.	Approved (2008)	Docket 08-920-EL-SSO Docket11-4393-EL-RDR
Oklahoma	A shared savings program has been approved for Public Service Oklahoma (AEP) which allows for two different returns: an incentive of 25% of net savings for programs for which savings can be estimated and 15% of the costs for other programs (e.g. education and marketing programs). OG&E also has an incentive mechanism where they receive shared benefits for achieving savings goals, calculated on a measure-by-measure basis.	Approved - PSO (2008), OG&E (2009)	Cause No. PUD 200700449, Order 555302; Cause No. PUD 200800059, Order 556179

State	Performance Incentive Description	Status	Relevant Statute, Code or Order
Rhode Island	The shareholder incentive mechanism includes two components: performance-based metrics for specific program achievements, and kWh savings targets by sector. The program performance metrics are established for each individual program, such as achieving specific savings or a certain market share for the targeted energy-efficient technology. If Narragansett (d/b/a National Grid) achieves the savings goal, it receives 4.4% of the eligible budget. The threshold performance level is 60% of the savings goal. Once the threshold level has been reached, the utility has the ability to earn an additional incentive per kWh saved up to 125% of target savings. Incentive rates change by customer class.	Approved (2005)	Docket 3635, Order 18152
South Carolina	South Carolina law stipulates that the PSC "may adopt procedures that encourage electrical utilities [...] to invest in cost-effective energy efficient technologies and energy conservation programs." The Commission approved Progress Energy Carolina's incentive mechanism that allows for an incentive of 8% of NPV of benefits from DSM programs and 13% of NPV from EE programs. The Commission issued a notice of decision approving Duke Energy Carolina's Save-A-Watt program in December 2009 with full decision to follow in January 2010. The program calls for Duke to receive 55% of the net present value (NPV) of the avoided costs for conservation and 75% of the NPV for demand response.	Approved for Progress Energy Carolinas (2009); Approved for Duke Energy (2010)	Title 58. Public Utilities, Services And Carriers, Chapter 37. Energy Supply And Efficiency; Dockets 2008-251-E (Progress Energy), 2007-358-E, & 2008-251-E (Duke Energy)
South Dakota	The South Dakota Commission approved performance incentives for OtterTail in 2008, and MidAmerican in 2010. OtterTail has a flat-rate bonus incentive, while MidAmerican has a straight return on the program's budget. Montana-Dakota Utilities and Northwestern Energy also have performance incentives.	Approved (2008)	Docket Nos. EL-07-015, GE10-001, NG09-001, and GE09-001
Texas	Texas state code specifies that a utility may be awarded a performance bonus (a share of the net benefits) for exceeding established demand reduction goals that do not exceed specified cost limits. Net benefits are the total avoided cost of the eligible programs administered by the utility minus program costs. The performance bonus is based on the utility's energy efficiency achievements for the previous calendar year. If a utility exceeds 100% of its demand reduction goal, the bonus is equal to 1% of the net benefits for every 2% that the demand reduction goal has been exceeded, up to a maximum of 20% of the utility's program costs. A utility that meets at least 120% of its demand reduction goal with at least 10% of its savings achieved through Hard-to-Reach programs receives an additional bonus of 10% of the bonus calculated.	Approved (2008)	PUC of Texas Substantial Rule §25.181(h); CenterPoint Energy Houston Electric 2008 Energy Plan & Report, Project No. 35440

State	Performance Incentive Description	Status	Relevant Statute, Code or Order
Vermont	The operator of Efficiency Vermont, VEIC, is eligible to receive a performance incentive for meeting or exceeding specific goals established in its contracts. There is also a holdback in the compensation received by VEIC, pending confirmation that contractual goals for savings and other performance indicators have been achieved. The initial contract (2000-2002) allowed incentives of up to 2% of the overall energy efficiency budget over the three-year contract period. Incentives increased to 3.5% of the EE budget for the 2006-2008 period.	Approved (2000)	Contract 0337956, Attachment C
West Virginia	On April 1, 2013, AEP filed a proposal to the Public Service Commission seeking performance incentives for its energy efficiency programs. AEP's proposal includes an incentive of 5% of the pre-tax net benefits of their programs, up to 12% of overall program costs. The PSC is still reviewing AEP's case (13-0462).	Pending	Case No. 13-0462
Wisconsin	As of 2008, Wisconsin Power & Light (Alliant Energy) may earn the same rate-of-return on its investments in energy efficiency made through its "shared savings" program for commercial and industrial customers as it earns on other capital investments. Utilities may propose incentives as part of their rate cases, but there have been no proposals from other utilities under the most recent version of performance incentives. [Note: Wisconsin dropped performance incentives in the 1990s.]	Approved (2008)	Docket 6680-UR-114

Summary of Incentive Mechanisms

Approach	State
Earn a percentage of program costs for achieving savings target	AL, CT, MA, MI, NH, RI, SD, VT
Earn a share of achieved savings	AZ, AR, CA, CO, GA, HI, IN, KY, MN, MO, OK, NM, NY
Earn a percentage of the NPV of avoided costs	NC, OH, SC, TX
Altered rate of return for achieving savings targets	WI

Note: Information on lost revenue recovery mechanisms and electric efficiency performance incentives for electric utilities was compiled using the latest public data available as of July 2013. Readers are encouraged to verify the most recent developments by contacting the appropriate commission or regulatory agency. Other resources used in the preparation of this report were ACEEE's State Energy Efficiency Program Database, documents from EPA's National Action Plan on Energy Efficiency, and resources from the Regulatory Assistance Project.

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About IEE

IEE is an Institute of The Edison Foundation focused on advancing the adoption of innovative and efficient technologies among electric utilities and their technology partners that will transform the power grid. IEE promotes the sharing of information, ideas, and experiences among regulators, policymakers, technology companies, thought leaders, and the electric power industry. IEE also identifies policies that support the business case for adoption of cost-effective technologies. IEE's members are committed to an affordable, reliable, secure, and clean energy future.

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SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
D/B/A VECTREN ENERGY DELIVERY OF INDIANA, INC.

("VECTREN SOUTH")

IURC CAUSE NO. 44495

DIRECT TESTIMONY

OF

MICHAEL P. HUBER

MANAGER, ELECTRIC DSM & CONSERVATION

ON

ELECTRIC DEMAND SIDE MANAGEMENT ("DSM")
2015 PROGRAM PORTFOLIO

SPONSORING PETITIONER'S EXHIBITS MPH-1 THROUGH MPH-3

VERIFIED DIRECT TESTIMONY OF MIKE HUBER

INTRODUCTION

Q. Please state your name and business address.

A. My name is Michael P. Huber. My business address is One Vectren Square, Evansville, Indiana, 47708

Q. By whom are you employed and in what capacity?

A. I am employed by Vectren Utility Holdings, Inc ("VUHI"), the immediate parent company of Indiana Gas Company, Inc. d/b/a Vectren Energy Delivery of Indiana, Inc. ("Vectren North"), Vectren Energy Delivery of Ohio, Inc. ("VEDO") and Southern Indiana Gas and Electric Company, Inc. d/b/a ("Vectren South"), which has both a gas division and an electric division. I am the Manager of Electric Demand Side Management ("DSM") and Conservation for VUHI.

Q. What is your educational background?

A. I received a Bachelor of Science degree in business administration from the University of Southern Indiana in 1992.

Q. What is your business experience?

A. My professional experience began in 1995 at Kimball International based in Jasper, Indiana. I worked there as a sales coordinator and later as Manager of Customer Service and Director of Customer Service. I began working for VUHI in 2001 and have held a variety of positions. Previously I was Manager of Gas Conservation, with responsibility for the management of all aspects of the gas conservation portfolio for all three VUHI regulated utilities. Prior to that, I was Manager of Conservation Marketing, with responsibility for all program communications for the gas and electric conservation programs. I have also held other positions including Manager of Customer Service Programs, Manager of Marketing and Contact Center Supervisor.

Q. Have you previously testified before the Indiana Utility Regulatory Commission ("Commission")?

A. No.

Q. Are you sponsoring any exhibits in this proceeding?

A. Yes. I am sponsoring the following exhibits:

Petitioner's Exhibit MPH-2, which is the Vectren South 2015 Electric DSM Plan ("2015 Plan"); and Petitioner's Exhibit MPH-3, which is the EnerNOC Market Potential Study ("MPS").

Q. What is the 2015 Plan and what does it contain?

A. The 2015 Plan is the roadmap for Vectren South to achieve its energy and demand savings goals cost effectively. It describes programs and their elements so that they can be implemented by the Company. Although it provides direction for Vectren South, it is important to note that the programs will continue to be refined. The new program descriptions include a program summary, target markets, market barriers/theory, initial measures/services recommended, estimated savings, implementation and delivery approach, incentive strategies, participation criteria, evaluation approach and budgets. From this information, a cost benefit analysis is completed to assure that the programs are cost effective when compared to supply side options.

Q. Were your testimony and exhibits in this proceeding prepared by you or under your supervision?

A. Yes.

PURPOSE

Q. What is the purpose of your testimony in this proceeding?

A. The purpose of my testimony is to describe the 2015 Plan, including estimated costs, benefits, load impacts, participation and program descriptions. I will also discuss potential DSM plans beyond 2015.

CURRENT ELECTRIC DSM PROGRAMS

Q. Please provide a brief description of the current portfolio of electric DSM programs offered by Vectren South in its service territory.

A. Vectren South's current portfolio of electric DSM programs includes the following Core and Core Plus Programs:

Core DSM Programs

- School Energy Efficiency Program
- Residential Lighting Program
- Home Energy Assessment ("HEA") Program
- Income Qualified Weatherization ("IQW") Program
- Commercial & Industrial Prescriptive Program

Core Plus DSM Programs

- Residential Appliance Pick-up Program
- Residential New Construction
- Residential HVAC Program
- Residential Behavioral Savings Program
- Multi-Family Direct Install Program
- Commercial & Industrial Audit and Customized Efficiency Program
- Commercial & Industrial New Construction Program

Q. Does Vectren South currently offer DSM programs to all classes of customers?

A. Yes. The Programs are devoted to efforts to reduce the electric demand and usage of customers served under the Residential, General Service and Industrial rate schedules. Specifically, programs are available to customers served under rate tariffs of RS, B, SGS, DGS, MLA, OSS, LP and HLF.

Q. Does Vectren South currently offer any joint gas/electric DSM programs?

A. Yes. Vectren South currently offers the following joint gas/electric DSM programs:

Core

- Home Energy Audit
- Income Qualified Weatherization

Core Plus

- Residential Behavioral Savings
- Multi-Family Direct Install
- Residential New Construction

2015 ELECTRIC DSM PROGRAM PORTFOLIO

Q. Please provide a brief description of the 2015 Plan.

A. The 2015 Plan was designed in large part based upon Vectren South's current program offerings. Many of the programs the Company currently offers will continue in 2015.

Vectren South has merged the current core program offerings into the 2015 Vectren South administered programs and will deliver all of the programs without making a distinction. The 2015 Plan includes many of the current programs from 2014 with minor adjustments to improve the performance of the programs. Table MPH-1 below compares the existing offerings to the new 2015 Plan:

Table MPH-1 – 2014/2015 Program Comparison

2014 DSM Program	2015 Program Status
Residential Lighting (Core)	Continues as standalone program under Vectren administration
Home Energy Audit (Core)	Continues as standalone program under Vectren administration
Income Qualified Weatherization (Core)	Continues as standalone program under Vectren administration
Energy Efficient Schools (Education & Audits) (Core)	Education portion continues as standalone program under Vectren administration; Audit portion merged into C&I Audit & Small Business Direct Install program
C&I Prescriptive (Core)	Continues as standalone program under Vectren administration
Residential Appliance Recycling (Core Plus)	Continues as standalone program under Vectren administration
Residential Behavioral Savings (Core Plus)	Continues as standalone program under Vectren administration
Residential New Construction (Core Plus)	Continues as standalone program under Vectren administration
Residential HVAC (Core Plus)	Continues as standalone program under Vectren administration
Multi-Family Direct Install (Core Plus)	Reached market saturation, program dropped from portfolio for 2015
C&I Custom (Core Plus)	Continues as standalone program under Vectren administration
C&I New Construction (Core Plus)	Continues as standalone program under Vectren administration
Small Business Direct Install (Core Plus)	Continues as standalone program under Vectren administration

Q. Please describe the proposed program changes.

A. Vectren South is proposing two changes to current programs for 2015. First, Vectren South is proposing to eliminate the audit component of the School Energy Efficiency Program. The audit component of the program has struggled to gain momentum and there are a limited number of available school systems in southern Indiana to take advantage of the program. Schools located in Vectren South's electric service territory will be able to continue to participate in the energy efficiency education program and can take advantage of the rebates and other incentives offered through Vectren South's commercial and industrial (C&I) custom and prescriptive program as well as small business direct install. The other change Vectren South is proposing is to eliminate the multi-family direct install program. Vectren South has offered this program since April 2010 and it has reached market saturation. Businesses that own multi-family dwellings will be able to participate in the Residential Efficient Products program beginning in 2015.

Q. Does the 2015 Plan include DSM program offerings for all customer classes?

A. Yes. The 2015 Plan includes efforts devoted to reduce the electric demand and usage of customers served under the Residential, General Service and Industrial rate schedules. Specifically, programs are available to customers served under rate tariffs of RS, B, SGS, DGS, MLA, OSS, LP and HLF.

Q. Does Vectren South have a process in place to allow Qualifying Customers to opt-out of participation in the Company's DSM programs?

A. Yes. Certain large C&I customers are eligible to opt-out of participation in Company sponsored DSM programs ("Qualifying Customers") and will be able to opt out in accordance with Senate Enrolled Act No. 340 ("SEA 340"). The procedures for the opt-out will adhere to those being addressed by the Commission in Cause No. 44441.

Q. What are the estimated participation costs and benefits of the 2015 Plan?

A. The 2015 DSM Plan has an estimated cost $8.6 million, $3.5 million for Residential Programs and $5.1 million for Commercial Programs. These amounts include anticipated evaluation costs. The 2015 DSM Plan establishes a portfolio of programs to achieve energy savings of 44,121 megawatt hours ("MWh"), 20,548 MWh for Residential Programs and 23,573 MWh for Commercial Programs. Table MPH-2 below outlines the program goals and shows participation, energy/demand impacts and program costs.

Table MPH-2 – 2015 DSM Program Goals and Budgets

Vectren South - Residential Program Impacts, Participation & Budget				
Program Year	Participation/ Measures	Annual Energy Savings MWh	Annual Peak Demand Savings kW	Program Budget $,000
2015	319,506	20,548	4,090	$3,540

Vectren South - Commercial & Industrial Impacts, Participation & Budget				
Program Year	Participation/ Measures	Annual Energy Savings MWh	Annual Peak Demand Savings kW	Program Budget $,000
2015	24,504	23,573	4,550	$5,087

Vectren South - Total Portfolio Impacts, Participation & Budget				
Program Year	Participation/ Measures	Annual Energy Savings MWh	Annual Peak Demand Savings kW	Program Budget $,000
2015	344,010	44,121	8,640	$8,627

Q. Please describe the process used to design the 2015 Plan.

A. Vectren South completed an MPS in April 2013, which assisted in the process for developing the 2015 Plan. With the passage of SEA 340, Vectren South decided to develop a one year action plan for 2015 which serves as the framework for the proposed 2015 Plan. The Company retained Morgan Marketing Partners to assist in creating that the 2015 Plan.

Q. Can you further explain how the MPS was incorporated in the planning process for the 2015 Plan?

A. Programs included as part of the planning process for the 2015 Plan were selected to meet targeted savings, stay within a budget target and be able to be effectively implemented by January 1, 2015. The MPS was used as a baseline for planning purposes. However, in the case of Income Qualified Weatherization ("IQW") Plus and Whole House Plus, both programs will be considered as part of program design planning for beyond 2015 and were not included due to timely implementation concerns. In the case of Strategic Energy Management ("SEM"), it was not included in 2015 due to the newness of this type of behavioral based program design and the uncertainty associated with the opt-out process. SEM will be considered as a program option for planning in future years.

Q. Are the budget and savings targets for the 2015 Plan consistent with actual program experience?

A. Yes. The forecasted 2014 DSM Plan program budget approved by the Commission in Cause No. 44318 was approximately 2% of participating customer revenue and the savings target was approximately 1.2% of participating customer sales. In developing the 2015 Plan, these approved 2014 levels served as the planning starting point. The 2015 Plan budget and goals referenced in Table MPH-1 reflects a budget of approximately 1.83% of participating customer revenue and a savings goal of 1.05% of participating customer sales. As a starting point, the budget and savings targets established in the 2015 Plan assumes that 50% of large customers will exercise the option to opt-out of participation in Company-sponsored DSM programs.

Q. Are the planned savings and costs of the 2015 Plan programs, as proposed in this filing, likely to change when the level of large customer opt-out participation is determined?

A. Yes. Vectren South anticipates that 50% of Qualifying Customers will opt-out of participation in Company-sponsored DSM programs, However, that number is subject to change and once the final level of opt-out participation is known, Vectren South will work with the Vectren South Oversight Board ("OSB")to adjust the program savings and costs to reflect the actual level of opt-out participation. Vectren South proposes to make a compliance filing in this Cause to revise its 2015 Plan to include the actual level of opt-out participation. The changes to the 2015 Plan should be limited to only those programs offered to Qualifying Customers.

Q. What did Vectren South learn from its historical program experience that supports the estimate of the budget for its 2015 Plan?

A. Vectren South made modifications to the 2015 Plan based on lessons learned and Evaluation, Measurement and Verification ("EM&V") results. In general, Vectren South learned that markets need time to react to program offerings. While uptake for some programs were immediate, such as the upstream Residential Lighting program, other programs have taken longer to attract participation levels necessary to cost effectively deliver the programs.

The savings methodology for both the Home Energy Audit and IQW programs were modified from a per home deemed savings value to record savings based on the actual number of measures installed. This adjustment was made to account for the number of types of measures being installed to provide more accurate savings and was also based on EM&V results and feedback.

The per unit incentive for the Appliance Recycle program was adjusted from $30 to $50 based on EM&V feedback to increase overall participation and program acceptance.

The Small Business Direct Install Program has been expanded in 2015 to include any participating Vectren South small business customer with a maximum peak demand of less than 300 kW. The program has been very well received in the marketplace. The maximum peak demand in 2014 was less than 150 kW.

Participation and savings targets for the C&I Custom and Prescriptive programs were reduced based on the anticipated large customer opt outs. Additionally, incentives for the

C&I Prescriptive program were increased based on lessons learned from a successful double rebate promotion as part of the statewide program in the fall of 2013.

Q. Does the 2015 Plan include any joint gas/electric programs?

A. Yes. The 2015 Plan includes the following two joint gas/electric programs: residential new construction and residential behavior program. There are multiple other programs where opportunities exist to integrate both gas and electric savings. Vectren South will work with the OSB to identify additional opportunities.

Q. Does Vectren South plan to introduce additional joint gas/electric programs during 2015?

A. Yes. Vectren South is requesting authority to work with the OSB to introduce additional programs into the marketplace over time.

Q. What other programs have the potential to be delivered as joint gas/electric programs in 2015?

A. The following programs from the 2015 Plan have the potential to be delivered as an integrated gas/electric program: home energy assessments, IQW, energy efficient schools, small business direct install and commercial & industrial custom.

Q. Why did Vectren South not include those programs in its 2015 Plan?

A. The planning cycle for Vectren South's gas programs will begin in late summer/early fall. The joint programs included in the 2015 Plan were previously approved by the gas OSB in the 2014 Operating Plan; however, the additional programs have not been approved by the gas OSB for delivery and have not been included in the 2015 Plan. When the OSB approves the 2015 gas operating plan, Vectren South will seek approval for joint delivery of the gas/electric programs listed above.

Q. Please describe the implementation requirements associated with the 2015 Plan.

A. Implementation of the 2015 Plan requires significant investment in internal and external resources. Detailed implementation planning will need to be completed as well as the selection of implementation partners. The general requirements for implementing the DSM programs contained in the 2015 Plan include the following:

- Selection of implementation partners;
- Development of detailed procedures for program administration;
- Development of the communication plan, promotional approaches as marketing and program support materials;
- Detailed review and development of qualifying equipment lists, related impacts and procedures for determining qualifying measures;
- Development of tracking procedures and procurement of appropriate tracking system provider; and,
- Recruitment and training of program staff.

Q. What is the implementation schedule for the 2015 Plan?

A. Commission approval of the 2015 Plan by October 1, 2014 will provide for the implementation of the 2015 Plan commencing January 1, 2015. There are program transition issues that make Commission approval of the 2015 Plan by this requested date beneficial. First, statewide Core program transition issues are being discussed by the Demand Side Management Coordination Committee ("DSMCC"). Approval of the 2015 Plan by the date requested would help minimize customer and trade ally confusion between vendors. Second, approval of the plan and associated cost recovery will help eligible opt out customers make informed decisions for their respective businesses by the November deadline to opt out prior to January 1, 2015.

Q. What kind of new DSM programs might Vectren South consider introducing into its service territory beyond 2015?

A. At the end of 2012, Vectren South, with guidance from the OSB, engaged Enernoc, Inc. to study its DSM market potential. EnerNOC conducted a detailed, bottom-up assessment of the Vectren South market in the Evansville metropolitan area to deliver a projection of baseline electric energy use, forecasts of the energy savings achievable through efficiency measures, and program designs and strategies to optimally deliver those savings. The Enernoc MPS is attached hereto as Petitioner's Exhibit MPH-3. In the MPS, EnerNOC recommended continuation of many of the current DSM programs. EnerNOC also recommended that Vectren South consider providing additional energy efficiency services and follow-on measures to the residential IQW and home energy audit program. Vectren South plans to work on these expanded offerings as part of integrated gas and electric programs offerings beyond 2015.

Enernoc also recommended a strategic energy management program that provides energy education, technical assistance, and company-wide coaching for large commercial and industrial customers in order to drive behavioral change and transformation of company culture which produce measureable improvements in energy efficiency and utilization. Vectren South plans to continue exploring this opportunity but the program may not be feasible, depending upon the level of large customers choosing to opt-out of participating in the program.

Vectren South is also exploring opportunities with conservation voltage reduction/optimization programs, which achieve energy conservation through automated monitoring and control of voltage levels provided on distribution circuits. End use customers realize lower energy and demand consumption when conservation voltage reduction/optimization is applied to the distribution circuit from which they are served.

2015 ELECTRIC DSM PROGRAM DESCRIPTIONS

Q. Please describe the Residential Lighting Program.

A. The Residential Lighting Program is a market-based residential DSM program designed to reach residential customers through retail outlets. The program consists of a buy-down strategy that provides incentives to consumers to facilitate the purchase of energy-efficient lighting products.

The Residential Lighting programs provides the following value: customers are empowered to take advantage of new lighting technologies, adoption of proven energy efficient technologies is accelerated, and participants experience the benefits of energy efficiency and decrease their energy consumption.

Q. Please describe the Home Energy Assessment Program.

A. The Home Energy Assessment Program targets a hybrid approach that combines helping customers analyze and understand their energy use via an on-site energy assessment as well as providing direct installation of energy efficiency measures including efficient low-flow water fixtures and CFL bulbs.

Collaboration and coordination between gas and electric conservation programs will be explored and to the extent possible implemented for greatest efficiencies.

Q. Please describe the Income Qualified Weatherization Program.

A. The Income Qualified Weatherization program is designed to produce long term energy and demand savings in the residential market. The program is designed to provide weatherization upgrades to low income homes that otherwise would not have been able to afford the energy saving measures. The program provides direct installation of energy-saving measures and educates consumers on ways to reduce energy consumption. Additionally, the program will address any moderate health and safety issue identified through the assessment, such as gas leaks, venting repairs, small repairs to furnaces, etc. Collaboration and coordination between gas and electric low-income programs along with state and federal funding is recommended to provide the greatest efficiencies among all programs.

Q. Please describe the Appliance Recycling Program.

A. The Residential Appliance Recycling program encourages customers to recycle their old inefficient refrigerators and freezers in an environmentally safe manner. The program recycles operable refrigerators or freezers so the appliance no longer uses electricity and is recycled instead of being disposed of in a landfill. An older refrigerator can use as much as twice the amount of energy as new efficient refrigerators. An incentive of $50 will be provided to the customer for each operational unit picked up.

Q. Please describe the Energy Efficient Schools Program.

A. The Energy Efficient Schools Program is designed to impact students by teaching them how to conserve energy and to produce cost effective electric savings by influencing students and their families to focus on conservation and the efficient use of electricity. The program consists of a school education program for 5th grade students attending schools served by Vectren South. To help in this effort, each child that participates will receive an energy kit. The kits are brought home to the parents and parents install these energy saving measures in the home. The kits along with the in-school teaching materials are designed to make a lasting impression on the students and help them learn ways to conserve energy.

The program has been modified from 2014 to eliminate the school facility audit component of the statewide program. The audit component will now be addressed as part of either the C&I Custom or Small Business Direct Install program depending on the size of the school.

Q. Please describe the Residential Efficient Products Program.

A. To assist customers with the purchase of energy efficient products, prescriptive incentives will be provided on efficient electric measures and equipment above the standard baseline. The program will be promoted through trade allies and appropriate retail outlets.

Q. Please describe the Residential New Construction Program.

A. The Residential New Construction Program will provide incentives and encourage home builders to construct homes that are more efficient than current building codes. The Residential New Construction Program will work closely with builders, educating them on the benefits of energy efficient new homes. Homes may feature additional insulation, better windows, and higher efficiency appliances. The homes should also be more efficient and comfortable than standard homes constructed to current building codes.

Program incentives are designed to be paid to both all-electric and combination homes that have natural gas heating and water heating. It is important to note that the program is structured such that an incentive will not be paid for an all-electric home that has natural gas available to the home site.

The Residential New Construction Program will address the lost opportunities of this customer segment by promoting energy efficiency at the time the initial decisions are being made. This will ensure efficient results for the life of the home.

Q. Please describe the Residential Behavior Savings Program.

A. The Residential Behavioral Savings Program motivates behavior change and provides relevant, targeted information to the consumer through regularly scheduled direct contact via mailed and/or emailed home energy reports. The direct contact helps the consumer to better understand their energy use and compares their usage on a rating scale verses similar households in the same general neighborhood. Once a consumer understands better how they use energy, they can then start conserving energy.

Program data and design was provided by OPower, the implementation vendor for the program. OPower provides energy usage insight that drives customers to take action by selecting the most relevant information for each particular household, which ensures maximum relevancy and high response rate to recommendations.

Q. Please describe the Small Business Direct Install Program.

A. The Small Business Direct Install Program provides value by directly installing energy efficient products such as high efficiency lighting, low flow water saving measures and vending machine controls. The program helps businesses identify and install cost effective energy saving measures by providing an on-site energy assessment customized for their business. The program has been very well received in the marketplace and has been expanded in the 2015 Plan to include any participating Vectren South small business customer with a maximum peak demand of less than 300 kilowatts ("kW"). The maximum peak demand in 2014 was less than 150 kW.

Q. Please describe the Commercial and Industrial ("C&I") Prescriptive Program.

A. The C&I Prescriptive Program is designed to provide financial incentives on qualifying products to produce greater energy savings in the C&I market. The rebates are designed to promote lower electric energy consumption, assist customers in managing their energy costs, and build a sustainable market around energy efficiency. Program participation is achieved by offering incentives structured to cover a portion of the customer's incremental cost of installing prescriptive efficiency measures.

Q. Please describe the C&INew Construction Program.

A. The C&I New Construction Program provides value by promoting energy efficient designs with the goal of developing projects the are more energy efficient than current Indiana building code. Incentives promoted through this program serve to reduce the incremental cost to upgrade to high-efficiency equipment over standard efficiency options for Vectren South customers. The program includes equipment with easily calculated savings and provides straightforward and easy participation for customers.

Q. Please describe the C&I Custom Program.

A. The C&I Custom Program promote the implementation of customized energy saving measures at qualifying customer facilities. Incentives promoted through this program serve to reduce the cost of implementing energy reducing projects and upgrading to high-efficiency equipment. Due to the nature of a custom energy efficiency program, a wide variety of projects are eligible.

The technical audit or compressed air system study offers an assessment to systematically identify energy saving opportunities for customers and provides a mechanism to prioritize and phase-in projects that best meet customer needs. In turn, the opportunities identified from the audit can be turned in for the customized efficiency program. These two components work hand in hand to deliver energy savings to Vectren South commercial and industrial customers.

Q. Please describe the Outreach and Education Program.

A. The Outreach and Education Program includes a communication plan to promote efficiency and disseminate conservation information and increase general awareness. The messages will specifically focus on directing customers to available programs and resources, such as the direct load control program and the rebate programs. The messages developed for the paid media campaign are designed to assist customers in reducing their consumption. As a result, in addition to formal programs, reductions in usage will also be triggered by simply changing customer behaviors such as turning back thermostats, using on-line tools available at vectren.com that clearly demonstrates the energy savings that can be realized by installing high efficiency equipment.

The Electric DSM Outreach program will include paid media, web based tools to analyze bills, and energy audit tools. The Conservation Connection website will also have enhanced features on energy conservation and DSM program education and information. Informational guides and sales promotion materials for specific programs will be included as part of the outreach and education effort. Vectren South also plans to utilize outreach efforts similar to those used to promote gas efficiency including leveraging general corporate sponsorships, employee communications and customer emails as opportunities to promote conservation.

<u>ADMINISTRATION OF 2015 PLAN</u>

Q. Please describe Vectren South's plans for administration of the 2015 Plan.

A. Vectren South will serve as the 2015 Plan program administrator and will likely utilize third party program implementers to deliver specific programs or program components where specialty expertise is required. It makes sense to contract directly with those specialty vendors to avoid an unnecessary layer of management, oversight and expense.

The appliance recycle program is an example where Vectren South intends to contract directly with one of the leading national providers of these services who has a proven track record of success and can cost effectively deliver the program.

In addition, Vectren South will increase staffing as needed in the Conservation Connection Center to support handling customer calls related to energy efficiency, providing conservation education and advice as well as processing of rebates. Vectren South will select independent contractors when necessary to support the implementation and fulfillment of selected DSM programs. To facilitate review, Vectren South will provide quarterly reports to the OSB on call volume, types of customers calling, rebates handled and program participation.

Q. What administrative costs are included in the budget for the 2015 Plan?

A. The administrative costs included in the 2015 Plan are all ongoing costs that have been included in prior Vectren South Demand Side Management Adjustment ("DSMA") filings. Based upon the DSM programs proposed in this proceeding Vectren South's budget includes funding for the following four (4) positions:

- Electric DSM Manager – Oversees the overall portfolio and staff necessary to support the program administration. Serves as primary contact for regulatory and oversight of programs.
- Electric DSM Analyst — Works with the selected EM&V Administrator and facilitates measurement and verification efforts, assists with program reporting/tracking.
- Electric DSM Financial Analyst — Responsible for all aspects of program reporting including, budget analysis/reporting, scorecards and filings.

- Electric DSM Representative — Serves as contact to trade allies regarding program awareness. Also serves as point of contact for residential and C&I customers to assist with program inquiries.

Furthermore, administrative costs includes the following indirect costs which will be incurred to support the portfolio: Conservation Connection resources to answer customer inquiries on Vectren South programs, annual licensing and maintenance fees for online energy audit software, memberships with energy efficiency organizations such as Consortium for Energy Efficiency ("CEE") and Midwest Energy Association ("MEA") and staff development & training. Vectren South included the costs of the proposed staffing requirements in the respective DSM programs' fixed cost budgets.

CONCLUSION

Q. Does this conclude your testimony?

A. Yes, at this time.

VERIFICATION

I, Michael P. Huber, Manager, Electric DSM & Conservation at Vectren Utility Holdings, Inc., affirm under the penalties of perjury that the statements and representations in the foregoing Direct Testimony are true to the best of my knowledge, information and belief.

Michael P. Huber

Michael P. Huber
Dated:

Vectren South
2015 Electric DSM Plan

Final 5-28-14

Prepared by:
Southern Indiana Gas & Electric Company
d/b/a Vectren Energy Delivery of Indiana Inc. (Vectren South)

Table of Contents

I. Introduction

Southern Indiana Gas and Electric Company d/b/a Vectren Energy Delivery of Indiana, Inc. ("Vectren South" or "Company") provides energy delivery services to approximately 142,000 electric customers and 111,000 gas customers located in southwestern Indiana. Vectren South is a direct, wholly owned subsidiary of Vectren Utility Holdings, Inc. ("VUHI") and an indirect subsidiary of Vectren Corporation ("Vectren"), headquartered in Evansville IN. This Vectren South 2015 Electric DSM Plan ("2015 Plan") describes the details of the electric DSM programs Vectren South plans to offer in its service territory in 2015.

Vectren South designed the 2015 Plan to save electric energy and reduce electric demand to cost effectively reduce energy use by approximately 1% of eligible retail sales. The 2015 Plan recommends electric DSM programs for the residential, commercial, and industrial sectors in Vectren South's service territory. Where appropriate, it also describes opportunities for coordination with some of Vectren South's gas conservation programs to leverage the best total energy efficiency opportunities for customers and to share costs of delivery.

An Order issued by the Indiana Utility Regulatory Commission on December 9, 2009 ("Phase II Order") established two separate categories of DSM programs to be offered by jurisdictional electric utilities in Indiana, core programs and core plus programs. Core programs were defined in the Phase II Order and were required to be administered in Indiana on a statewide basis by a single third party administrator. Core plus programs were then defined as all other programs offered directly by the participating utility. As a result, since 2012, a statewide third party administrator has been running core programs in Indiana. That delivery model will end on December 31, 2014 and Vectren South will be responsible for implementing all electric DSM programs in its service territory.

As a result of the change in the delivery model, Vectren South has explicitly identified its administrative costs in this 2015 Plan. The change to the delivery model is required as a result of the passage of Senate Enrolled Act No. 340, which also requires jurisdictional electric utilities in Indiana to provide certain large commercial and industrial ("C&I") customers ("Qualifying Customers") a process to opt-out of participation in Company-sponsored DSM programs. Vectren South recently submitted a process to the Commission for approval in Cause No. 44441.

Once the process has been finalized by the Commission and Qualifying customers begin to take advantage of the opportunity to opt-out of participation in Company-sponsored DSM programs, the proposed savings targets and costs are likely to change from what is defined herein. This 2015 Plan was designed assuming at least 50% of Qualifying Customers would not opt-out and would continue participating in Company-sponsored DSM programs.

If the actual number of Qualifying Customers who opt-out is materially higher or lower than 50%, then the impact on the plan could be significant. Vectren South will work with its oversight board to make adjustments to the 2015 Plan as necessary, once the Company knows the precise number of Qualifying Customers, and their load, will opt-out of participation in Company sponsored DSM programs for calendar year 2015.

Planning Process

The 2015 Plan was developed during an Integrated Resource Plan ("IRP") planning period; therefore, the 2014 IRP could not serve as a key input into the 2015 Plan. As a result, the avoided cost basis from the 2011 IRP was used to develop the 2015 Plan. However, there were many steps involved in developing the 2015 Plan. The objective of these steps was to develop a plan based on market-specific information for Vectren South, which could be successfully implemented utilizing realistic assessments of achievable market potential.

The first step in the process was retaining EnerNOC to complete a Market Potential Study[1] (MPS). EnerNOC conducted a detailed, bottom-up assessment of the Vectren South service territory to deliver forecasts of electric energy use, forecasts of the energy savings achievable through efficiency measures, and program designs and strategies to optimally deliver those savings. The study developed technical, economic and achievable potential estimates by sector, customer type and measure. According to the MPS, EnerNOC performed the following tasks in completing the study:

1. Conducted onsite energy consumption surveys with 30 of Vectren's largest commercial and industrial customers in order to provide data and guidance for these market sectors that had not formerly received focused DSM program efforts.
2. Performed a market characterization to describe sector-level electricity use for the residential, commercial, and industrial sectors for the base year, 2011. This included using existing information contained in prior Vectren and Indiana studies, new information from the aforementioned onsite surveys with large customers, EnerNOC's own databases and tools, and other secondary data sources such as the American Community Survey (ACS) and the Energy Information Administration (EIA).
3. Developed a baseline electricity forecast by sector, segment, and end use for 2011 through 2023. Results presented in this volume focus on the upcoming implementation years of 2015 through 2019.

[1] Electric Demand Side Management: Market Potential Study and Action Plan, EnerNOC Utility Solutions Consulting, April 22, 2013

4. Identified several hundred measures and estimated their effects in five tiers of measure-level energy efficiency potential: Technical, Economic, Achievable High, Achievable Recommended and Achievable Low.
5. Reviewed the current programs offered by Vectren in light of the study findings to make strategic program recommendations for achieving savings.
6. Created recommended program designs and action plans through 2019 representing the program potential for Vectren, basing them on the potential analysis and strategic recommendations developed in the previous steps.

The EnerNOC MPS and other study information were used to help guide the plan design. Study analysis and results details can be found in the MPS and its appendices. For planning purposes we used the "Recommended Achievable" scenario as a guide for developing the 2015 Plan. A comparison between the Recommended MPS scenario and the 2015 Plan is made in Section II B of this document.

The second primary step in the planning process was to hire outside expertise to assist with the plan design and development. Vectren South retained Morgan Marketing Partners to assist with designing the 2015 Plan. Rick Morgan, President of Morgan Marketing Partners, was the primary planner working with the Vectren South team. Mr. Morgan brings over 35 years of energy efficiency experience to the process. He has worked with most of the utilities in Indiana in various planning capacities and has developed filed plans for many different utilities including but not limited to NIPSCO, DTE Energy, and Consumers Power.

The third primary step in the planning process was to obtain input from various sources to help develop and refine a workable plan. The first group providing input was the Vectren South's Program Managers who have been overseeing the current Vectren South's programs. In addition, vendors and other implementation partners who operate the current programs were very involved in the process as well. They provided suggestions for program changes and enhancements. They also provided technical information about measures to include, recommended incentives, estimates of participation and estimated implementation costs. These data provided a foundation for the 2015 Plan based on actual experience within Vectren South's territory. These companies also bring their experience operating programs for other utilities.

Other sources of program information were also considered. Current evaluations were used for adjustments to inputs. In addition, best practices were researched and reviewed to gain insights into the program design of successful DSM programs implemented at other utilities.

The last step was cost benefit analysis. Utilizing DSMore the measures and programs were analyzed for cost effectiveness. The DSMore tool is nationally recognized and used in many states across the country to determine cost-effectiveness. Developed and licensed by

Integral Analytics based in Cincinnati Ohio, the DSMore cost-effectiveness modeling tool takes hourly prices and hourly energy savings from the specific measures/technologies being considered for the energy efficiency program, and then correlates both to weather. This tool looks at over 30 years of historic weather variability to get the full weather variances appropriately modeled. In turn, this allows the model to capture the low probability, but high consequence weather events and apply appropriate value to them. Thus, a more accurate view of the value of the efficiency measure can be captured in comparison to other alternative supply options. The outputs include all the California Standard Practice Manual results including TRC, UCT, Participant and RIM tests. Inputs into the model include participation rates, incentives paid, and energy savings of the measure, life of the measure, implementation costs, administrative costs, and incremental costs to the participant of the high efficiency measure. Financial inputs such as escalation rates and discount rates are provided by Vectren South and match the company's other financial plans. Table 1 below outlines that all programs pass the TRC at greater than one. The total portfolio for the Vectren South programs passes the TRC test for both Residential and Commercial programs.

Table 1. Vectren South 2015 Plan Cost Effectiveness Results without Performance Incentive

COMMERCIAL	TRC	UCT	RIM	Participant	Lifetime Cost/kWh	1st Year Cost/kWh	TRC NPV $	UCT NPV $
Small Business Direct Install	2.00	2.21	0.83	3.66	$0.04	$0.32	$2,116,270	$2,319,485
Commercial & Industrial Prescriptive	3.97	5.57	1.02	3.34	$0.01	$0.15	$7,415,610	$8,135,889
Commercial & Industrial New Construction	1.09	2.82	0.88	0.98	$0.03	$0.35	$40,440	$311,588
Commercial & Industrial Custom	1.70	4.16	0.94	1.52	$0.02	$0.21	$1,838,430	$3,399,052
Commercial Sector Portfolio	**2.42**	**3.72**	**0.94**	**2.57**	**$0.02**	**$0.22**	**$11,212,741**	**$13,968,004**

RESIDENTIAL	TRC	UCT	RIM	Participant	Lifetime Cost/kWh	1st Year Cost/kWh	TRC NPV $	UCT NPV $
Residential Lighting	2.18	2.88	0.85	2.94	$0.03	$0.07	$929,179	$1,121,826
Home Energy Assessments	1.02	1.02	0.56	NA	$0.08	$0.35	$15,690	$15,690
Income Qualified Weatherization	1.14	1.14	0.66	NA	$0.07	$0.78	$115,688	$115,688
Appliance Recycling	2.52	2.51	0.97	5.79	$0.04	$0.16	$320,800	$319,656
Residential Schools	2.67	2.67	0.81	NA	$0.03	$0.23	$214,237	$214,237
Efficient Products	1.51	2.02	1.05	1.13	$0.06	$0.67	$352,915	$524,039
Residential New Construction	1.28	1.52	0.75	1.89	$0.04	$0.92	$39,816	$61,965
Residential Behavior Savings	1.64	1.64	0.77	NA	$0.06	$0.07	$274,885	$274,885
Residential Sector Portfolio	**1.49**	**1.64**	**0.77**	**3.36**	**$0.05**	**$0.18**	**$1,992,542**	**$2,377,317**

Total Portfolio*	**2.10**	**2.85**	**0.89**	**2.75**	**$0.03**	**$0.20**	**$13,205,283**	**$16,345,321**

*Total Portfolio includes Outreach and Tracking for benefit/cost runs

Table 2 below demonstrates that with the Utility Performance Incentive set at the maximum of 12%, each sector, as well as the total portfolio, remains cost-effective.

Table 2. Vectren South 2015 Plan Cost Effectiveness Results with Utility Performance Incentive

2015 Portfolio - Including Utility Performance Incentives	TRC	UCT	RIM	Participant	Lifetime Cost/kWh**	1st Year Cost/kWh**	TRC NPV $	UCT NPV $
Commercial Sector Portfolio	2.25	3.32	0.91	2.57	$0.02	$0.24	$10,602,240	$13,357,503
Residential Sector Portfolio	1.37	1.50	0.73	3.36	$0.06	$0.20	$1,645,669	$2,030,443
Total Portfolio*	1.95	2.57	0.86	2.75	$0.03	$0.22	$12,247,909	$15,387,946

*Total Portfolio includes Outreach, Tracking and Utility Incentives for benefit/cost runs

**Cost/kwh values do not include utility incentives

Integration with Vectren South Gas

Opportunities exist to gain both gas and electric savings from some types of measures. When this occurs savings will be captured by the respective utility. For purposes of this 2015 Plan, cost sharing was only factored in on the Residential Behavior program and the Residential New Construction program where cost share methodology was already approved by the Vectren Oversight Board. In the case of the Residential New Construction this program will work with builders who provide either gas or electrically heated homes. Delivery will be by the same implementation contractor for both utilities and it will be transparent in the marketplace. Another example is the Residential Behavior Program where costs will be shared for Vectren South dual fuel customers. Both utilities will contribute to the cost of implementation and appropriate incentives will be paid by each utility. There are multiple other programs where opportunities exist to integrate both gas and electric savings. Due to the timing of this plan not being in alignment with the planning cycle for the gas division, which occurs in late summer, Vectren South will work with the Oversight Board to identify those opportunities and incorporate into the final 2015 Plan.

II. DSM Portfolio Objectives and Impact

The framework for the 2015 Plan is a continuation of programs offered in 2014, at a savings level of 1.2% of sales, of which the 2011 IRP served as the background. The programs as proposed are consistent with the goals stated in the 2014 IRP and were designed to reach a reduction in sales of 1% of adjusted retail sales, including the option for customer “opt-out”, in 2015 through 2019 with future planning at 0.5% each year thereafter. The IRP process will confirm whether these goals are set at appropriate levels and Vectren South will leverage the 2014 IRP, once completed, for future planning years.

A. Plan Savings

The 2015 Plan goal was calculated based on a percentage of weather normalized electric sales for 2013 with a target of 1% of adjusted retail sales.. Goals are based on “gross” energy savings assuming 50% of eligible customers will “opt-out” of the program. To reach the reduction of the 1% of adjusted retail sales goals, the savings targets for Residential and Commercial were designated based on the percentage of sales revenue that each sector represents. Table 3 below demonstrates the portfolio, residential and commercial energy savings targets at the 1% adjusted retail sales level:

Table 3. Vectren South 2015 Plan Portfolio Summary Energy Savings Targets

Portfolio Summary	2015 kWh Total
Portfolio Goal	42,213,562
Residential Total	20,547,593
Commercial Total	23,573,014
Portfolio Total	**44,120,607**
Variance above Goal	**1,907,045**

Table 4 below lists the Commercial and Residential programs' individual gross energy savings targets split by program:

Table 4. Vectren South 2015 Plan Commercial and Residential Program Energy Savings Target

COMMERCIAL	2015 kWh Total	2015 kW
Small Business Direct Install	6,001,171	1,724
Commercial & Industrial Prescriptive	12,051,363	1,879
Commercial & Industrial New Construction	491,400	89
Commercial & Industrial Custom	5,029,080	858
Commercial Total	**23,573,014**	**4,550**
Commercial Goal	**23,639,595**	
Commercial Variance Above Goal	**(66,581)**	

RESIDENTIAL	2015 kWh Total	2015 kW
Residential Lighting	8,334,008	514
Home Energy Assessments	2,072,900	307
Income Qualified Weatherization	1,027,651	272
Appliance Recycling	1,301,338	235
Residential Schools	560,786	76
Efficient Products	771,461	484
Residential New Construction	129,048	22
Behavior Savings	6,350,400	2,181
Residential Total	**20,547,593**	**4,090**
Residential Goal	**18,573,967**	
Residential Variance Above Goal	**1,973,625**	

B. Comparison of Savings to Market Potential Study

The program design used the MPS for guidance to determine if the plan estimates were reasonable. While building from the bottom up with estimates from program implementers to help determine participation, this comparison to the MPS allowed the planning team to see if the results were reasonable.

The MPS resulted in the following three scenarios for the plan: Low Achievable, High Achievable, and Recommended. Tables 5 and 6 below compare the 2015 Plan to the Recommended savings estimates.

Table 5. Commercial Program EnerNOC MPS vs. Vectren South's 2015 Plan

MPS Recommended MWH		Vectren Plan MWH	
	2015	2015	
Commercial & Industrial Prescriptive	17,217	12,051	Commercial & Industrial Prescriptive
Commercial & Industrial Custom	17,519	5,029	Commercial & Industrial Custom
Commercial Schools	987	0	Commercial Schools
Education & Training	1,663	0	Education & Training
Commercial & Industrial New Construction	1,459	491	Commercial & Industrial New Construction
Small Business Direct Install	2,134	6,001	Small Business Direct Install
Totals	**40,978**	**23,573**	**Totals**

Table 6. Residential Program EnerNOC MPS vs. Vectren South's 2015 Plan

MPS Recommended MWH		Vectren Plan MWH	
	2015	2015	
Residential Lighting	10,280	8,334	Residential Lighting
Efficient Products	3,031	771	Efficient Products
Residential Income Qualified	1,876	1,028	Residential Income Qualified
Residential Income Qualified Plus	142	0	Residential Income Qualified Plus
Residential New Construction	203	129	Residential New Construction
Multi Family Direct Install	610	0	Multi Family Direct Install
Home Energy Assessments	2,846	2,073	Home Energy Assessments
Residential School Kit	1,059	561	Residential School Kit
Whole House	1,918	0	Whole House
Appliance Recycling	802	1,301	Appliance Recycling
Behavioral Feedback	4,659	6,350	Behavioral Feedback
Totals	**27,426**	**20,548**	**Totals**

C. Budgets

The program budgets were built based upon many inputs. First the measures were assigned incentives based upon existing program incentives, proposed incentives and leveraged evaluation recommendations. Program budgets were discussed with both current and potential delivery providers as a basis for the development of this plan. The full set of incentives and the projected participation by program measure can be seen in Appendix A. The second primary input for the costs were estimates for implementation informed by the current statewide program implementation costs. This helps to assure that the estimates are realistic for successful delivery. The third cost area is the administrative costs made up of the internal costs for Vectren South management of the programs and implementers and other costs such as marketing. Administrative costs were allocated back to programs and measures based on the percent of savings these programs and measures represent. The last cost area is the Evaluation, Measurement and Verification ("EM&V") costs based on 6% of the budget. Table 7 below lists the summary budgets by program.

Table 7. Vectren South 2015 Plan Summary Budget

Commercial & Industrial	Administration	Evaluation	Implementation	Incentives	Total Program Costs
Small Business Direct Install	$62,500	$108,067	$600,000	$1,138,621	$1,909,188
Commercial & Industrial Prescriptive	$62,500	$100,784	$360,000	$1,257,231	$1,780,514
Commercial & Industrial New Construction	$31,250	$9,671	$75,000	$54,933	$170,854
Commercial & Industrial Custom	$62,500	$60,959	$350,000	$603,490	$1,076,949
Outreach	$150,000				$150,000
Commercial Total	**$368,750**	**$279,481**	**$1,385,000**	**$3,054,274**	**$5,087,506**

Residential	Administration	Evaluation	Implementation	Incentives	Total Program Costs
Residential Lighting	$62,500	$33,768	$196,000	$304,299	$596,567
Home EnergyAssessments	$46,875	$40,538	$400,000	$228,750	$716,163
Income Qualified Weatherization	$46,875	$45,197	$270,000	$436,403	$798,474
Appliance Recycling	$62,500	$12,021	$84,970	$52,875	$212,366
Residential Schools	$31,250	$7,247	$31,250	$58,286	$128,033
Efficient Products	$93,750	$29,218	$121,446	$271,775	$516,189
Residential New Construction	$31,250	$6,741	$48,691	$32,410	$119,092
Behavioral Savings	$31,250	$24,464	$376,488	n/a	$432,202
Outreach	$150,000				$150,000
Tracking	$20,000				$20,000
Residential Total	**$576,250**	**$199,194**	**$1,528,845**	**$1,384,798**	**$3,689,086**

Portfolio Total	**$945,000**	**$478,675**	**$2,913,845**	**$4,439,072**	**$8,776,592**

D. Key Inputs

The programs are based on known existing measures and technologies. The measure savings were calculated using the Indiana TRM and any Company specific evaluation data. When a measure was not in the Indiana TRM, then other TRMs were referenced including Michigan and Illinois. If needed, estimates were made from actual projects or experience of the implementation contractors.

III. Program Administration

Vectren South will serve as the 2015 Plan program administrator. Vectren South will likely utilize third party program implementers to deliver specific programs or program components where specialty expertise is required. Contracting directly with specialty vendors avoids an unnecessary layer of management, oversight and expense that occurs when utilizing a third-party administration approach.

There are three major components of program administration that were considered in the 2015 Plan. They include: internal labor/program support, program tracking and customer outreach/education.

A. Internal Labor/Program Support

Based upon the DSM programs proposed in the 2015 Plan, Vectren South is proposing to maintain the staffing levels that were previously approved to support the portfolio. The following four (4) positions are included as part of this 2015 Plan:

- Electric DSM Manager – Oversees the overall portfolio and staff necessary to support the program administration. Serves as primary contact for regulatory and oversight of programs.
- Electric DSM Analyst - Works with the selected EM&V Administrator and facilitate measurement and verification efforts, assists with program reporting/tracking
- Electric DSM Financial Analyst – Responsible for all aspects of program reporting including, budget analysis/reporting, scorecards and filings. Electric DSM Representative – Serves as contact to trade allies regarding program awareness. Also serves as point of contact for residential and commercial/industrial customers to assist with regard to program inquiries.

Additionally, internal labor includes the following indirect costs which will be incurred to support the portfolio:

- Conservation Connection resources to answer customer inquiries on Vectren South programs
- Memberships with energy efficiency organizations such as Consortium for Energy Efficiency (CEE) and Midwest Energy Association (MEA)
- Annual license and maintenance fees for the online energy audit and bill analyzer tool
- Staff Development & Training

Vectren South allocated the costs of the proposed staffing and support requirements in the respective DSM programs' fixed cost budgets.

B. Program Tracking

Program tracking includes license and maintenance fees necessary to support the database that serves as the repository for all program data and reporting.

C. Customer Outreach and Education

Vectren South's Customer Outreach and Education program serves to raise awareness and drive customer participation as well as educate customers on how to manage their energy bills. The program includes the following goals as objectives:

1. Build awareness;
2. Educate consumers on how to conserve energy and reduce demand;
3. Educate customers on how to manage their energy costs and reduce their bill;
4. Communicate support of customer energy efficiency needs; and,
5. Drive participation in the DSM programs.

The marketing approach includes paid media, as well as web based tools to help analyze bills, energy audit tools, energy efficiency and DSM program education and information. Informational guides and sales promotion materials for specific programs are included in this budget.

This effort is the key to achieving greater energy savings by convincing the families and businesses making housing/facility, appliance and equipment investments to opt for greater energy efficiency. The first step in convincing the public and businesses to invest in energy efficiency is to raise their awareness.

It is essential that a broad public education and outreach campaign not only raise awareness of what consumers can do to save energy and control their energy bills, but to prime them for participation in the various DSM programs. The budget is $150,000 each for Residential and Commercial programs, for a total of $300,000.

Marketing Plans

This effort will provide funding for cross-program public education activities, outreach, marketing and promotion to raise awareness of the benefits and methods of improving energy efficiency in homes and commercial businesses. Beyond energy efficiency education, an objective will be to motivate participation in the programs.

Types of activities that will be included in this effort are:

- Enhancement of the Conservation Connection website to include the latest electric energy efficiency information for residential and commercial use.
- Targeted educational campaign for businesses to support the programs.

- Targeted educational campaign for residences to support the programs.
- Targeted training and educational program for trade allies.
- Distribution of federal Energy Star and other national organization materials in the service territory.

Delivery Organization

Vectren South will oversee outreach and education for the programs. The Company will work closely with its implementation partners to provide consistent messaging across different program outreach and education efforts. Vectren South will utilize the services of communication and energy efficiency experts to deliver the demand and energy efficiency message.

IV. Program Descriptions

The 2015 Plan is built from the existing programs currently being offered by Vectren South to its customers. The existing Core programs will continue to be offered by Vectren South through its implementation partner. This change will ensure closer integration with Vectren South's current Core Plus programs. The programs in the 2015 Plan include:

- Residential Lighting
- Home Energy Assessments
- Income Qualified Weatherization
- Appliance Recycling - Refrigerator and Freezer
- Energy Efficient Schools & Education
- Residential Efficient Products
- Residential New Construction
- Residential Behavior Savings Program
- Small Business Direct Install
- Commercial & Industrial Prescriptive Rebates
- Commercial & Industrial New Construction
- Commercial & Industrial Custom Program

Table 8 below shows the comparison between the 2014 and 2015 program offering.

Table 8. Vectren South 2014 and 2015 Program Comparison

2014 DSM Program	2015 Program Status
Residential Lighting (Core)	Continues as standalone program under Vectren administration
Home Energy Audit (Core)	Continues as standalone program under Vectren administration
Income Qualified Weatherization (Core)	Continues as standalone program under Vectren administration
Energy Efficient Schools (Education & Audits) (Core)	Education portion continues as standalone program under Vectren administration; Audit portion merged into C&I Audit & Small Business Direct Install program
C&I Prescriptive (Core)	Continues as standalone program under Vectren administration
Residential Appliance Recycling (Core Plus)	Continues as standalone program under Vectren administration
Residential Behavioral Savings (Core Plus)	Continues as standalone program under Vectren administration
Residential New Construction (Core Plus)	Continues as standalone program under Vectren administration
Residential HVAC (Core Plus)	Continues as standalone program under Vectren administration
Multi-Family Direct Install (Core Plus)	Reached market saturation, program dropped from portfolio for 2015
C&I Custom (Core Plus)	Continues as standalone program under Vectren administration
C&I New Construction (Core Plus)	Continues as standalone program under Vectren administration
Small Business Direct Install (Core Plus)	Continues as standalone program under Vectren administration

A. Residential Lighting

Program Description

The Residential Lighting Program is a market-based residential DSM program designed to reach residential customers through retail outlets. The program consists of a buy-down strategy that provides incentives to consumers to facilitate the purchase of energy-efficient lighting products.

The program not only empowers customers to take advantage of new lighting technologies and accelerate the adoption of proven energy efficient technologies, but also allows the customers to experience the benefits of energy efficiency and decrease their energy consumption.

Eligible Customers

Any residential customer who receives electric service from Vectren South.

Marketing Plan

The program is designed to reach residential customers through retail outlets. Proposed marketing efforts include point of purchase promotional activities, the use of utility bill inserts and coordinated advertising with selected manufacturers and retail outlets.

Barriers/Theory

The program addresses the market barriers by empowering customers to take advantage of new lighting technologies through education and availability in the marketplace; accelerating the adoption of proven energy efficient technologies through incentives to lower price; and working with retailers to allow them to sell more high efficient products.

Initial Measures, Products and Services

The measures will include a variety of ENERGY STAR-qualified lighting products currently available at retailers in Indiana, including compact fluorescent lamps (CFLs), light-emitting diodes (LEDs), fixtures, and ceiling fans.

Table 9. Residential Lighting Program Budget & Energy Savings Targets

Market	Program	Number of Measures	Energy Savings kWh	Peak Demand kW	Total Program Budget $
Residential	**Residential Lighting**				
	2015	261,316	8,334,008	514	$ 596,567
Per Participant Avg Energy Savings (kWh)*					32
Per Participant Avg Demand Savings (kW)*					0.002
Weighted Avg Measure Life*					6
Net To Gross Ratio					62%

*These values represent averages, detailed information by measure is available in Appendix A

Table 10. Residential Lighting Estimated Energy Savings & Budget

Residential	2015 kWh Total	2015 kW	Administration	Evaluation	Implementation	Incentives	Total Program Costs
Residential Lighting	8,334,008	514	$62,500	$33,768	$196,000	$304,299	$596,567

Table 11. Residential Lighting Cost Effectiveness

Residential	TRC	UCT	RIM	Participant	Lifetime Cost/kWh	1st Year Cost/kWh	TRC NPV $	UCT NPV $
Residential Lighting	2.18	2.88	0.85	2.94	$0.03	$0.07	$929,179	$1,121,826

Program Delivery

Vectren South will oversee the program and may partner with an implementation provider to deliver the program.

Evaluation, Measurement and Verification

The implementation contractor will verify the paperwork of the participating retail stores. They will also spot check stores to assure that the program guidelines are being followed. A third party evaluator will evaluate the program using standard EM&V protocols.

B. Home Energy Assessments

Program Description

The Home Energy Assessment Program targets a hybrid approach that combines helping customers analyze and understand their energy use via an on-site energy assessment as well as providing direct installation of energy efficiency measures including efficient low-flow water fixtures and CFL bulbs.

Collaboration and coordination between gas and electric conservation programs will be explored and to the extent possible implemented for greatest efficiencies.

Eligible Customers

Any residential customer who receives electric service from Vectren South at a single-family residence, provided the home:

- was built prior to 1/1/2010;
- has not had an audit within the last three years; and
- is owner occupied or non-owner occupied where occupants have the electric service in their name.

Marketing Plan

Proposed marketing efforts include utilizing Vectren South online audit tools, bill inserts as well as other outreach and education efforts and promotional campaigns throughout the year to ensure participation levels are maintained.

Barriers/Theory

The primary barrier addressed through this program is customer education and awareness. Often customers do not understand what opportunities exist to reduce their home energy use. This program not only informs the customer but helps them start down the path of energy savings by directly installing low cost measures. The program is also a "gateway" to other Vectren South gas and electric programs.

Initial Measures, Products and Services

The direct install measures available for installation at the home include:

- CFL lamps
- LED night lights
- Low flow kitchen and bath aerators
- Low flow showerheads
- Pipe wrap
- Water heater tank wrap

Table 12. Home Energy Assessments Program Budget & Energy Savings Targets

Market	Program	Number of Participants	Energy Savings kWh	Peak Demand kW	Total Program Budget $
Residential	**Home Energy Assessments**				
	2015	2,000	2,072,900	307	$ 716,163
Per Participant Avg Energy Savings (kWh)*					1,036
Per Participant Avg Demand Savings (kW)*					0.153
Weighted Avg Measure Life*					6
Net To Gross Ratio					88%

*These values represent averages, detailed information by measure is available in Appendix A

Table 13. Home Energy Assessments Estimated Energy Savings & Budget

Residential	2015 kWh Total	2015 kW	Administration	Evaluation	Implementation	Incentives	Total Program Costs
Home Energy Assessments	2,072,900	307	$46,875	$40,538	$400,000	$228,750	$716,163

Table 14. Home Energy Assessments Cost Effectiveness

Residential	TRC	UCT	RIM	Participant	Lifetime Cost/kWh	1st Year Cost/kWh	TRC NPV $	UCT NPV $
Home Energy Assessments	1.02	1.02	0.56	NA	$0.08	$0.35	$15,690	$15,690

Program Delivery

Vectren South will oversee the program and may partner with an implementation provider to deliver the program.

Integration with Vectren South Gas

Vectren South will evaluate the opportunities that exist to gain both gas and electric savings for this program. For purposes of this plan, cost sharing has not been factored in; however, gas and electric integration will be considered and discussed with the Vectren South Electric Oversight Board as the Operating Plan is finalized.

Evaluation, Measurement and Verification

To assure compliance with program guidelines, field visits with auditors will occur as well as spot check verifications of measure installations. A third party evaluator will evaluate the program using standard EM&V protocols.

C. Income Qualified Weatherization

Program Description

The Income Qualified Weatherization program is designed to produce long term energy and demand savings in the residential market. The program is designed to provide weatherization upgrades to low income homes that otherwise would not have been able to afford the energy saving measures. The program provides direct installation of energy-saving measures and educates consumers on ways to reduce energy consumption.

Collaboration and coordination between gas and electric low-income programs along with state and federal funding is recommended to provide the greatest efficiencies among all programs.

Eligible Customers

The Residential Low Income Weatherization Program targets single-family homeowners and tenants, who have electric service in their name with Vectren South, and with a total household income up to 200% of the federally-established poverty level. Priority will be given to:

a. Single parent households with children under 18 years of age living in dwelling.
b. Households headed by occupants over 65 years of age.
c. Disabled homeowners as defined by the EAP.
d. Households with high energy intensity usage levels.

Marketing Plan

Vectren South will provide a list to the implementation contractor of high consumption customers who have received Energy Assistance Program ("EAP") funds within the past 12 months to help prioritize those customers who will benefit most from the program. This will also help in any direct marketing activities to specifically target to those customers.

Barriers/Theory

Lower income homeowners do not have the money to make even simple improvements to lower their bill and often live in homes with the most need for energy efficiency improvements. This program provides those customers with basic improvements to help them start saving energy without needing to make the investment themselves.

Initial Measures, Products and Services

Measures available for installation will vary based on the home and include:

- CFLs
- Aerators
- Low flow showerheads
- Pipe wrap
- Furnace filter whistles
- Infiltration reduction
- Attic Insulation
- Refrigerator replacement

Additionally, the program includes an average budget per home of $250 to address any moderate health and safety issue identified through the assessment to such as gas leaks, venting repairs, small repairs to furnaces, etc.

Table 15. Income Qualified Weatherization Program Budget & Energy Savings Targets

Market	Program	Number of Participants	Energy Savings kWh	Peak Demand kW	Total Program Budget $
Residential	Income Qualified Weatherization				
	2015	564	1,027,651	272	$ 798,474
Per Participant Avg Energy Savings (kWh)*					1,822
Per Participant Avg Demand Savings (kW)*					0.482
Weighted Avg Measure Life*					15
Net To Gross Ratio					100%

*These values represent averages, detailed information by measure is available in Appendix A

Table 16. Income Qualified Weatherization Estimated Energy Savings & Budget

Residential	2015 kWh Total	2015 kW	Administration	Evaluation	Implementation	Incentives	Total Program Costs
Income Qualified Weatherization	1,027,651	272	$46,875	$45,197	$270,000	$436,403	$798,474

Table 17. Income Qualified Weatherization Cost Effectiveness

Residential	TRC	UCT	RIM	Participant	Lifetime Cost/kWh	1st Year Cost/kWh	TRC NPV $	UCT NPV $
Income Qualified Weatherization	1.14	1.14	0.66	NA	$0.07	$0.78	$115,688	$115,688

Program Delivery

Vectren South will oversee the program and may partner with an implementation provider to deliver the program.

Integration with Vectren South Gas

Vectren South will evaluate the opportunities that exist to gain both gas and electric savings for this program. For purposes of this plan, cost sharing has not been factored in; however, gas and electric integration will be considered and discussed with the Vectren South Electric Oversight Board as the Operating Plan is finalized.

Evaluation, Measurement and Verification

To assure quality installations, 10% of the installations will be field inspected. A third party evaluator will evaluate the program using standard EM&V protocols.

D. Appliance Recycling

Program Description

The Residential Appliance Recycling program encourages customers to recycle their old inefficient refrigerators and freezers in an environmentally safe manner. The program recycles operable refrigerators or freezers so the appliance no longer uses electricity and is recycled instead of being disposed of in a landfill. An older refrigerator can use as much as twice the amount of energy as new efficient refrigerators. An incentive of $50 will be provided to the customer for each operational unit picked up.

Eligible Customers

Any residential customer with an operable secondary refrigerator or freezer receiving electric service from Vectren South.

Marketing Plan

The program will be marketed through a variety of mediums, including the use of utility bill inserts, retail campaigns coordinated with appliance sales outlets as well as the potential for direct mail, web and media promotional campaigns.

Barriers/Theory

Many homes have second refrigerators and freezers that are very inefficient. Customers are not aware of the high energy consumption of these units. Customers also often have no way to move and dispose of the units so keep them in their homes past their usefulness. This program educates customers about the waste of these units and provides a simple way for customers to dispose of the units.

Table 18. Appliance Recycling Program Budget & Energy Savings Targets

Market	Program	Number of Participants	Energy Savings kWh	Peak Demand kW	Total Program Budget $
Residential	**Appliance Recycling**				
	2015	1,058	1,301,338	235	$ 212,366
Per Participant Avg Energy Savings (kWh)*					1,230
Per Participant Avg Demand Savings (kW)*					0.222
Weighted Avg Measure Life*					8
Net To Gross Ratio					54%

*These values represent averages, detailed information by measure is available in Appendix A

Table 19. Appliance Recycling Estimated Energy Savings & Budget

Residential	2015 kWh Total	2015 kW	Administration	Evaluation	Implementation	Incentives	Total Program Costs
Appliance Recycling	1,301,338	235	$62,500	$12,021	$84,970	$52,875	$212,366

Table 20. Appliance Recycling Cost Effectiveness

Residential	TRC	UCT	RIM	Participant	Lifetime Cost/kWh	1st Year Cost/kWh	TRC NPV $	UCT NPV $
Appliance Recycling	2.52	2.51	0.97	5.79	$0.04	$0.16	$320,800	$319,656

Program Delivery

Vectren South will oversee the program and may partner with an implementation provider to deliver the program.

Evaluation, Measurement and Verification

Recycled units will be logged and tracked to assure proper handling and disposal. The utility will monitor the activity for disposal. Customer satisfaction surveys will also be used to understand the customer experience with the program. A third party evaluator will evaluate the program using standard EM&V protocols.

E. Energy Efficient Schools

Program Description

The Energy Efficient Schools Program is designed to impact students by teaching them how to conserve energy and to produce cost effective electric savings by influencing students and their families to focus on conservation and the efficient use of electricity.

The program consists of a school education program for 5th grade students attending schools served by Vectren South. To help in this effort, each child that participates will receive a take-home energy kit with various energy saving measures for their parents to install in the home. The kits along with the in-school teaching materials are designed to make a lasting impression on the students and help them learn ways to conserve energy.

Eligible Customers

The program will be available to selected 5th grade students/schools in the Vectren South electric service territory.

Marketing Plan

The program will be marketed directly to elementary schools in Vectren South electric service territory as well as other channels identified by the implementation contractor. A list of the eligible schools will be provided by Vectren South to the implementation contractor for direct marketing to the schools via email, phone, and mail (if necessary) to obtain desired participation levels in the program.

Barriers/Theory

This program addresses the barrier of education and awareness of energy efficiency opportunities. Working through schools both students and families are educated about opportunities to save. As well, the families receive energy savings devices they can install to begin their savings.

Initial Measures, Products and Services

The kits for students will include:

- Low flow showerhead
- Low flow kitchen aerator
- Low flow bathroom aerator
- CFLs
- LED nightlight
- Air Filter Alarm

Table 21. Energy Efficient Schools Program Budget & Energy Savings Targets

Market	Program	Number of Participants	Energy Savings kWh	Peak Demand kW	Total Program Budget $
Residential	**Residential Schools**				
	2015	2,600	560,786	76	$ 128,033
Per Participant Avg Energy Savings (kWh)*					216
Per Participant Avg Demand Savings (kW)*					0.029
Weighted Avg Measure Life*					7
Net To Gross Ratio					96%

*These values represent averages, detailed information by measure is available in Appendix A

Table 22. Energy Efficient Schools Estimated Energy Savings & Budget

Residential	2015 kWh Total	2015 kW	Administration	Evaluation	Implementation	Incentives	Total Program Costs
Residential Schools	560,786	76	$31,250	$7,247	$31,250	$58,286	$128,033

Table 23. Energy Efficient Schools Cost Effectiveness

Residential	TRC	UCT	RIM	Participant	Lifetime Cost/kWh	1st Year Cost/kWh	TRC NPV $	UCT NPV $
Residential Schools	2.67	2.67	0.81	NA	$0.03	$0.23	$214,237	$214,237

Program Delivery

Vectren South will oversee the program and may partner with an implementation provider to deliver the program.

Evaluation, Measurement and Verification

Classroom participation will be tracked. A third party evaluator will evaluate the program using standard EM&V protocols.

F. Residential Efficient Products

Program Description

To assist customers with the purchase of energy efficient products, prescriptive incentives will be provided on efficient electric measures and equipment above the standard baseline. The program will be promoted through trade allies and appropriate retail outlets.

Eligible Customers

Any residential customer located in the Vectren South electric service territory.

Marketing Plan

The marketing plan includes program specific marketing materials that will target contractors and trade allies in the HVAC industry. The HVAC industry will be marketed to by using targeted direct marketing, direct contact by the program vendor personnel, trade shows and trade association outreach. Vectren South will also use web banners, bill inserts, and mass market advertising.

Barriers/Theory

First cost is one of the key barriers to the adoption of energy efficient technology. Customers don't always understand the long term benefits of the energy savings from these efficient alternatives. Trade allies are also often reluctant to sell the higher cost items as they don't want to be the high cost bidder. Incentives help address this first cost issue and provide a good reason for Trade Allies to promote these higher efficient options.

Initial Measures, Products and Services

The initial measure list is designed not to overlap with the other program offerings. Details of the measures, savings and incentives can be found in Appendix A. The initial measure list includes the following measures:

Measure	Energy Savings (kWh)	Incentive
Heat Pump Water Heater	2,076	$300
Programmable Thermostat	176	$20
Duct Sealing Gas Heating with A/C	326	$225
Duct Sealing Electric Heat Pump	756	$400
Duct Sealing Electric Resistive Furnace	2,878	$400
Variable Speed Pool Pump	1,173	$300
Pool Heater	4,068	$1,000
Air Source Heat Pump 16 SEER - no gas available	727	$400
Air Source Heat Pump 16 SEER -gas available	727	$300

Measure	Energy Savings (kWh)	Incentive
Dual Fuel Air Sourc Heat Pump 16 SEER	727	$300
Air Source Heat Pump 18 SEER - no gas available	1,077	$600
Air Source Heat Pump 18 SEER - gas available	1,077	$500
Duel Fuel Air Source Heat Pump 18 SEER	1,077	$500
Central Air Conditioner 16 SEER	344	$300
Central Air Conditioner 18 SEER	462	$500
ECM HVAC Motor	380	$100
Smart Programmable Thermostat	696	$100
Ductless Heat Pump 17 SEER 9.5 HSPF	3,939	$750
Ductless Heat Pump 19 SEER 9.5 HSPF	3,972	$750
Ductless Heat Pump 21 SEER 10.0 HSPF	4,093	$1,000
Ductless Heat Pump 23 SEER 10.0 HSPF	4,115	$1,000

Note that measures included in the program will change over time as baselines change, new technologies become available and customer needs are identified.

Table 24. Residential Efficient Products Program Budget & Energy Savings Targets

Market	Program	Number of Measures	Energy Savings kWh	Peak Demand kW	Total Program Budget $
Residential	**Efficient Products**				
	2015	1,500	771,461	484	$ 516,189
Per Participant Avg Energy Savings (kWh)*					514
Per Participant Avg Demand Savings (kW)*					0.323
Weighted Avg Measure Life*					15
Net To Gross Ratio					80%

*These values represent averages, detailed information by measure is available in Appendix A

Table 25. Residential Efficient Products Estimated Energy Savings & Budget

Residential	2015 kWh Total	2015 kW	Administration	Evaluation	Implementation	Incentives	Total Program Costs
Efficienct Products	771,461	484	$93,750	$29,218	$121,446	$271,775	$516,189

Table 26. Residential Efficient Products Cost Effectiveness

Residential	TRC	UCT	RIM	Participant	Lifetime Cost/kWh	1st Year Cost/kWh	TRC NPV $	UCT NPV $
Efficient Products	1.51	2.02	1.05	1.13	$0.06	$0.67	$352,915	$524,039

Program Delivery

Vectren South will oversee the program and may partner with an implementation provider to deliver the program.

Integration with Vectren South Gas

Vectren will evaluate the opportunities that exist to gain both gas and electric savings for this program. For purposes of this plan, cost sharing has been factored in, as the cost share methodology was previously approved by the Vectren South Electric Oversight Board.

Evaluation, Measurement and Verification

There will be 100% paper verification that the equipment/products purchased meet the program efficiency standards and a field verification of 10% of the measures installed. A third party evaluator will review the program using appropriate EM&V protocols.

G. Residential New Construction

Program Description

The Residential New Construction Program will provide incentives and encourage home builders to construct homes that are more efficient than current building codes. The Residential New Construction Program will work closely with builders, educating them on the benefits of energy efficient new homes. Homes may feature additional insulation, better windows, and higher efficiency appliances. The homes should also be more efficient and comfortable than standard homes constructed to current building codes.

Program incentives are designed to be paid to both all-electric and combination homes that have natural gas heating and water heating. It is important to note that the program is structured such that an incentive will not be paid for an all-electric home that has natural gas available to the home site.

The Residential New Construction Program will address the lost opportunities in this customer segment by promoting energy efficiency at the time the initial decisions are being made. This will ensure efficient results for the life of the home.

Eligible Customers

Any home builder constructing a home to the program specifications in the Vectren South electric service territory.

Marketing Plan

In order to move the market toward an improved home building standard, education will be required for home builders, architects and designers as well as customers buying new homes. A combination of in-person meetings with these market participants as well as other educational methods will be necessary.

Barriers/Theory

There are three primary barriers addressed by the Residential New Construction program. The first is customer knowledge. The HERS rating system allows customers to understand building design and construction improvements through a rating system completed by professionals. The second barrier is first cost. The program provides incentives to help reduce the first cost of the energy efficiency upgrades. The third barrier is the lack of skill and knowledge of the builders. The program provides opportunities for builders and developers to gain knowledge and skills concerning energy efficient building practices and coaches them on application of these skills.

Incentive Strategy

Incentives will be based on the rating tier qualification. For all-electric homes, where Vectren South natural gas service is not available, the initial incentives will be:

Tier	Total Incentive	Vectren Electric Incentive Portion
Platinum Star	$1,000	$1,000
Gold Star	$900	$900
Silver Star	$600	$600

For homes with central air conditioning and Vectren South natural gas space heating the electric portion of the incentive will be:

Tier	Total Incentive	Vectren Electric Incentive Portion
Platinum Star	$1,000	$500
Gold Star	$900	$450
Silver Star	$600	$300

Incentives will be paid to the builder.

Table 27. Residential New Construction Program Budget & Energy Savings Targets

Market	Program	Number of Participants	Energy Savings kWh	Peak Demand kW	Total Program Budget $
Residential	Residential New Construction				
	2015	68	129,048	22	$ 119,092
Per Participant Avg Energy Savings (kWh)*					1,898
Per Participant Avg Demand Savings (kW)*					0.317
Weighted Avg Measure Life*					25
Net To Gross Ratio					95%

*These values represent averages, detailed information by measure is available in Appendix A

Table 28. Residential New Construction Estimated Energy Savings & Budget

Residential	2015 kWh Total	2015 kW	Administration	Evaluation	Implementation	Incentives	Total Program Costs
Residential New Construction	129,048	22	$31,250	$6,741	$48,691	$32,410	$119,092

Table 29. Residential New Construction Cost Effectiveness

Residential	TRC	UCT	RIM	Participant	Lifetime Cost/kWh	1st Year Cost/kWh	TRC NPV $	UCT NPV $
Residential New Construction	1.28	1.52	0.75	1.89	$0.04	$0.92	$39,816	$61,965

Program Delivery

Vectren South will oversee the program and may partner with an implementation provider to deliver the program.

Integration with Vectren South Gas

Vectren will evaluate the opportunities that exist to gain both gas and electric savings for this program. For the purpose of this plan, cost sharing has been factored in, as the cost share methodology was already approved by the Vectren South Electric Oversight Board.

Evaluation, Measurement and Verification

Field inspections of the home will occur during construction at least once and upon completion. All paperwork will be reviewed and the HERS ratings archived. A third party evaluator will evaluate the program using standard EM&V protocols.

H. Residential Behavior Savings

Program Description

The Residential Behavioral Savings (RBS) Program motivates behavior change and provides relevant, targeted information to the consumer through regularly scheduled direct contact via mailed and emailed home energy reports. The report and web portal include a comparison against a group of similarly sized and equipped homes in the area, usage history comparisons, goal setting tools, and progress trackers. The Home Energy Report program anonymously compares customers' energy use with that of their neighbors of similar home size and demographics. Customers can view the past twelve months of their energy usage and compare and contract their energy consumption and costs with others in the same neighborhood. Once a consumer understands better how they use energy, they can then start conserving energy.

Program data and design was provided by OPower, the implementation vendor for the program. OPower provides energy usage insight that drives customers to take action by selecting the most relevant information for each particular household, which ensures maximum relevancy and high response rate to recommendations.

Eligible Customers

Residential customers who receive electric service from Vectren South.

Barriers/Theory

The RBS program is a proven energy efficiency program that leverages large-scale consumer engagement to drive measureable and sustainable energy savings. The RBS program provides residential customers with better energy information through personalized reports delivered by mail, email and an integrated web portal to help them put their energy usage in context and make better energy usage decisions. Behavioral science research has demonstrated that peer-based comparisons are highly motivating ways to present information. The RBS program will leverage a dynamically created comparison group for each residence and compare it to other similarly sized and located households.

Implementation & Delivery Strategy

The program will be delivered by OPower system and include energy reports and a web portal. Customers typically receive between 4-6 reports annually. These reports provide updates on energy consumption patterns compared to neighbors and provide energy savings strategies to reduce energy use. They can promote other Vectren South programs to interested customers. The web portal is an interactive system for customers to perform a self-audit, monitor energy usage over time, access energy savings tips and be connected to other Vectren South gas and electric programs.

Table 30. Residential Behavior Savings Program Budget & Energy Savings Targets

Market	Program	Number of Participants	Energy Savings kWh	Peak Demand kW	Total Program Budget $
Residential	**Behavioral Savings**				
	2015	50,400	6,350,400	2,181	$ 432,202
Per Participant Avg Energy Savings (kWh)*					126
Per Participant Avg Demand Savings (kW)*					0.043
Weighted Avg Measure Life*					1
Net To Gross Ratio					100%

*These values represent averages, detailed information by measure is available in Appendix A

Table 31. Residential Behavior Savings Estimated Energy Savings & Budget

Residential	2015 kWh Total	2015 kW	Administration	Evaluation	Implementation	Incentives	Total Program Costs
Behavior Savings	6,350,400	2,181	$31,250	$24,464	$376,488	$0	$432,202

Table 32. Residential Behavior Savings Cost Effectiveness

Residential	TRC	UCT	RIM	Participant	Lifetime Cost/kWh	1st Year Cost/kWh	TRC NPV $	UCT NPV $
Residential Behavior Savings	1.64	1.64	0.77	NA	$0.06	$0.07	$274,885	$274,885

Program Delivery

Vectren South will oversee the program and partner with OPower to deliver the program.

Evaluation, Measurement and Verification

To understand the savings with behavior programs detailed evaluation protocols will need to be used including having matching control groups of non-participants. Billing analysis will compare the participant and non-participant groups. A third party evaluator will complete the evaluation of this program and work with Vectren South to select the participant and non-participant groups.

I. Small Business Direct Install

Program Description

The Small Business Direct Install Program provides value by directly installing energy efficient products such as high efficiency lighting, low flow water saving measures and vending machine controls. The program helps businesses identify and install cost effective energy saving measures by providing an on-site energy assessment customized for their business.

Eligible Customers

Any participating Vectren South small business customer with a maximum peak energy demand of less than 300 kW.

Marketing Plan

The Small Business Direct Install Program will be marketed through direct mailing, trade associations, educational seminars, and direct personal communication from Vectren South staff and third party contractors.

Barriers/Theory

Small business customers generally do not have the knowledge, time or money to invest in energy efficiency. This program assists these small businesses with direct installation and turn-key services to get measures installed at no or low out-of-pocket cost.

Initial Measures, Products and Services

The program will have two types of measures provided. The first are measures that will be installed at the time of the audit at no additional cost. They will include but are not limited to the following:

- Anti-sweat heater controls
- Efficient CFL and LED lamps
- LED exit signs
- Occupancy sensors
- Pre-rinse sprayers
- Programmable thermostats
- Delamping
- Efficient aerators and showerheads
- Pipe insulation
- Smart strips

The second type of measure requires the customer to pay up to 25% of the cost of the measure. These are primarily linear fluorescent lighting fixtures and refrigeration improvements.

Incentive Strategy

In addition to the low cost measures installed during the audit, the program will also pay a cash incentive of up to 75% of the cost of any recommended improvements identified through the audit.

Table 33. Small Business Direct Install Program Budget & Energy Savings Targets

Market	Program	Number of Projects	Energy Savings kWh	Peak Demand kW	Total Program Budget $
Commercial	**Small Business Direct Install**				
	2015	1,000	6,001,171	1,724	$ 1,909,188
Per Participant Avg Energy Savings (kWh)*					6,001
Per Participant Avg Demand Savings (kW)*					1.724
Weighted Avg Measure Life*					10
Net To Gross Ratio					100%

*These values represent averages, detailed information by measure is available in Appendix A

Table 34. Small Business Direct Install Estimated Energy Savings & Budget

Commercial	2015 kWh Total	2015 kW	Administration	Evaluation	Implementation	Incentives	Total Program Costs
Small Business Direct Install	6,001,171	1,724	$62,500	$108,067	$600,000	$1,138,621	$1,909,188

Table 35. Small Business Direct Install Cost Effectiveness

Commercial	TRC	UCT	RIM	Participant	Lifetime Cost/kWh	1st Year Cost/kWh	TRC NPV $	UCT NPV $
Small Business Direct Install	2.00	2.21	0.83	3.66	$0.04	$0.32	$2,116,270	$2,319,485

Program Delivery

Vectren South will oversee the program and may partner with an implementation provider to deliver the program.

Integration with Gas

Vectren South will evaluate the opportunities that exist to gain both gas and electric savings for this program. For purposes of this plan, cost sharing has not been factored in; however, gas and electric integration will be considered and discussed with the Vectren South Electric Oversight Board as the 2015 Plan is finalized and implemented.

Evaluation, Measurement and Verification

To assure quality installation, 10% of the installations will be inspected. A third party evaluator will evaluate the program using standard EM&V protocols.

J. Commercial & Industrial Prescriptive Rebates

Program Description

The Commercial and Industrial (C&I) Prescriptive Program is designed to provide financial incentives on qualifying products to produce greater energy savings in the C&I market. The rebates are designed to promote lower electric energy consumption, assist customers in managing their energy costs, and build a sustainable market around energy efficiency. Program participation is achieved by offering incentives structured to cover a portion of the customer's incremental cost of installing prescriptive efficiency measures.

Eligible Customers

Any participating commercial or industrial customer receiving electric service from Vectren South.

Marketing Plan

Proposed marketing efforts include trade ally outreach, trade ally meetings, direct mail, face-to-face meetings with customers, web-based marketing, and coordination with key account executives.

Barriers/Theory

Customers often have the barrier of higher first cost for energy efficiency measures which precludes them from purchasing the more energy efficient alternative. They also lack information on high efficiency alternatives. Trade allies often run into the barrier of not being able to promote higher energy efficient alternatives because of first cost. Allies also gain credibility with customers for their energy efficiency claims when a measure is included in a utility prescriptive program. Through the program the Trade Allies can promote energy efficiency measures directly to their customers encouraging them to purchase more efficient equipment while helping customers get over the initial cost barrier.

Initial Measures, Products and Services

High efficient lighting and lighting controls for various applications will be the primary measures included. In addition variable frequency drives (VFD) for HVAC system and compressors will be included in the program. Table 36 below lists the other new measures that will be added.

Table 36. Commercial & Industrial Prescriptive Measure Listing

Measure	Energy Savings (kWh)	Incentive
Barrel Wraps (Inj Mold Only)	1,439	$40
Clothes Washer CEE Tier 2	542	$60
Clothes Washer CEE Tier 3	542	$70
Clothes Washer ENERGY STAR/CEE Tier 1	542	$50
Cooler - Glass Door <15 vol	957	$50
Cooler - Glass Door >50 vol	2,876	$70
Cooler - Glass Door 15-30 vol	1,419	$55
Cooler - Glass Door 30-50 vol	1,752	$60
Cooler - Reach-In Electronically Commutated (EC) Motor	325	$30
Cooler - Solid Door <15 vol	496	$50
Cooler - Solid Door >50 vol	2,242	$70
Cooler - Solid Door 15-30 vol	617	$55
Cooler - Solid Door 30-50 vol	1,484	$60
Cooler - Walk-In Electronically Commutated (EC) Motor	354	$30
Cooler Anti-Sweat Heater Controls - Conductivity-Based	700	$50
Cooler Anti-Sweat Heater Controls - Humidity-Based	550	$50
Cooler Door Gaskets	1	$0
Demand Controlled Ventilation - CO	747	$46
Demand Controlled Ventilation - CO2	747	$46
Electric Chiller - Air cooled, with condenser	305	$30
Electric Chiller - Air cooled, without condenser	35	$10
Electric Chiller - Water Cooled, Centrifugal <150 tons	216	$30
Electric Chiller - Water Cooled, Centrifugal >300 tons	174	$30
Electric Chiller - Water Cooled, Centrifugal 150-300 tons	177	$30
Electric Chiller - Water Cooled, Rotary Screw <150 tons	168	$30
Electric Chiller - Water Cooled, Rotary Screw >300 tons	178	$30
Electric Chiller - Water Cooled, Rotary Screw 150-300 tons	181	$30
Electric Chiller Tune-up - Air cooled, with condenser	186	$8
Electric Chiller Tune-up - Air cooled, without condenser	165	$8
Electric Chiller Tune-up - Water Cooled, Centrifugal <150 tons	108	$8
Electric Chiller Tune-up - Water Cooled, Centrifugal >300 tons	89	$8
Electric Chiller Tune-up - Water Cooled, Centrifugal 150-300 tons	96	$8
Electric Chiller Tune-up - Water Cooled, Rotary Screw <150 tons	109	$8
Electric Chiller Tune-up - Water Cooled, Rotary Screw >300 tons	92	$8
Electric Chiller Tune-up - Water Cooled, Rotary Screw 150-300 tons	101	$8
ENERGY STAR CEE Tier 1 Window\Sleeve\Room AC < 14,000 BTUH	136	$16
ENERGY STAR CEE Tier 1 Window\Sleeve\Room AC >= 14,000 BTUH	215	$18
ENERGY STAR Combination Oven	18,432	$1,000
ENERGY STAR Commercial Dishwasher - Door Type, High Temp	14,143	$500
ENERGY STAR Commercial Dishwasher - Door Type, Low Temp	12,135	$500
ENERGY STAR Commercial Dishwasher - Multi-Tank Conveyor, High Temp	34,153	$750
ENERGY STAR Commercial Dishwasher - Multi-Tank Conveyor, Low Temp	17,465	$750
ENERGY STAR Commercial Dishwasher - Single Tank Conveyor, High Temp	19,235	$250
ENERGY STAR Commercial Dishwasher - Single Tank Conveyor, Low Temp	11,384	$150
ENERGY STAR Commercial Dishwasher - Under Counter, High Temp	7,471	$350
ENERGY STAR Commercial Dishwasher - Under Counter, Low Temp	1,213	$150
ENERGY STAR Commercial Fryer	983	$100
ENERGY STAR Commercial Hot Holding Cabinets Full Size	5,256	$500
ENERGY STAR Commercial Hot Holding Cabinets Half Size	1,862	$250
ENERGY STAR Commercial Hot Holding Cabinets Three Quarter Size	2,847	$350
ENERGY STAR Commercial Ice Machine < 500 lb/day harvest rate	397	$100

Measure	Energy Savings (kWh)	Incentive
ENERGY STAR Commercial Ice Machine >=1000 lb/day harvest rate	1,693	$250
ENERGY STAR Commercial Ice Machine >=500 and <1000 lb/day harvest rate	958	$175
ENERGY STAR Commercial Steam Cookers 3 Pan	6,629	$750
ENERGY STAR Commercial Steam Cookers 4 Pan	8,429	$1,000
ENERGY STAR Commercial Steam Cookers 5 Pan	11,466	$1,250
ENERGY STAR Commercial Steam Cookers 6 Pan	13,608	$1,500
ENERGY STAR Convection Oven	3,235	$350
ENERGY STAR Griddles	6,996	$700
ENERGY STAR Window\Sleeve\Room AC < 14,000 BTUH	136	$12
ENERGY STAR Window\Sleeve\Room AC >= 14,000 BTUH	215	$14
ENERGY STAR CEE Tier 2 Window\Sleeve\Room AC < 14,000 BTUH	117	$20
ENERGY STAR CEE Tier 2 Window\Sleeve\Room AC >= 14,000 BTUH	206	$22
Freezer - Glass Door <15 vol	1,338	$100
Freezer - Glass Door >50 vol	8,579	$350
Freezer - Glass Door 15-30 vol	2,226	$150
Freezer - Glass Door 30-50 vol	4,407	$200
Freezer - Reach-In Electronically Commutated (EC) Motor	409	$30
Freezer - Solid Door <15 vol	1,017	$100
Freezer - Solid Door >50 vol	5,488	$350
Freezer - Solid Door 15-30 vol	2,419	$150
Freezer - Solid Door 30-50 vol	3,074	$200
Freezer - Walk-In Electronically Commutated (EC) Motor	620	$40
Freezer Anti-Sweat Heater Controls - Conductivity-Based	1,483	$100
Freezer Anti-Sweat Heater Controls - Humidity-Based	1,165	$150
Freezer Door Gaskets	3	$0
Heat Pump Water Heater 10-50 MBH	21,156	$2,000
HID >400W to Exterior LED or Induction	4	$0
HID >400W to Garage LED or Induction	4	$0
High Efficiency Pumps - 1.5hp	617	$60
High Efficiency Pumps - 10hp	5,952	$240
High Efficiency Pumps - 15hp	7,848	$280
High Efficiency Pumps - 20hp	7,246	$320
High Efficiency Pumps - 2hp	900	$100
High Efficiency Pumps - 3hp	1,841	$120
High Efficiency Pumps - 5hp	3,528	$160
High Efficiency Pumps - 7.5hp	5,438	$200
High Performance Glazing	4	$2
Low Flow Pre-Rinse Sprayer - Electric	3,727	$25
MH 1000W To T8VHO 48" 8 Lamp (2 fixtures)	1,921	$125
MH 250W To T8VHO 48" 4 Lamp	549	$50
MH 400W To T8VHO 48" 6 Lamp	884	$60
MH 400W To T8VHO 48" 8 Lamp	648	$60
Network PC Power Management Software	135	$3
No controls To Ceiling-Mounted Occupancy Sensors >500W Connected	1,143	$40
No controls To Central Lighting Controls (Timeclocks) >500W Connected	381	$20
No controls To Fixture Mounted Daylight Dimming Sensors >500W Connected	1,143	$40
No controls To Fixture Mounted Occupancy Sensors >500W Connected	1,143	$40
No controls To LED Case Lighting Sensor Controls	675	$30
No controls To Remote-Mounted Daylight Dimming Sensors >500W Connected	1,143	$40
No controls To Switching Controls for Multi-Level Lighting >500W Connected	1,143	$40
No controls To Wall-Mounted Occupancy Sensors >500W Connected	1,143	$40
Outside Air Economizer with Dual-Enthalpy Sensors	350	$50

Measure	Energy Savings (kWh)	Incentive
Packaged Terminal Air Conditioner (PTAC) <65,000 BtuH	669	$75
Packaged Terminal Air Conditioner (PTAC) 65,000-135,000 BtuH	1,341	$150
Packaged Terminal Heat Pump (PTHP) <65,000 BtuH	669	$75
Packaged Terminal Heat Pump (PTHP) 65,000-135,000 BtuH	1,341	$150
Pellet Dryer Duct Insulation 3in -8in dia	347	$30
Plug Load Occupancy Sensors	169	$20
PSMH 1000W To T8VHO 48" 8 Lamp (2 fixtures)	1,921	$60
Refrigerated Case Covers	158	$15
Smart Strip Plug Outlet	24	$4
Snack Machine Controller (Non-refrigerated vending)	343	$30
Split System Heat Pump <65,000 BtuH	669	$75
Split System Heat Pump 135,000-240,000 BtuH	1,966	$250
Split System Heat Pump 240,000-760,000 BtuH	3,120	$400
Split System Heat Pump 65,000-135,000 BtuH	1,341	$150
Split System Unitary Air Conditioner <65,000 BtuH	669	$75
Split System Unitary Air Conditioner >760,000 BtuH	3,253	$500
Split System Unitary Air Conditioner 135,000-240,000 BtuH	1,966	$250
Split System Unitary Air Conditioner 240,000-760,000 BtuH	3,120	$400
Split System Unitary Air Conditioner 65,000-135,000 BtuH	1,341	$150
T12 6' To Refrigerated Display Case Lighting 6' LED - Cooler	252	$40
T12 6' To Refrigerated Display Case Lighting 6' LED - Freezer	252	$40
T8 5' To Refrigerated Display Case Lighting 5' LED - Cooler	145	$25
T8 5' To Refrigerated Display Case Lighting 5' LED - Freezer	145	$25
T8 To 21" Tubular Skylight/Light Tube	413	$50
VFD CHW Pump 20-100hp - Hospital	402,820	$2,500
VFD CHW Pump 20-100hp - Hotel	406,540	$2,500
VFD CHW Pump 20-100hp - Large Office	233,560	$2,500
VFD CW Pump 20-100hp - Hospital	122,020	$1,200
VFD CW Pump 20-100hp - Hotel	4,380	$1,200
VFD CW Pump 20-100hp - Large Office	62,840	$1,200
VFD HW Pump 20-100hp - Hospital	341,760	$2,000
VFD HW Pump 20-100hp - Hotel	429,740	$2,000
VFD HW Pump 20-100hp - Large Office	228,340	$2,000
VFD Return Fan 20-100hp - Hospital	114,420	$1,000
VFD Return Fan 20-100hp - Hotel	9,000	$1,000
VFD Return Fan 20-100hp - Large Office	83,220	$1,000
VFD Supply Fan <100hp - Hospital	132,300	$1,000
VFD Supply Fan <100hp - Hotel	3,540	$1,000
VFD Supply Fan <100hp - Large Office	106,920	$1,000
VFD Tower Fan 20-100hp - Hospital	51,320	$750
VFD Tower Fan 20-100hp - Hotel	70,560	$750
VFD Tower Fan 20-100hp - Large Office	3,700	$750
Window Film	4	$1

Note that measures included in the program will change over time as baselines change, new technologies become available and customer needs are identified. Detailed measure listings, participation and incentives are in Appendix A.

Implementation & Delivery Strategy

The program will be delivered primarily through the trade allies working with their customers. Vectren South and its implementation partners will work with the trade allies to make them aware of the offerings and help them promote the program to their customers. The implementation partner will provide training and technical support to the trade allies to become familiar with the energy efficiency technologies offered through the program. The program will be managed by the same implementation provider as the Commercial & Industrial Custom program so that customers can seamlessly receive assistance and all incentives can be efficiently processed through a single procedure.

Incentive Strategy

Incentives are provided to customers to reduce the difference in first cost between the lower efficient technology and the high efficient option. There is no fixed incentive percentage amount based on the difference in price because some technologies are newer and need higher amounts. Others have been available in the marketplace longer and do not need as much to motivate customers. Incentives will be adjusted to respond to market activity and bonuses may be available for limited time if required to meet goals.

Table 37. Commercial & Industrial Prescriptive Program Budget & Energy Savings Targets

Market	Program	Number of Measures	Energy Savings kWh	Peak Demand kW	Total Program Budget $
Commercial & Industrial	**Commercial & Industrial Prescriptive**				
	2015	23,440	12,051,363	1,879	$ 1,780,514
Per Participant Avg Energy Savings (kWh)*					514
Per Participant Avg Demand Savings (kW)*					0.080
Weighted Avg Measure Life*					14
Net To Gross Ratio					80%

*These values represent averages, detailed information by measure is available in Appendix A

Table 38. Commercial & Industrial Prescriptive Estimated Energy Savings & Budget

Commercial & Industrial	2015 kWh Total	2015 kW	Administration	Evaluation	Implementation	Incentives	Total Program Costs
Commercial & Industrial Prescriptive	12,051,363	1,879	$62,500	$100,784	$360,000	$1,257,231	$1,780,514

Table 39. Commercial & Industrial Prescriptive Cost Effectiveness

Commercial & Industrial	TRC	UCT	RIM	Participant	Lifetime Cost/kWh	1st Year Cost/kWh	TRC NPV $	UCT NPV $
Commercial & Industrial Prescriptive	3.97	5.57	1.02	3.34	$0.01	$0.15	$7,415,610	$8,135,889

Program Delivery

Vectren South will oversee the program and may partner with an implementation provider to deliver the program.

Evaluation, Measurement and Verification

Site visits will be made on 10% of the installations to verify the correct equipment was installed. EM&V protocols will be used for the third party evaluation of the program.

K. Commercial & Industrial New Construction

Program Description

The Commercial and Industrial New Construction Program provides value by promoting energy efficient designs with the goal of developing projects that are more energy efficient than current Indiana building code. Incentives promoted through this program serve to reduce the incremental cost to upgrade to high-efficiency equipment over standard efficiency options for Vectren South customers. The program includes equipment with easily calculated savings and provides straightforward and easy participation for customers.

Eligible Customers

Any participating commercial or industrial customer receiving electric service from Vectren South.

Marketing Plan

The Commercial and Industrial New Construction Program will be marketed through trade ally meetings, trade association training, educational seminars, and direct personal communication from Vectren South staff and third party contractors.

Barriers/Theory

There are three primary barriers addressed by the new construction program. The first is knowledge. For commercial and industrial buildings is it the knowledge and experience of the design team including the owner, architect, lighting and HVAC engineers, general contractor and others. This team may not understand new technologies and energy efficiency options that could be considered. The second barrier is cost. There is a cost during the design phase of the building in modeling energy efficiency options to see what can cost-effectively work within the building. The program provides incentives to help reduce the design cost for the consideration of energy efficiency upgrades. The third barrier is the first cost of the high efficiency upgrades in equipment and materials. The incentives from the standard programs will provide incentives to help reduce this first cost.

Implementation & Delivery Strategy

Standard EDA targets buildings that are less than 100,000 square feet, but is also available for larger new buildings that are beyond the schematic design phase or are on an accelerated schedule. Commercial new construction projects for buildings greater than 100,000 square feet still in the conceptual design phase qualify for Vectren South's Enhanced EDA incentives. The Vectren South implementation partner staff expert will work with the design team through the conceptual design, schematic design and design development processes providing advice and counsel on measures that should be considered and energy efficiency modeling issues. Incentives will be paid after the design team submits completed construction documents for review to verify that the facility design reflects the minimum energy savings requirements.

Incentive Strategy

All buildings in Vectren South's service territory receiving electric service qualify for the measure incentives available in the Prescriptive and Custom programs. In addition Vectren South will provide incentives to help offset some of the expenses for the design team's participation in the EDA process with the design team service incentive. The design team service incentive is a fixed amount based on the new conditioned square footage and is paid to the designated design team lead provided that the proposed energy efficiency projects associated with the construction documents exceed a minimum energy savings threshold. Vectren South will offer a one-time, lump-sum incentive to building owners for participation in the Enhanced EDA program. Facilities must exceed Indiana Energy Code requirements by 10 percent in order to qualify for an Enhanced EDA incentive. Facilities earn $0.12 per kilowatt hour (kWh) saved up to $100,000 based on the first-year energy savings determined in the final energy model.

Facility Size – Square Feet	Design Team Incentives	Minimum Savings
Small <25,000	$750	25,000 kWh
Medium 25,000 - 100,000	$2,500	75,000 kWh
Large >1000,000	$3,750	150,000 kWh
Enhance Large >100,000	$5,000	10% beyond code

Table 40. Commercial & Industrial New Construction Program Budget & Energy Savings Targets

Market	Program	Number of Participants	Energy Savings kWh	Peak Demand kW	Total Program Budget $
Commercial & Industrial	**Commercial & Industrial New Construction**				
	2015	14	491,400	89	$ 170,854
Per Participant Avg Energy Savings (kWh)*					35,100
Per Participant Avg Demand Savings (kW)*					6.364
Weighted Avg Measure Life*					14
Net To Gross Ratio					95%

*These values represent averages, detailed information by measure is available in Appendix A

Table 41. Commercial & Industrial New Construction Estimated Energy Savings & Budget

Commercial & Industrial	2015 kWh Total	2015 kW	Administration	Evaluation	Implementation	Incentives	Total Program Costs
Commercial & Industrial New Construction	491,400	89	$31,250	$9,671	$75,000	$54,933	$170,854

Table 42. Commercial & Industrial New Construction Cost Effectiveness

Commercial & Industrial	TRC	UCT	RIM	Participant	Lifetime Cost/kWh	1st Year Cost/kWh	TRC NPV $	UCT NPV $
Commercial & Industrial New Construction	1.09	2.82	0.88	0.98	$0.03	$0.35	$40,440	$311,588

Program Delivery

Vectren South will oversee the program and may partner with an implementation provider to deliver the program.

Evaluation, Measurement and Verification

All construction documents will be reviewed and archived. A third party evaluator will evaluate the program using standard EM&V protocols.

L. Commercial & Industrial Custom

Program Description

The Commercial and Industrial Custom Program promote the implementation of customized energy saving measures at qualifying customer facilities. Incentives promoted through this program serve to reduce the cost of implementing energy reducing projects and upgrading to high-efficiency equipment. Due to the nature of a custom energy efficiency program, a wide variety of projects are eligible.

The technical audit or compressed air system study offers an assessment to systematically identify energy saving opportunities for customers and provides a mechanism to prioritize and phase-in projects that best meet customer needs. In turn, the opportunities identified from the audit can be turned in for the customized efficiency program. These two components work hand in hand to deliver energy savings to Vectren South commercial and industrial customers.

Eligible Customers

Any participating commercial or industrial customer receiving electric service from Vectren South.

Marketing Plan

Proposed marketing efforts include coordination with key account representatives to leverage the contacts and relationships they have with the customers. Direct mail, media outreach, trade shows, trade ally meetings, and educational seminars could also be used to promote the program.

Barriers/Theory

Applications of some specific energy efficient technologies are unique to that customer's application or process. The energy savings estimates for these measures are highly variable and cannot be assessed without an engineering estimation of that application; however, they offer a large opportunity for energy savings. To promote the installation of these high efficient technologies or measures, the Commercial and Industrial Custom program will provide incentives based on the kWh saved as calculated by the engineering analysis. To assure savings, these projects will require program engineering reviews and pre approvals. Energy assessments offered will help remove customer barriers regarding opportunity identification and energy savings potential. The large commercial and industrial education provides a systematic approach to integrating energy management into an organization's business practices and creating lasting energy management processes that produce reliable energy savings.

Initial Measures, Products and Services

All technologies or measures that save kWh qualify for the program. Facility energy assessments, technical assistance and energy management educational services will be offered to eligible and motivated customers to implement multiple energy efficiency measures.

Implementation & Delivery Strategy

The implementation partner for this program will provide engineering field support to customers and trade allies to calculate the energy savings. Customers or trade allies with a proposed project will complete an application form with the energy savings calculations for the project. The implementation team will review all calculations and where appropriate complete site visits to assess and document pre installation conditions. Customers will be informed and funds reserved for the project. Implementation engineering staff will review the final project information as installed and verify the energy savings. Incentives are then paid on the verified savings expected.

The implementation partner will work collaboratively with Vectren South staff to recruit and screen customers for receiving facility energy assessments, technical assistance and energy management education. The program will seek to gain customer commitment towards setting up an energy management process and implementing multiple energy efficiency improvements. The implementation partner will help customers achieve agreed upon milestones in support for their commitment.

Incentive Strategy

Incentives will be calculated on a per kWh basis. The initial kWh rate will be $0.12/kWh and is paid based on the first year annual savings reduction. Rates may change over time and vary with some of the special initiatives. Incentives will not pay more than 50% of the project cost nor provide incentives for projects with paybacks less than 12 months. Vectren South will offer a cost share on facility energy assessments that will cover up to 100% of the assessment cost. Energy education, technical assistance, and company-wide coaching will be offered to large commercial and industry customers that generate an agreement with Vectren South to implement strategies and projects that result from receiving those activities.

Table 43. Commercial & Industrial Custom Program Budget & Energy Savings Targets

Market	Program	Number of Projects	Energy Savings kWh	Peak Demand kW	Total Program Budget $
Commercial & Industrial	Commercial & Industrial Custom				
	2015	50	5,029,080	858	$ 1,076,949
Per Participant Avg Energy Savings (kWh)*					100,582
Per Participant Avg Demand Savings (kW)*					17.156
Weighted Avg Measure Life*					12
Net To Gross Ratio					99%

*These values represent averages, detailed information by measure is available in Appendix A

Table 44. Commercial & Industrial Custom Estimated Energy Savings & Budget

Commercial & Industrial	2015 kWh Total	2015 kW	Administration	Evaluation	Implementation	Incentives	Total Program Costs
Commercial & Industrial Custom	5,029,080	858	$62,500	$60,959	$350,000	$603,490	$1,076,949

Table 45. Commercial & Industrial Custom Cost Effectiveness

Commercial & Industrial	TRC	UCT	RIM	Participant	Lifetime Cost/kWh	1st Year Cost/kWh	TRC NPV $	UCT NPV $
Commercial & Industrial Custom	1.70	4.16	0.94	1.52	$0.02	$0.21	$1,838,430	$3,399,052

Program Delivery

Vectren South will oversee the program and may partner with an implementation provider to deliver the program.

Evaluation, Measurement and Verification

Given the variability and uniqueness of each project, all projects will be pre-approved. Pre and post visits to the site to verify installation and savings will be performed as defined by the program implementation partner. Monitoring and verification may occur on the largest projects. A third party evaluator will be used for this project and use standard EM&V protocols.

V. Appendix A – Program Measure listings, participation and initial incentives

Residential

Measures	Program Name	Measure Life	Install Adjusted Savings per unit (kWh)	2015 Participation	2015 Total kWh	2015 Total kWh (net)	NTG	2015 Freeridership	Average Incentive Paid per unit	Total Incentives 2015	Incremental Cost per unit
Heat Pump Water Heater	Residential Efficiency Products	10	2,076	39	79,926	71,933	90%	10%	$300	$11,550	$700
programmable thermostat	Residential Efficiency Products	15	176	350	61,632	49,305	80%	20%	$20	$7,000	$35
Duct Sealing Gas Heating with A/C	Residential Efficiency Products	20	326	175	57,068	45,654	80%	20%	$225	$39,375	$450
Duct Sealing Electric Heat Pump	Residential Efficiency Products	20	756	53	39,664	31,731	80%	20%	$400	$21,000	$450
Duct Sealing Electric Resistive Furnace	Residential Efficiency Products	20	2,878	7	20,147	16,117	80%	20%	$400	$2,800	$450
Variable Speed Pool Pump	Residential Efficiency Products	10	1,173	70	82,110	65,688	80%	20%	$300	$21,000	$750
Pool Heater	Residential Efficiency Products	10	4,068	9	37,021	29,617	80%	20%	$1,000	$9,100	$3,254
Air Source Heat Pump 16 SEER - no gas available	Residential Efficiency Products	18	727	12	8,650	4,412	51%	49%	$400	$4,760	$1,439
Air Source Heat Pump 16 SEER -gas available	Residential Efficiency Products	18	727	12	8,650	4,412	51%	49%	$300	$3,570	$1,439
Dual Fuel Air Sourc Heat Pump 16 SEER	Residential Efficiency Products	18	727	12	8,650	4,412	51%	49%	$300	$3,570	$1,439
Air Source Heat Pump 18 SEER - no gas available	Residential Efficiency Products	18	1,077	2	1,885	1,508	80%	20%	$600	$1,050	$2,398
Air Source Heat Pump 18 SEER - gas available	Residential Efficiency Products	18	1,077	2	1,885	1,508	80%	20%	$500	$875	$2,398
Duel Fuel Air Source Heat Pump 18 SEER	Residential Efficiency Products	18	1,077	2	1,885	1,508	80%	20%	$500	$875	$2,398
Central Air Conditioner 16 SEER	Residential Efficiency Products	18	344	123	42,140	21,491	51%	49%	$300	$36,750	$714
Central Air Conditioner 18 SEER	Residential Efficiency Products	18	462	105	48,463	38,770	80%	20%	$500	$52,500	$1,192
ECM HVAC Motor	Residential Efficiency Products	10	380	350	133,000	67,830	51%	49%	$100	$35,000	$250
Smart programmable thermostat	Residential Efficiency Products	15	696	175	121,867	97,493	80%	20%	$100	$17,500	$200
Ductless Heat Pump 17 SEER 9.5 HSPF	Residential Efficiency Products	15	3,939	1	5,515	4,412	80%	20%	$750	$1,050	$959
Ductless Heat Pump 19 SEER 9.5 HSPF	Residential Efficiency Products	15	3,972	1	5,561	4,449	80%	20%	$750	$1,050	$1,439
Ductless Heat Pump 21 SEER 10.0 HSPF	Residential Efficiency Products	15	4,093	1	2,865	2,292	80%	20%	$1,000	$700	$1,918
Ductless Heat Pump 23 SEER 10.0 HSPF	Residential Efficiency Products	15	4,115	1	2,881	2,304	80%	20%	$1,000	$700	$2,398
Siver Star HERS =<75 Electric	Residential New Construction	25	1,356	14	18,984	18,035	95%	5%	$300	$4,200	$354
Gold Star HERS =<67 Electric	Residential New Construction	25	1,698	28	47,544	45,167	95%	5%	$450	$12,600	$564
Platinum Star- EPAct Tax Credit Electric	Residential New Construction	25	1,746	18	30,555	29,027	95%	5%	$500	$8,750	$957
Siver Star HERS =<75 All Electric	Residential New Construction	25	2,919	3	8,173	7,765	95%	5%	$600	$1,680	$871
Gold Star HERS =<67 All Electric	Residential New Construction	25	4,074	4	17,111	16,255	95%	5%	$900	$3,780	$3,081
Platinum Star- EPAct Tax Credit All Electric	Residential New Construction	25	4,772	1	6,681	6,347	95%	5%	$1,000	$1,400	$3,264
Compact Fluorescent Lamps V	Home Energy Assessments	5	44	24,000	1,058,400	931,392	88%	12%	NA	$168,000	$7
Kitchen Aerator V	Home Energy Assessments	10	158	500	79,000	69,520	88%	12%	NA	$2,500	$5
Bathroom Aerator V	Home Energy Assessments	10	158	500	79,000	69,520	88%	12%	NA	$1,750	$4
LF Showerhead (Whole House) V	Home Energy Assessments	5	328	1,000	328,000	288,640	88%	12%	NA	$12,000	$12
Pipe Wrap (5', 3/4" Wall) V	Home Energy Assessments	15	51	1,000	51,000	44,880	88%	12%	NA	$16,500	$17
Audit Recommendations V	Home Energy Assessments	1	375	1,000	375,000	330,000	88%	12%	NA	$0	$0
Water Heater Tank Wrap	Home Energy Assessments	5	205	500	102,500	90,200	88%	12%	NA	$28,000	$56

Measures	Program Name	Measure Life	Install Adjusted Savings per unit (kWh)	2015 Participation	2015 Total kWh	2015 Total kWh (net)	NTG	2015 Freeridership	Average Incentive Paid per unit	Total Incentives 2015	Incremental Cost per unit
Energy Star Specialty CFL V	Residential Lighting	5	32	3,470	111,025	54,402	49%	51%	NA	$6,939	$10
Energy Star Reflector CFL V	Residential Lighting	5	32	3,470	111,025	54,402	49%	51%	NA	$6,939	$10
Energy Star Reflector LED V	Residential Lighting	15	37	402	14,803	11,843	80%	20%	NA	$2,414	$15
CFL 0-15W	Residential Lighting	5	27	101,520	2,781,648	1,363,008	49%	51%	NA	$101,520	$2
CFL 16-20W	Residential Lighting	5	32	83,880	2,690,870	1,318,526	49%	51%	NA	$83,880	$3
CFL 21W or Greater	Residential Lighting	5	39	63,720	2,455,769	1,203,327	49%	51%	NA	$63,720	$3
LED 7W	Residential Lighting	15	22	549	11,818	9,454	80%	20%	NA	$4,389	$16
LED 9W	Residential Lighting	15	20	889	17,668	14,135	80%	20%	NA	$7,114	$16
LED 13W	Residential Lighting	15	29	1,465	43,033	34,426	80%	20%	NA	$11,722	$16
LED 22W	Residential Lighting	15	49	936	46,004	36,804	80%	20%	NA	$7,488	$20
Energy Star Fixtures	Residential Lighting	15	49	1,008	49,543	24,276	49%	51%	NA	$8,064	$30
Energy Star Ceiling Fans	Residential Lighting	10	108	7	801	392	49%	51%	NA	$111	$86
Opower	Residential Behavioral Savings	1	126	50,400	6,350,400	6,350,400	100%	0%	NA		$0
Compact Fluorescent Lamps IQW V	Income Qualified Weatheization	5	29	8,126	235,770	235,770	100%	0%	NA	$56,879	$7
Kitchen Aerator IQW V	Income Qualified Weatheization	10	30	131	3,905	3,905	100%	0%	NA	$656	$5
Bathroom Aerator IQW V	Income Qualified Weatheization	10	30	204	6,074	6,074	100%	0%	NA	$715	$4
LF Showerhead (Whole House) IQW V	Income Qualified Weatheization	5	595	102	60,763	60,763	100%	0%	NA	$1,225	$12
Pipe Wrap (10', 3/4" Wall) IQW V	Income Qualified Weatheization	15	178	127	22,533	22,533	100%	0%	NA	$2,093	$17
Furnace Filter Whistle IQW V	Income Qualified Weatheization	15	105	339	35,628	35,628	100%	0%	NA	$1,777	$5
30% Infil. Reduction Electric Furnace w/ CAC V	Income Qualified Weatheization	15	2,512	43	107,658	107,658	100%	0%	NA	$9,643	$225
30% Infil. Reduction Heat Pump V	Income Qualified Weatheization	15	1,245	9	11,266	11,266	100%	0%	NA	$2,036	$225
30% Infil. Reduction Electric Furnace no CAC V	Income Qualified Weatheization	15	2,314	0	892	892	100%	0%	NA	$87	$225
30% Infil. Reduction Gas Furnace w/ CAC V	Income Qualified Weatheization	15	125	283	35,367	35,367	100%	0%	NA	$63,763	$225
30% Infil. Reduction Gas Furnace no CAC V	Income Qualified Weatheization	15	38	3	98	98	100%	0%	NA	$573	$225
Attic Insulation V	Income Qualified Weatheization	15	338	17	5,885	5,885	100%	0%	NA	$14,816	$850
Refrigerator Replacement IQW V	Income Qualified Weatheization	17	1,251	282	352,955	352,955	100%	0%	NA	$141,069	$500
Audit Recommendations IQW V	Income Qualified Weatheization	1	264	564	148,856	148,856	100%	0%	NA	$0	$0
Appliance Recycling Refrigerators	Residential Appliance Recycling	8	1,260	846	1,065,537	554,079	52%	48%	NA	$42,300	$93
Appliance Recycling Freezers	Residential Appliance Recycling	8	1,115	212	235,801	129,691	55%	45%	NA	$10,575	$93
5th Grade Kit- Low Flow Showerhead 1.5 gpm V	Energy Efficient Schools	5	78	1,479	114,643	155,915	136%	-36%	NA	$11,461	$8
5th Grade Kit- Kitchen Flip Aerator 1.5 gpm V	Energy Efficient Schools	10	9	707	6,084	8,274	136%	-36%	NA	$2,650	$4
5th Grade Kit- Bathroom Aerator 1.0 gpm V	Energy Efficient Schools	10	9	1,413	12,167	16,548	136%	-36%	NA	$1,766	$1
5th Grade Kit- CFL - 13 W V	Energy Efficient Schools	5	26	5,295	138,091	187,804	136%	-36%	NA	$14,296	$3
5th Grade Kit- CFL - 23 W V	Energy Efficient Schools	5	46	4,848	224,781	305,702	136%	-36%	NA	$19,876	$4
5th Grade Kit- Air Filter Alarm V	Energy Efficient Schools	15	46	638	29,240	39,767	136%	-36%	NA	$1,660	$3
5th Grade Kit- LED Nightlight V	Energy Efficient Schools	10	14	2,631	35,779	48,659	136%	-36%	NA	$6,577	$3

Commercial

Measures	Program Name	Measure Life	Install Adjusted Savings per unit (kWh)	2015 Participation	2015 Total kWh	2015 Total kWh (net)	NTG	2015 Freeridership	Average Incentive Paid per unit	Total Incentives 2015	Incremental Cost per unit
Anti Sweat - Cooler V	Small Business Direct Install	12	510	189	96,558	96,558	100%	0%	$240	$240	$240
Anti Sweat - Freezer V	Small Business Direct Install	12	1,278	47	60,512	60,512	100%	0%	$240	$240	$240
CFL Fixture, Direct Install, 18 Watt, Exterior V	Small Business Direct Install	12	130	44	5,782	5,782	100%	0%	$45	$45	$45
CFL Fixture, Direct Install, 36 Watt, Interior V	Small Business Direct Install	12	230	133	30,718	30,718	100%	0%	$45	$45	$45
CFL screw-in: <30W V	Small Business Direct Install	3	139	1,184	164,102	164,102	100%	0%	$7	$7	$7
Cooler Controller - occupancy sensor V	Small Business Direct Install	10	1,209	28	34,429	34,429	100%	0%	$75	$75	$100
Delamping, >=400 Watt Fixture V	Small Business Direct Install	12	1,890	44	84,045	84,045	100%	0%	$0	$0	
Delamping, T12 to T8, 4' V	Small Business Direct Install	12	116	888	102,564	102,564	100%	0%	$0	$0	
Delamping, T12 to T8, 8' V	Small Business Direct Install	12	239	178	42,500	42,500	100%	0%	$0	$0	
EC Motor Reach-in V	Small Business Direct Install	15	345	47	16,320	16,320	100%	0%	$113	$113	$150
EC Motor Walk-in V	Small Business Direct Install	15	392	47	18,565	18,565	100%	0%	$188	$188	$250
Faucet Aerators-electric V	Small Business Direct Install	10	92	59	5,446	5,446	100%	0%	$7	$7	$7
LED Fixture <250W, Replacing 400W HID, HighBay V	Small Business Direct Install	15	660	44	29,361	29,361	100%	0%	$375	$375	$500
LED for Walk in Cooler V	Small Business Direct Install	16	202	189	38,305	38,305	100%	0%	$225	$225	$300
LED for Walk in Freezer V	Small Business Direct Install	16	208	95	19,740	19,740	100%	0%	$225	$225	$300
LED Open Sign V	Small Business Direct Install	12	1,418	36	50,360	50,360	100%	0%	$150	$150	$200
LED Recessed Downlight V	Small Business Direct Install	15	257	142	36,500	36,500	100%	0%	$70	$70	$95
LED, Exit Sign, Retrofit V	Small Business Direct Install	16	83	267	22,124	22,124	100%	0%	$30	$30	$30
LED, Refrigerated Case, Replaces T12 or T8 V	Small Business Direct Install	16	272	332	90,273	90,273	100%	0%	$225	$225	$300
LEDs: >12W Flood V	Small Business Direct Install	8	231	474	109,402	109,402	100%	0%	$33	$33	$44
LEDs: >12W Flood V	Small Business Direct Install	8	231	178	41,026	41,026	100%	0%	$33	$33	$44
LEDs: 8-12W V	Small Business Direct Install	8	136	474	64,457	64,457	100%	0%	$26	$26	$35
LEDs: 8-12W V	Small Business Direct Install	8	136	267	36,279	36,279	100%	0%	$26	$26	$35
LEDs: MR16 track V	Small Business Direct Install	8	165	474	78,144	78,144	100%	0%	$26	$26	$35
LEDs: MR16 track V	Small Business Direct Install	8	165	267	43,982	43,982	100%	0%	$26	$26	$35
Night Covers V	Small Business Direct Install	5	158	142	22,378	22,378	100%	0%	$42	$42	$56
Occupancy Sensor, Wall Mount, <=200 Watts V	Small Business Direct Install	8	186	89	16,520	16,520	100%	0%	$45	$45	$60
Occupancy Sensor, Wall Mount, >200 Watts V	Small Business Direct Install	8	433	267	115,474	115,474	100%	0%	$60	$60	$80
Pre-Rinse Spray Valves - ele V	Small Business Direct Install	5	7,454	3	19,083	19,083	100%	0%	$75	$75	$75
Showerheads-electric V	Small Business Direct Install	10	250	24	5,915	5,915	100%	0%	$18	$18	$18
Specialty CFLs: Reflectors V	Small Business Direct Install	2	139	474	65,641	65,641	100%	0%	$15	$15	$15
T8 2L 4', 28W, CEE V	Small Business Direct Install	12	50	1,332	65,942	65,942	100%	0%	$50	$50	$67
T8 3L 4', 28W, CEE V	Small Business Direct Install	12	79	267	21,005	21,005	100%	0%	$60	$60	$80
T8 4L 4', 28W, CEE V	Small Business Direct Install	12	80	710	56,832	56,832	100%	0%	$70	$70	$93
T8 6L or T5HO 4L Replacing 400-999 W HID V	Small Business Direct Install	12	1,139	710	808,861	808,861	100%	0%	$225	$225	$300
Vending Miser V	Small Business Direct Install	5	1,612	36	57,251	57,251	100%	0%	$200	$200	$267
Programmable Thermostat	Small Business Direct Install	5	905	2,156	1,951,457	1,951,457	100%	0%	$125	$125	$125
Smart Strips	Small Business Direct Install	8	24	1,078	25,435	25,435	100%	0%	$33	$33	$33
Water Heater Pipe Insulation - 6'	Small Business Direct Install	15	125	3,772	472,124	472,124	100%	0%	$15	$15	$15
Water Heater Setback (manual adj)	Small Business Direct Install	2	86	3,772	325,915	325,915	100%	0%	$5	$5	$5
Door Closers for Cooler	Small Business Direct Install	4	961	76	72,575	72,575	100%	0%	$152	$152	$203
Door Closers for Freezer	Small Business Direct Install	4	2,319	76	175,131	175,131	100%	0%	$152	$152	$203
Strip Curtains Cooler	Small Business Direct Install	4	422	100	42,403	42,403	100%	0%	$334	$334	$445
Strip Curtains Freezer	Small Business Direct Install	4	2,974	121	359,735	359,735	100%	0%	$334	$334	$445

Measures	Program Name	Measure Life	Install Adjusted Savings per unit (kWh)	2015 Participation	2015 Total kWh	2015 Total kWh (net)	NTG	2015 Freeridership	Average Incentive Paid per unit	Total Incentives 2015	Incremental Cost per unit
MH 150W Pulse Start To T5 46" 2 Lamp HO - Turnover	Commercial and Industrial Prescriptive	15	252	351	88,284	70,627	80%	20%	$25	$25	$150
MH 200W Pulse Start To T5 46" 3 Lamp HO - Turnover	Commercial and Industrial Prescriptive	15	194	351	68,219	54,576	80%	20%	$25	$25	$150
MH 320W Pulse Start To T5 46" 4 Lamp HO - Turnover	Commercial and Industrial Prescriptive	15	499	500	249,616	199,693	80%	20%	$40	$40	$150
MH 350W Pulse Start To T5 46" 6 Lamp HO - Turnover	Commercial and Industrial Prescriptive	15	187	250	46,684	37,347	80%	20%	$40	$40	$150
MH 1000W Pulse Start To T5 46" 10 Lamp HO - Turnover	Commercial and Industrial Prescriptive	15	1,886	250	471,602	377,282	80%	20%	$125	$125	$150
MH 1000W Pulse Start To T5 46" 12 Lamp HO - Turnover	Commercial and Industrial Prescriptive	15	1,441	211	303,952	243,162	80%	20%	$125	$125	$150
Halogen 50W x2 To MH 20W Track - Turnover	Commercial and Industrial Prescriptive	15	293	108	31,692	25,353	80%	20%	$30	$30	$155
Halogen 75W x2 To MH 39W Track - Turnover	Commercial and Industrial Prescriptive	15	408	130	53,010	42,408	80%	20%	$40	$40	$155
Halogen 75W x3 To MH 70W Track - Turnover	Commercial and Industrial Prescriptive	15	564	130	73,322	58,658	80%	20%	$50	$50	$145
Halogen 50W x2 To CMH 20W - Turnover	Commercial and Industrial Prescriptive	15	282	80	22,561	18,049	80%	20%	$25	$25	$130
Halogen 75W x2 To CMH 39W - Turnover	Commercial and Industrial Prescriptive	15	400	80	32,012	25,609	80%	20%	$40	$40	$130
Halogen 65W x3 To CMH 50W - Turnover	Commercial and Industrial Prescriptive	15	534	80	42,682	34,146	80%	20%	$30	$30	$95
Halogen 75W x3 To CMH 70W - Turnover	Commercial and Industrial Prescriptive	15	556	80	44,512	35,609	80%	20%	$30	$30	$95
Halogen 90W x3 To CMH 100W - Turnover	Commercial and Industrial Prescriptive	15	610	80	48,780	39,024	80%	20%	$35	$35	$90
Halogen 120W x3 To CMH 150W - Turnover	Commercial and Industrial Prescriptive	15	751	80	60,060	48,048	80%	20%	$40	$40	$90
MH 250W To LED Low Bay 85 W3	Commercial and Industrial Prescriptive	8	800	86	68,825	55,060	80%	20%	$80	$80	$200
T8 HO 96" 2 Lamp To LED Low Bay 85 W3	Commercial and Industrial Prescriptive	8	286	259	74,027	59,222	80%	20%	$50	$50	$200
MH 200W To LED High Bay 139W	Commercial and Industrial Prescriptive	8	354	86	30,480	24,384	80%	20%	$40	$40	$200
MH 250W To LED High Bay 175W	Commercial and Industrial Prescriptive	8	457	431	197,101	157,681	80%	20%	$50	$50	$200
MH 175W To T5 46" 2 Lamp HO - Retrofit	Commercial and Industrial Prescriptive	15	347	351	121,725	97,380	80%	20%	$40	$40	$150
MH 175W To T5 46" 3 Lamp HO - Retrofit	Commercial and Industrial Prescriptive	15	103	351	36,116	28,893	80%	20%	$40	$40	$150
MH 400W To T5 46" 4 Lamp HO - Retrofit	Commercial and Industrial Prescriptive	15	854	500	426,824	341,459	80%	20%	$85	$85	$150
MH 400W To T5 46" 6 Lamp HO - Retrofit	Commercial and Industrial Prescriptive	15	408	500	203,885	163,108	80%	20%	$50	$50	$150
MH 1000W To T5 46" 10 Lamp HO - Retrofit	Commercial and Industrial Prescriptive	15	1,886	250	471,602	377,282	80%	20%	$125	$125	$150
MH 1000W To T5 46" 12 Lamp HO - Retrofit	Commercial and Industrial Prescriptive	15	1,441	140	201,674	161,339	80%	20%	$125	$125	$150
Halogen 50W x2 To MH 20W Track - Retrofit	Commercial and Industrial Prescriptive	15	293	22	6,456	5,165	80%	20%	$30	$30	$155
Halogen 75W x2 To MH 39W Track - Retrofit	Commercial and Industrial Prescriptive	15	408	22	8,971	7,177	80%	20%	$40	$40	$155
Halogen 75W x3 To MH 70W Track - Retrofit	Commercial and Industrial Prescriptive	15	564	22	12,408	9,927	80%	20%	$50	$50	$145
Halogen 50W x2 To CMH 20W - Retrofit	Commercial and Industrial Prescriptive	15	282	71	20,023	16,018	80%	20%	$30	$30	$130
Halogen 75W x2 To CMH 39W - Retrofit	Commercial and Industrial Prescriptive	15	400	62	24,809	19,847	80%	20%	$40	$40	$130
Halogen 65W x3 To CMH 50W - Retrofit	Commercial and Industrial Prescriptive	15	534	71	37,881	30,305	80%	20%	$45	$45	$95
Halogen 75W x3 To CMH 70W - Retrofit	Commercial and Industrial Prescriptive	15	556	62	34,497	27,597	80%	20%	$50	$50	$95
Halogen 90W x3 To CMH 100W - Retrofit	Commercial and Industrial Prescriptive	15	610	71	43,292	34,634	80%	20%	$55	$55	$90
Halogen 120W x3 To CMH 150W - Retrofit	Commercial and Industrial Prescriptive	15	751	71	53,303	42,643	80%	20%	$60	$60	$90
Fluorescent Exit Sign To LED Exit Sign	Commercial and Industrial Prescriptive	16	83	2,025	168,075	134,460	80%	20%	$20	$20	$30
Incandescent Traffic Signal To LED Traffic Signal Round 8" Red	Commercial and Industrial Prescriptive	10	299	135	40,327	32,261	80%	20%	$30	$30	$120
Incandescent Traffic Signal To LED Traffic Signal Pedestrian 12"	Commercial and Industrial Prescriptive	10	946	135	127,721	102,177	80%	20%	$50	$50	$200
Incandescent To CFL <15W Screw-In	Commercial and Industrial Prescriptive	3	92	774	71,028	56,822	80%	20%	$2	$2	$3
Incandescent To CFL 16-20W Screw-In	Commercial and Industrial Prescriptive	3	128	387	49,554	39,643	80%	20%	$2	$2	$3
Incandescent To CFL 21W+ Screw-In	Commercial and Industrial Prescriptive	3	165	129	21,262	17,010	80%	20%	$5	$5	$5
CFL <15W Fixture 1 Lamp	Commercial and Industrial Prescriptive	12	85	258	21,985	17,588	80%	20%	$8	$8	$35
CFL 16-20W Fixture 1 Lamp	Commercial and Industrial Prescriptive	12	128	258	33,036	26,429	80%	20%	$10	$10	$35
CFL 21W+ Fixture 1 Lamp	Commercial and Industrial Prescriptive	12	165	129	21,262	17,010	80%	20%	$12	$12	$35
CFL <15W Fixture 2 Lamp	Commercial and Industrial Prescriptive	12	170	258	43,970	35,176	80%	20%	$16	$16	$40
CFL 16-20W Fixture 2 Lamp	Commercial and Industrial Prescriptive	12	256	258	66,072	52,858	80%	20%	$20	$20	$40
CFL 21W+ Fixture 2 Lamp	Commercial and Industrial Prescriptive	12	330	129	42,524	34,019	80%	20%	$24	$24	$40
T12 18” 1 Lamp To Delamp	Commercial and Industrial Prescriptive	10	57	68	3,887	3,110	80%	20%	$4	$4	$0
T12 24” 1 Lamp To Delamp	Commercial and Industrial Prescriptive	10	76	341	25,991	20,792	80%	20%	$4	$4	$0
T12 36” 1 Lamp To Delamp	Commercial and Industrial Prescriptive	10	114	68	7,774	6,219	80%	20%	$4	$4	$0
T12 48” 1 Lamp To Delamp	Commercial and Industrial Prescriptive	10	149	1,877	278,971	223,177	80%	20%	$5	$5	$0
T12 60” 1 Lamp To Delamp	Commercial and Industrial Prescriptive	10	191	68	12,957	10,366	80%	20%	$5	$5	$0
T12 72” 1 Lamp To Delamp	Commercial and Industrial Prescriptive	10	210	137	28,715	22,972	80%	20%	$5	$5	$0
T12 96” 1 Lamp To Delamp	Commercial and Industrial Prescriptive	10	286	853	243,804	195,043	80%	20%	$5	$5	$0

Measures	Program Name	Measure Life	Install Adjusted Savings per unit (kWh)	2015 Participation	2015 Total kWh	2015 Total kWh (net)	NTG	2015 Freeridership	Average Incentive Paid per unit	Total Incentives 2015	Incremental Cost per unit
T12 46" 1 Lamp To T5 46" 1 Lamp	Commercial and Industrial Prescriptive	10	46	137	6,265	5,012	80%	20%	$6	$6	$25
T12 46" 2 Lamp To T5 46" 2 Lamp	Commercial and Industrial Prescriptive	10	91	410	37,500	30,000	80%	20%	$9	$9	$25
T12 46" 3 Lamp To T5 46" 3 Lamp	Commercial and Industrial Prescriptive	10	137	273	37,454	29,963	80%	20%	$12	$12	$25
T12 46" 4 Lamp To T5 46" 4 Lamp	Commercial and Industrial Prescriptive	10	191	546	104,038	83,231	80%	20%	$15	$15	$25
HID 75W-100W To T5 Garage 1 Lamp	Commercial and Industrial Prescriptive	7	76	347	26,448	21,158	80%	20%	$35	$35	$150
HID 101W-175W To T5 Garage 2 Lamp	Commercial and Industrial Prescriptive	7	114	347	39,672	31,737	80%	20%	$60	$60	$150
HID 176W+ To T5 Garage 3 Lamp	Commercial and Industrial Prescriptive	7	152	174	26,524	21,219	80%	20%	$94	$94	$150
LED Decoratives 2-4W	Commercial and Industrial Prescriptive	6	65	47	3,045	2,436	80%	20%	$10	$10	$29
LED A-Line 8-12W	Commercial and Industrial Prescriptive	6	118	824	97,346	77,877	80%	20%	$10	$10	$29
LED PAR 20 7-9W	Commercial and Industrial Prescriptive	8	100	118	11,804	9,443	80%	20%	$10	$10	$40
LED PAR 30 10-13W	Commercial and Industrial Prescriptive	8	114	471	53,848	43,079	80%	20%	$10	$10	$40
LED PAR 38 10-21W	Commercial and Industrial Prescriptive	8	193	777	149,905	119,924	80%	20%	$20	$20	$50
LED MR16 4-7W	Commercial and Industrial Prescriptive	8	71	118	8,432	6,745	80%	20%	$15	$15	$40
LED Outdoor Decorative Post <30W	Commercial and Industrial Prescriptive	12	403	94	37,865	30,292	80%	20%	$40	$40	$125
LED Outdoor Decorative Post 30W-75W	Commercial and Industrial Prescriptive	12	497	71	35,283	28,226	80%	20%	$50	$50	$250
LED Outdoor Decorative Post 75W+	Commercial and Industrial Prescriptive	12	932	71	66,183	52,946	80%	20%	$75	$75	$375
LED Parking Garage/Canopy <30W	Commercial and Industrial Prescriptive	12	403	63	25,377	20,302	80%	20%	$40	$40	$125
LED Parking Garage/Canopy 30W-75W	Commercial and Industrial Prescriptive	12	497	47	23,356	18,685	80%	20%	$50	$50	$250
LED Parking Garage/Canopy 75W+	Commercial and Industrial Prescriptive	12	932	47	43,811	35,049	80%	20%	$75	$75	$375
LED Exterior Wall-Pack <30W	Commercial and Industrial Prescriptive	12	403	94	37,865	30,292	80%	20%	$40	$40	$125
LED Exterior Wall-Pack 30W-75W	Commercial and Industrial Prescriptive	12	497	71	35,283	28,226	80%	20%	$50	$50	$250
LED Exterior Wall-Pack 75W+	Commercial and Industrial Prescriptive	12	932	71	66,183	52,946	80%	20%	$75	$75	$375
T8 U-Tube 2 Lamp 2' To LED U-Tube	Commercial and Industrial Prescriptive	12	61	43	2,638	2,111	80%	20%	$15	$15	$75
T8 3 Lamp 4' To LED 2 Lamp Linear 4'	Commercial and Industrial Prescriptive	12	131	256	33,561	26,848	80%	20%	$30	$30	$125
T8 2 Lamp 4' To LED 1 Lamp Linear 4'	Commercial and Industrial Prescriptive	12	102	554	56,582	45,265	80%	20%	$20	$20	$100
No controls To Wall-Mounted Occupancy Sensors	Commercial and Industrial Prescriptive	8	286	493	140,909	112,727	80%	20%	$20	$20	$42
No controls To Ceiling-Mounted Occupancy Sensors	Commercial and Industrial Prescriptive	8	560	493	276,182	220,945	80%	20%	$30	$30	$66
No controls To Fixture Mounted Occupancy Sensors	Commercial and Industrial Prescriptive	8	143	74	10,575	8,460	80%	20%	$20	$20	$125
No controls To Remote-Mounted Daylight Dimming Sensors	Commercial and Industrial Prescriptive	8	560	25	14,005	11,204	80%	20%	$30	$30	$65
No controls To Fixture Mounted Daylight Dimming Sensors	Commercial and Industrial Prescriptive	8	143	62	8,860	7,088	80%	20%	$15	$15	$50
No controls To Switching Controls for Multi-Level Lighting	Commercial and Industrial Prescriptive	8	143	62	8,860	7,088	80%	20%	$20	$20	$274
No controls To Central Lighting Controls (Timeclocks)	Commercial and Industrial Prescriptive	8	187	25	4,668	3,735	80%	20%	$25	$25	$103
Vending Machine Occ Sensor - Refrigerated Beverage	Commercial and Industrial Prescriptive	5	1,612	48	77,368	61,895	80%	20%	$50	$50	$216
Vending Machine Occ Sensor - Refrigerated Glass Front Cooler	Commercial and Industrial Prescriptive	5	1,209	16	19,342	15,474	80%	20%	$50	$50	$216
VFD Return Fan <20hp - Hospital	Commercial and Industrial Prescriptive	15	1,907	16	30,512	24,410	80%	20%	$40	$40	$199
VFD Tower Fan <20hp - Hospital	Commercial and Industrial Prescriptive	15	855	16	13,685	10,948	80%	20%	$30	$30	$199
VFD CHW Pump <20hp - Hospital	Commercial and Industrial Prescriptive	15	6,714	16	107,419	85,935	80%	20%	$125	$125	$199
VFD HW Pump <20hp - Hospital	Commercial and Industrial Prescriptive	15	5,696	7	39,872	31,898	80%	20%	$100	$100	$199
VFD CW Pump <20hp - Hospital	Commercial and Industrial Prescriptive	15	2,034	7	14,236	11,389	80%	20%	$40	$40	$199
VFD Return Fan <20hp - Hotel	Commercial and Industrial Prescriptive	15	150	8	1,200	960	80%	20%	$40	$40	$199
VFD Tower Fan <20hp - Hotel	Commercial and Industrial Prescriptive	15	1,176	16	18,816	15,053	80%	20%	$30	$30	$199
VFD CHW Pump <20hp - Hotel	Commercial and Industrial Prescriptive	15	6,776	8	54,205	43,364	80%	20%	$125	$125	$199
VFD HW Pump <20hp - Hotel	Commercial and Industrial Prescriptive	15	7,162	3	21,487	17,190	80%	20%	$100	$100	$199
VFD CW Pump <20hp - Hotel	Commercial and Industrial Prescriptive	15	73	3	219	175	80%	20%	$40	$40	$199
VFD Return Fan <20hp - Large Office	Commercial and Industrial Prescriptive	15	1,387	16	22,192	17,754	80%	20%	$40	$40	$199
VFD Tower Fan <20hp - Large Office	Commercial and Industrial Prescriptive	15	62	16	987	789	80%	20%	$30	$30	$199
VFD CHW Pump <20hp - Large Office	Commercial and Industrial Prescriptive	15	3,893	16	62,283	49,826	80%	20%	$125	$125	$199
VFD HW Pump <20hp - Large Office	Commercial and Industrial Prescriptive	15	3,806	7	26,640	21,312	80%	20%	$100	$100	$199
VFD CW Pump <20hp - Large Office	Commercial and Industrial Prescriptive	15	1,047	7	7,331	5,865	80%	20%	$40	$40	$199
VFD Compressor	Commercial and Industrial Prescriptive	15	944	45	42,477	33,982	80%	20%	$75	$75	$300

Measures	Program Name	Measure Life	Install Adjusted Savings per unit (kWh)	2015 Participation	2015 Total kWh	2015 Total kWh (net)	NTG	2015 Freeridership	Average Incentive Paid per unit	Total Incentives 2015	Incremental Cost per unit
HID To Induction Lamp and Fixture 55-100W	Commercial and Industrial Prescriptive	16	114	13	1,486	1,189	80%	20%	$20	$20	$200
HID To Induction Lamp and Fixture >100W	Commercial and Industrial Prescriptive	16	381	118	44,969	35,975	80%	20%	$40	$40	$800
Barrel Wraps (Inj Mold Only)	Commercial and Industrial Prescriptive	5	1,439	33	46,765	37,412	80%	20%	$40	$40	$80
Clothes Washer CEE Tier 2	Commercial and Industrial Prescriptive	10	542	1	542	433	80%	20%	$60	$60	$475
Clothes Washer CEE Tier 3	Commercial and Industrial Prescriptive	10	542	1	542	433	80%	20%	$70	$70	$604
Clothes Washer ENERGY STAR/CEE Tier 1	Commercial and Industrial Prescriptive	10	542	1	704	563	80%	20%	$50	$50	$347
Cooler - Glass Door <15 vol	Commercial and Industrial Prescriptive	12	957	1	1,244	995	80%	20%	$50	$50	$143
Cooler - Glass Door >50 vol	Commercial and Industrial Prescriptive	12	2,876	1	3,739	2,991	80%	20%	$70	$70	$164
Cooler - Glass Door 15-30 vol	Commercial and Industrial Prescriptive	12	1,419	1	1,844	1,475	80%	20%	$55	$55	$249
Cooler - Glass Door 30-50 vol	Commercial and Industrial Prescriptive	12	1,752	1	2,277	1,822	80%	20%	$60	$60	$164
Cooler - Reach-In Electronically Commutated (EC) Motor	Commercial and Industrial Prescriptive	15	325	26	8,450	6,760	80%	20%	$30	$30	$50
Cooler - Solid Door <15 vol	Commercial and Industrial Prescriptive	12	496	1	645	516	80%	20%	$50	$50	$143
Cooler - Solid Door >50 vol	Commercial and Industrial Prescriptive	12	2,242	1	2,914	2,331	80%	20%	$70	$70	$164
Cooler - Solid Door 15-30 vol	Commercial and Industrial Prescriptive	12	617	3	1,604	1,283	80%	20%	$55	$55	$249
Cooler - Solid Door 30-50 vol	Commercial and Industrial Prescriptive	12	1,484	1	1,930	1,544	80%	20%	$60	$60	$164
Cooler - Walk-In Electronically Commutated (EC) Motor	Commercial and Industrial Prescriptive	15	354	20	6,903	5,522	80%	20%	$30	$30	$50
Cooler Anti-Sweat Heater Controls - Conductivity-Based	Commercial and Industrial Prescriptive	12	700	3	1,819	1,455	80%	20%	$50	$50	$200
Cooler Anti-Sweat Heater Controls - Humidity-Based	Commercial and Industrial Prescriptive	12	550	1	715	572	80%	20%	$50	$50	$300
Demand Controlled Ventilation - CO	Commercial and Industrial Prescriptive	15	747	7	4,856	3,884	80%	20%	$46	$46	$115
Demand Controlled Ventilation - CO2	Commercial and Industrial Prescriptive	15	747	13	9,711	7,769	80%	20%	$46	$46	$115
Electric Chiller - Air cooled, with condenser	Commercial and Industrial Prescriptive	20	305	1	305	244	80%	20%	$30	$30	$82
Electric Chiller - Air cooled, without condenser	Commercial and Industrial Prescriptive	20	35	1	46	37	80%	20%	$10	$10	$82
Electric Chiller - Water Cooled, Centrifugal <150 tons	Commercial and Industrial Prescriptive	20	216	1	281	225	80%	20%	$30	$30	$125
Electric Chiller - Water Cooled, Centrifugal >300 tons	Commercial and Industrial Prescriptive	20	174	3	452	362	80%	20%	$30	$30	$69
Electric Chiller - Water Cooled, Centrifugal 150-300 tons	Commercial and Industrial Prescriptive	20	177	1	231	184	80%	20%	$30	$30	$92
Electric Chiller - Water Cooled, Rotary Screw <150 tons	Commercial and Industrial Prescriptive	20	168	1	218	175	80%	20%	$30	$30	$83
Electric Chiller - Water Cooled, Rotary Screw >300 tons	Commercial and Industrial Prescriptive	20	178	1	231	185	80%	20%	$30	$30	$42
Electric Chiller - Water Cooled, Rotary Screw 150-300 tons	Commercial and Industrial Prescriptive	20	181	1	235	188	80%	20%	$30	$30	$60
Electric Chiller Tune-up - Air cooled, with condenser	Commercial and Industrial Prescriptive	5	186	1	242	194	80%	20%	$8	$8	$22
Electric Chiller Tune-up - Air cooled, without condenser	Commercial and Industrial Prescriptive	5	165	0	0	0	80%	20%	$8	$8	$22
Electric Chiller Tune-up - Water Cooled, Centrifugal <150 tons	Commercial and Industrial Prescriptive	5	108	0	0	0	80%	20%	$8	$8	$22
Electric Chiller Tune-up - Water Cooled, Centrifugal >300 tons	Commercial and Industrial Prescriptive	5	89	1	115	92	80%	20%	$8	$8	$22
Electric Chiller Tune-up - Water Cooled, Centrifugal 150-300 tons	Commercial and Industrial Prescriptive	5	96	1	125	100	80%	20%	$8	$8	$22
Electric Chiller Tune-up - Water Cooled, Rotary Screw <150 tons	Commercial and Industrial Prescriptive	5	109	0	0	0	80%	20%	$8	$8	$22
Electric Chiller Tune-up - Water Cooled, Rotary Screw >300 tons	Commercial and Industrial Prescriptive	5	92	1	120	96	80%	20%	$8	$8	$22
Electric Chiller Tune-up - Water Cooled, Rotary Screw 150-300 tons	Commercial and Industrial Prescriptive	5	101	1	132	105	80%	20%	$8	$8	$22
ENERGY STAR CEE Tier 1 Window\Sleeve\Room AC < 14,000 BTUH	Commercial and Industrial Prescriptive	12	136	1	177	142	80%	20%	$16	$16	$80
ENERGY STAR CEE Tier 1 Window\Sleeve\Room AC >= 14,000 BTUH	Commercial and Industrial Prescriptive	12	215	0	0	0	80%	20%	$18	$18	$80
ENERGY STAR Combination Oven	Commercial and Industrial Prescriptive	12	18,432	0	0	0	80%	20%	$1,000	$1,000	$2,125
ENERGY STAR Commercial Dishwasher - Door Type, High Temp	Commercial and Industrial Prescriptive	15	14,143	1	18,386	14,709	80%	20%	$500	$500	$500
ENERGY STAR Commercial Dishwasher - Door Type, Low Temp	Commercial and Industrial Prescriptive	15	12,135	0	0	0	80%	20%	$500	$500	$530
ENERGY STAR Commercial Dishwasher - Multi-Tank Conveyor, High Temp	Commercial and Industrial Prescriptive	20	34,153	0	0	0	80%	20%	$750	$750	$970
ENERGY STAR Commercial Dishwasher - Multi-Tank Conveyor, Low Temp	Commercial and Industrial Prescriptive	20	17,465	1	22,705	18,164	80%	20%	$750	$750	$970
ENERGY STAR Commercial Dishwasher - Single Tank Conveyor, High Temp	Commercial and Industrial Prescriptive	20	19,235	0	0	0	80%	20%	$250	$250	$270
ENERGY STAR Commercial Dishwasher - Single Tank Conveyor, Low Temp	Commercial and Industrial Prescriptive	20	11,384	0	0	0	80%	20%	$150	$150	$170
ENERGY STAR Commercial Dishwasher - Under Counter, High Temp	Commercial and Industrial Prescriptive	10	7,471	1	9,712	7,770	80%	20%	$350	$350	$1,000
ENERGY STAR Commercial Dishwasher - Under Counter, Low Temp	Commercial and Industrial Prescriptive	10	1,213	1	1,577	1,262	80%	20%	$150	$150	$530
ENERGY STAR Commercial Fryer	Commercial and Industrial Prescriptive	12	983	1	1,278	1,022	80%	20%	$100	$100	$500
ENERGY STAR Commercial Hot Holding Cabinets Full Size	Commercial and Industrial Prescriptive	12	5,256	1	6,833	5,466	80%	20%	$500	$500	$1,110
ENERGY STAR Commercial Hot Holding Cabinets Half Size	Commercial and Industrial Prescriptive	12	1,862	1	2,421	1,936	80%	20%	$250	$250	$1,110

Measures	Program Name	Measure Life	Install Adjusted Savings per unit (kWh)	2015 Participation	2015 Total kWh	2015 Total kWh (net)	NTG	2015 Freeridership	Average Incentive Paid per unit	Total Incentives 2015	Incremental Cost per unit
ENERGY STAR Commercial Hot Holding Cabinets Three Quarter Size	Commercial and Industrial Prescriptive	12	2,847	1	3,701	2,961	80%	20%	$350	$350	$1,110
ENERGY STAR Commercial Ice Machine < 500 lb/day harvest rate	Commercial and Industrial Prescriptive	9	397	1	516	413	80%	20%	$100	$100	$537
ENERGY STAR Commercial Ice Machine >=1000 lb/day harvest rate	Commercial and Industrial Prescriptive	9	1,693	1	2,201	1,761	80%	20%	$250	$250	$2,008
ENERGY STAR Commercial Ice Machine >=500 and <1000 lb/day harvest rate	Commercial and Industrial Prescriptive	9	958	13	12,450	9,960	80%	20%	$175	$175	$1,485
ENERGY STAR Commercial Steam Cookers 3 Pan	Commercial and Industrial Prescriptive	12	6,629	3	17,235	13,788	80%	20%	$750	$750	$3,500
ENERGY STAR Commercial Steam Cookers 4 Pan	Commercial and Industrial Prescriptive	12	8,429	3	21,915	17,532	80%	20%	$1,000	$1,000	$3,500
ENERGY STAR Commercial Steam Cookers 5 Pan	Commercial and Industrial Prescriptive	12	11,466	1	14,906	11,925	80%	20%	$1,250	$1,250	$3,500
ENERGY STAR Commercial Steam Cookers 6 Pan	Commercial and Industrial Prescriptive	12	13,608	1	17,691	14,152	80%	20%	$1,500	$1,500	$3,500
ENERGY STAR Convection Oven	Commercial and Industrial Prescriptive	12	3,235	1	4,206	3,364	80%	20%	$350	$350	$1,113
ENERGY STAR Griddles	Commercial and Industrial Prescriptive	12	6,996	1	9,094	7,275	80%	20%	$700	$700	$2,090
ENERGY STAR Window\Sleeve\Room AC < 14,000 BTUH	Commercial and Industrial Prescriptive	12	136	1	177	142	80%	20%	$12	$12	$40
ENERGY STAR Window\Sleeve\Room AC >= 14,000 BTUH	Commercial and Industrial Prescriptive	12	215	1	279	223	80%	20%	$14	$14	$40
ENERGY STAR CEE Tier 2 Window\Sleeve\Room AC < 14,000 BTUH	Commercial and Industrial Prescriptive	12	117	1	152	122	80%	20%	$20	$20	$250
ENERGY STAR CEE Tier 2 Window\Sleeve\Room AC >= 14,000 BTUH	Commercial and Industrial Prescriptive	12	206	1	268	214	80%	20%	$22	$22	$500
Freezer - Glass Door <15 vol	Commercial and Industrial Prescriptive	12	1,338	1	1,739	1,392	80%	20%	$100	$100	$142
Freezer - Glass Door >50 vol	Commercial and Industrial Prescriptive	12	8,579	1	11,153	8,922	80%	20%	$350	$350	$407
Freezer - Glass Door 15-30 vol	Commercial and Industrial Prescriptive	12	2,226	1	2,894	2,315	80%	20%	$150	$150	$166
Freezer - Glass Door 30-50 vol	Commercial and Industrial Prescriptive	12	4,407	1	5,730	4,584	80%	20%	$200	$200	$166
Freezer - Reach-In Electronically Commutated (EC) Motor	Commercial and Industrial Prescriptive	15	409	3	1,063	851	80%	20%	$30	$30	$50
Freezer - Solid Door <15 vol	Commercial and Industrial Prescriptive	12	1,017	1	1,321	1,057	80%	20%	$100	$100	$142
Freezer - Solid Door >50 vol	Commercial and Industrial Prescriptive	12	5,488	1	7,135	5,708	80%	20%	$350	$350	$407
Freezer - Solid Door 15-30 vol	Commercial and Industrial Prescriptive	12	2,419	1	3,145	2,516	80%	20%	$150	$150	$166
Freezer - Solid Door 30-50 vol	Commercial and Industrial Prescriptive	12	3,074	1	3,996	3,197	80%	20%	$200	$200	$166
Freezer - Walk-In Electronically Commutated (EC) Motor	Commercial and Industrial Prescriptive	15	620	7	4,030	3,224	80%	20%	$40	$40	$50
Freezer Anti-Sweat Heater Controls - Conductivity-Based	Commercial and Industrial Prescriptive	12	1,483	1	1,928	1,542	80%	20%	$100	$100	$200
Freezer Anti-Sweat Heater Controls - Humidity-Based	Commercial and Industrial Prescriptive	12	1,165	1	1,514	1,212	80%	20%	$150	$150	$300
Heat Pump Water Heater 10-50 MBH	Commercial and Industrial Prescriptive	15	21,156	7	137,514	110,011	80%	20%	$2,000	$2,000	$4,000
HID >400W to Exterior LED or Induction	Commercial and Industrial Prescriptive	16	4	26	112	90	80%	20%	$0	$0	$2
HID >400W to Garage LED or Induction	Commercial and Industrial Prescriptive	16	4	7	28	22	80%	20%	$0	$0	$2
High Efficiency Pumps - 1.5hp	Commercial and Industrial Prescriptive	15	617	3	1,604	1,283	80%	20%	$60	$60	$350
High Efficiency Pumps - 10hp	Commercial and Industrial Prescriptive	15	5,952	1	7,738	6,190	80%	20%	$240	$240	$332
High Efficiency Pumps - 15hp	Commercial and Industrial Prescriptive	15	7,848	1	10,202	8,162	80%	20%	$280	$280	$585
High Efficiency Pumps - 20hp	Commercial and Industrial Prescriptive	15	7,246	3	18,840	15,072	80%	20%	$320	$320	$850
High Efficiency Pumps - 2hp	Commercial and Industrial Prescriptive	15	900	1	1,170	936	80%	20%	$100	$100	$350
High Efficiency Pumps - 3hp	Commercial and Industrial Prescriptive	15	1,841	1	2,393	1,915	80%	20%	$120	$120	$350
High Efficiency Pumps - 5hp	Commercial and Industrial Prescriptive	15	3,528	1	4,586	3,669	80%	20%	$160	$160	$341
High Efficiency Pumps - 7.5hp	Commercial and Industrial Prescriptive	15	5,438	1	7,069	5,656	80%	20%	$200	$200	$498
Low Flow Pre-Rinse Sprayer - Electric	Commercial and Industrial Prescriptive	5	3,727	7	24,227	19,381	80%	20%	$25	$25	$35
MH 1000W To T8VHO 48" 8 Lamp (2 fixtures)	Commercial and Industrial Prescriptive	7	1,921	13	24,969	19,975	80%	20%	$125	$125	$150
MH 250W To T8VHO 48" 4 Lamp	Commercial and Industrial Prescriptive	7	549	52	28,536	22,829	80%	20%	$50	$50	$150
MH 400W To T8VHO 48" 6 Lamp	Commercial and Industrial Prescriptive	7	884	52	45,975	36,780	80%	20%	$60	$60	$150
MH 400W To T8VHO 48" 8 Lamp	Commercial and Industrial Prescriptive	7	648	13	8,422	6,738	80%	20%	$60	$60	$150
Network PC Power Management Software	Commercial and Industrial Prescriptive	4	135	26	3,510	2,808	80%	20%	$3	$3	$12
No controls To Ceiling-Mounted Occupancy Sensors >500W Connected	Commercial and Industrial Prescriptive	8	1,143	26	29,725	23,780	80%	20%	$40	$40	$66
No controls To Central Lighting Controls (Timeclocks) >500W Connected	Commercial and Industrial Prescriptive	8	381	1	495	396	80%	20%	$20	$20	$103
No controls To Fixture Mounted Daylight Dimming Sensors >500W Connected	Commercial and Industrial Prescriptive	8	1,143	52	59,450	47,560	80%	20%	$40	$40	$50
No controls To Fixture Mounted Occupancy Sensors >500W Connected	Commercial and Industrial Prescriptive	8	1,143	52	59,450	47,560	80%	20%	$40	$40	$125
No controls To LED Case Lighting Sensor Controls	Commercial and Industrial Prescriptive	8	675	26	17,550	14,040	80%	20%	$30	$30	$130
No controls To Remote-Mounted Daylight Dimming Sensors >500W Connected	Commercial and Industrial Prescriptive	8	1,143	7	7,431	5,945	80%	20%	$40	$40	$65
No controls To Switching Controls for Multi-Level Lighting >500W Connected	Commercial and Industrial Prescriptive	8	1,143	7	7,431	5,945	80%	20%	$40	$40	$274

Measures	Program Name	Measure Life	Install Adjusted Savings per unit (kWh)	2015 Participation	2015 Total kWh	2015 Total kWh (net)	NTG	2015 Freeridership	Average Incentive Paid per unit	Total Incentives 2015	Incremental Cost per unit
No controls To Wall-Mounted Occupancy Sensors >500W Connected	Commercial and Industrial Prescriptive	8	1,143	26	29,725	23,780	80%	20%	$40	$40	$42
Outside Air Economizer with Dual-Enthalpy Sensors	Commercial and Industrial Prescriptive	10	350	3	910	728	80%	20%	$50	$50	$400
Packaged Terminal Air Conditioner (PTAC) <65,000 BtuH	Commercial and Industrial Prescriptive	15	669	52	34,772	27,817	80%	20%	$75	$75	$500
Packaged Terminal Air Conditioner (PTAC) 65,000-135,000 BtuH	Commercial and Industrial Prescriptive	15	1,341	26	34,856	27,885	80%	20%	$150	$150	$1,000
Packaged Terminal Heat Pump (PTHP) <65,000 BtuH	Commercial and Industrial Prescriptive	15	669	52	34,772	27,817	80%	20%	$75	$75	$500
Packaged Terminal Heat Pump (PTHP) 65,000-135,000 BtuH	Commercial and Industrial Prescriptive	15	1,341	26	34,856	27,885	80%	20%	$150	$150	$1,000
Pellet Dryer Duct Insulation 3in -8in dia	Commercial and Industrial Prescriptive	5	347	26	9,031	7,225	80%	20%	$30	$30	$65
Plug Load Occupancy Sensors	Commercial and Industrial Prescriptive	8	169	26	4,394	3,515	80%	20%	$20	$20	$70
PSMH 1000W To T8VHO 48" 8 Lamp (2 fixtures)	Commercial and Industrial Prescriptive	15	1,921	13	24,969	19,975	80%	20%	$60	$60	$150
Refrigerated Case Covers	Commercial and Industrial Prescriptive	5	158	26	4,095	3,276	80%	20%	$15	$15	$42
Smart Strip Plug Outlet	Commercial and Industrial Prescriptive	8	24	26	614	491	80%	20%	$4	$4	$15
Snack Machine Controller (Non-refrigerated vending)	Commercial and Industrial Prescriptive	5	343	26	8,905	7,124	80%	20%	$30	$30	$108
Split System Heat Pump <65,000 BtuH	Commercial and Industrial Prescriptive	15	669	3	1,739	1,391	80%	20%	$75	$75	$500
Split System Heat Pump 135,000-240,000 BtuH	Commercial and Industrial Prescriptive	15	1,966	10	20,442	16,354	80%	20%	$250	$250	$1,500
Split System Heat Pump 240,000-760,000 BtuH	Commercial and Industrial Prescriptive	15	3,120	5	16,224	12,979	80%	20%	$400	$400	$4,500
Split System Heat Pump 65,000-135,000 BtuH	Commercial and Industrial Prescriptive	15	1,341	9	12,200	9,760	80%	20%	$150	$150	$1,000
Split System Unitary Air Conditioner <65,000 BtuH	Commercial and Industrial Prescriptive	15	669	39	26,079	20,863	80%	20%	$75	$75	$500
Split System Unitary Air Conditioner >760,000 BtuH	Commercial and Industrial Prescriptive	15	3,253	9	29,605	23,684	80%	20%	$500	$500	$6,500
Split System Unitary Air Conditioner 135,000-240,000 BtuH	Commercial and Industrial Prescriptive	15	1,966	7	12,776	10,221	80%	20%	$250	$250	$1,500
Split System Unitary Air Conditioner 240,000-760,000 BtuH	Commercial and Industrial Prescriptive	15	3,120	7	20,280	16,224	80%	20%	$400	$400	$4,500
Split System Unitary Air Conditioner 65,000-135,000 BtuH	Commercial and Industrial Prescriptive	15	1,341	20	26,142	20,914	80%	20%	$150	$150	$1,000
T12 6' To Refrigerated Display Case Lighting 6' LED - Cooler	Commercial and Industrial Prescriptive	8	252	65	16,349	13,079	80%	20%	$40	$40	$250
T12 6' To Refrigerated Display Case Lighting 6' LED - Freezer	Commercial and Industrial Prescriptive	8	252	52	13,079	10,463	80%	20%	$40	$40	$250
T8 5' To Refrigerated Display Case Lighting 5' LED - Cooler	Commercial and Industrial Prescriptive	8	145	13	1,883	1,506	80%	20%	$25	$25	$250
T8 5' To Refrigerated Display Case Lighting 5' LED - Freezer	Commercial and Industrial Prescriptive	8	145	13	1,883	1,506	80%	20%	$25	$25	$250
T8 To 21" Tubular Skylight/Light Tube	Commercial and Industrial Prescriptive	10	413	7	2,683	2,147	80%	20%	$50	$50	$500
VFD CHW Pump 20-100hp - Hospital	Commercial and Industrial Prescriptive	15	402,820	1	523,666	418,933	80%	20%	$2,500	$2,500	$6,530
VFD CHW Pump 20-100hp - Hotel	Commercial and Industrial Prescriptive	15	406,540	1	528,502	422,802	80%	20%	$2,500	$2,500	$6,530
VFD CHW Pump 20-100hp - Large Office	Commercial and Industrial Prescriptive	15	233,560	1	303,628	242,902	80%	20%	$2,500	$2,500	$6,530
VFD CW Pump 20-100hp - Hospital	Commercial and Industrial Prescriptive	15	122,020	1	158,626	126,901	80%	20%	$1,200	$1,200	$6,530
VFD CW Pump 20-100hp - Hotel	Commercial and Industrial Prescriptive	15	4,380	1	5,694	4,555	80%	20%	$1,200	$1,200	$6,530
VFD CW Pump 20-100hp - Large Office	Commercial and Industrial Prescriptive	15	62,840	1	81,692	65,354	80%	20%	$1,200	$1,200	$6,530
VFD HW Pump 20-100hp - Hospital	Commercial and Industrial Prescriptive	15	341,760	1	444,288	355,430	80%	20%	$2,000	$2,000	$6,530
VFD HW Pump 20-100hp - Hotel	Commercial and Industrial Prescriptive	15	429,740	1	558,662	446,930	80%	20%	$2,000	$2,000	$6,530
VFD HW Pump 20-100hp - Large Office	Commercial and Industrial Prescriptive	15	228,340	1	296,842	237,474	80%	20%	$2,000	$2,000	$6,530
VFD Return Fan 20-100hp - Hospital	Commercial and Industrial Prescriptive	15	114,420	1	148,746	118,997	80%	20%	$1,000	$1,000	$6,530
VFD Return Fan 20-100hp - Hotel	Commercial and Industrial Prescriptive	15	9,000	1	11,700	9,360	80%	20%	$1,000	$1,000	$6,530
VFD Return Fan 20-100hp - Large Office	Commercial and Industrial Prescriptive	15	83,220	1	108,186	86,549	80%	20%	$1,000	$1,000	$6,530
VFD Supply Fan <100hp - Hospital	Commercial and Industrial Prescriptive	15	132,300	1	171,990	137,592	80%	20%	$1,000	$1,000	$6,530
VFD Supply Fan <100hp - Hotel	Commercial and Industrial Prescriptive	15	3,540	1	4,602	3,682	80%	20%	$1,000	$1,000	$6,530
VFD Supply Fan <100hp - Large Office	Commercial and Industrial Prescriptive	15	106,920	1	138,996	111,197	80%	20%	$1,000	$1,000	$6,530
VFD Tower Fan 20-100hp - Hospital	Commercial and Industrial Prescriptive	15	51,320	1	66,716	53,373	80%	20%	$750	$750	$6,530
VFD Tower Fan 20-100hp - Hotel	Commercial and Industrial Prescriptive	15	70,560	1	91,728	73,382	80%	20%	$750	$750	$6,530
VFD Tower Fan 20-100hp - Large Office	Commercial and Industrial Prescriptive	15	3,700	1	4,810	3,848	80%	20%	$750	$750	$6,530
Window Film	Commercial and Industrial Prescriptive	10	4	65	274	219	80%	20%	$1	$1	$3
EDA - Lighting Power Density Reduction	Commercial and Industrial New Construction	15	72,000	4	302,400	287,280	95%	5%	$6,840	$28,728	$41,096
EDA - Non Lighting Measures	Commercial and Industrial New Construction	10	45,000	4	189,000	179,550	95%	5%	$4,275	$17,955	$37,200
EDA - Design Team Participation Incentives - Small Buildings	Commercial and Industrial New Construction		0	1	0	0	95%	5%	$750	$750	$750
EDA - Design Team Participation Incentives - Med Buildings	Commercial and Industrial New Construction	10	0	3	0	0	95%	5%	$2,500	$2,500	$2,500
EDA - Design Team Participation Incentives - Large Buildings	Commercial and Industrial New Construction		0	1	0	0	95%	5%	$5,000	$5,000	$5,000

Measures	Program Name	Measure Life	Install Adjusted Savings per unit (kWh)	2015 Participation	2015 Total kWh	2015 Total kWh (net)	NTG	2015 Freeridership	Average Incentive Paid per unit	Total Incentives 2015	Incremental Cost per unit
Large Industrial Custom Measure - Non Lighting	Commercial and Industrial Custom	10	2,250,000	0	945,000	935,550	99%	1%	$270,000	$270,000	$750,000
System Study	Commercial and Industrial Custom	10	250,000	1	210,000	207,900	99%	1%	$30,000	$30,000	$22,000
Typical Custom Measure - Lighting	Commercial and Industrial Custom	15	174,000	9	1,607,760	1,591,682	99%	1%	$20,880	$20,880	$83,386
Typical Custom Measure - Non-Lighting	Commercial and Industrial Custom	10	62,000	31	1,900,920	1,881,911	99%	1%	$7,440	$7,440	$31,000
Market Segment Programs - Elec	Commercial and Industrial Custom	10	174,000	0	73,080	72,349	99%	1%	$20,880	$20,880	$62,640
Performance Based Industrial Assessments - Elec	Commercial and Industrial Custom	10	174,000	0	73,080	72,349	99%	1%	$20,880	$20,880	$62,640
Self-Generation Efficiency Improvements - Elec	Commercial and Industrial Custom	10	174,000	0	73,080	72,349	99%	1%	$20,880	$20,880	$62,640
Industrial Staffing Grants - Elec	Commercial and Industrial Custom	10	174,000	0	73,080	72,349	99%	1%	$20,880	$20,880	$62,640
Industrial Request for Proposals - Elec	Commercial and Industrial Custom	10	174,000	0	73,080	72,349	99%	1%	$20,880	$20,880	$62,640

ELECTRIC DEMAND SIDE MANAGEMENT: MARKET POTENTIAL STUDY AND ACTION PLAN

Volume 1: Executive Summary

Report Number 1432

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INTRODUCTION

Background

Energy efficiency (EE) efforts are increasing in magnitude and gaining traction in Indiana, building on the momentum of recently established statewide electric energy efficiency targets. Vectren Energy Delivery of Indiana (Vectren) is investigating the electric energy efficiency potential for their service territory. The findings of this investigation will lead directly into the development of a portfolio of energy efficiency programs to be delivered to customers over the time period 2015 to 2019.

Toward this end, Vectren has contracted with EnerNOC Utility Solutions (EnerNOC) to conduct a Market Potential Study and assemble an Action Plan that considers all metered electric customers in the residential, commercial, and industrial sectors for this time period.

EnerNOC conducted a detailed, bottom-up assessment of the Vectren market in the Evansville metropolitan area to deliver a projection of baseline electric energy use, forecasts of the energy savings achievable through efficiency measures, and program designs and strategies to optimally deliver those savings. This report describes the study approach and results.

Report Organization

This report is presented in 4 volumes as outlined below. This document is **Volume 1: Executive Summary**.

- Volume 1, Executive Summary
- Volume 2, Market Potential and Action Plan Report
- Volume 3, Detailed Appendices: Market Potential Study
- Volume 4, Detailed Appendices: Action Plan & Program Write-ups

Definitions of Potential

In this study, we estimate the potential for energy efficiency savings. The savings estimates represent net savings[1] developed into three types of potential: technical potential, economic potential, and achievable potential. Technical and economic potential are both theoretical limits to efficiency savings. Achievable potential embodies a set of assumptions about the decisions consumers make regarding the efficiency of the equipment they purchase, the maintenance activities they undertake, the controls they use for energy-consuming equipment, and the elements of building construction. Because estimating achievable potential involves the inherent uncertainty of predicting human behaviors and responses to market conditions, we developed low and high achievable potential as boundaries for a likely range. The various levels are described below.

- **Technical potential** is defined as the theoretical upper limit of energy efficiency potential. It assumes that customers adopt all feasible measures regardless of their cost. At the time of existing equipment failure, customers replace their equipment with the most efficient option available. In new construction, customers and developers also choose the most efficient

[1] Savings in "net" terms instead of "gross" means that the baseline forecast includes naturally occurring efficiency. In other words, the baseline assumes that natural early adopters continue to make purchases of equipment and measures at efficiency levels higher than the minimum standard.

equipment option. Examples of measures that make up technical potential for electricity in the residential sector include:

- o Ductless mini-split air conditioners with variable refrigerant flow
- o Ground source (or geothermal) heat pumps
- o LED lighting

Technical potential also assumes the adoption of every other available measure, where applicable. For example, it includes installation of high-efficiency windows in all new construction opportunities and furnace maintenance in all existing buildings with furnace systems. These retrofit measures are phased in over a number of years, which is longer for higher-cost and complex measures.

- **Economic potential** represents the adoption of all ***cost-effective*** energy efficiency measures. In this analysis, the cost effectiveness is measured by the total resource cost (TRC) test, which compares lifetime energy and capacity benefits to the incremental cost of the measure. If the benefits outweigh the costs (that is, if the TRC ratio is greater than 1.0), a given measure is considered in the economic potential. Customers are then assumed to purchase the most cost-effective option applicable to them at any decision juncture.
- **Achievable High potential** estimates customer adoption of economic measures when delivered through efficiency programs under ideal market, implementation, and customer preference conditions. Information channels are assumed to be established and efficient for marketing, educating consumers, and coordinating with trade allies and delivery partners. Achievable High potential establishes a maximum target for the EE savings that an administrator can hope to achieve through its EE programs and involves incentives that represent a substantial portion of the incremental cost combined with high administrative and marketing costs.
- **Achievable Low potential** reflects expected program participation given significant barriers to customer acceptance, non-ideal implementation conditions, and limited program budgets. This represents a lower bound on achievable potential.

ANALYSIS APPROACH AND DATA DEVELOPMENT

This section describes the analysis approach taken for the study and the data sources used to develop the potential estimates.

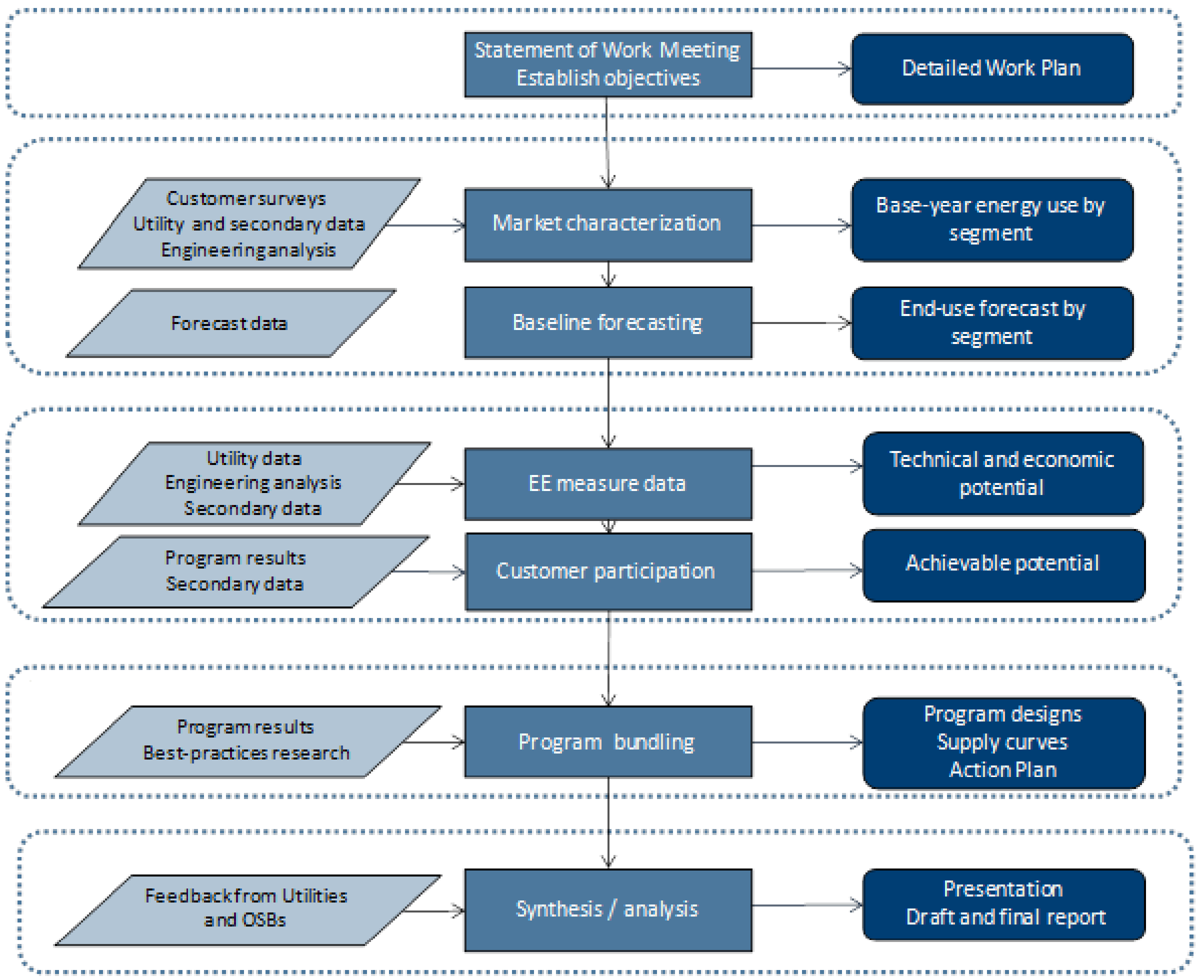
Analysis Approach

To perform the energy efficiency analysis, EnerNOC used a bottom-up analysis approach as shown in Figure 2-1. This involved the following steps.

1. Held a meeting with the client project team to refine the objectives of the project in detail. This resulted in a work plan for the study.
2. Conducted onsite energy consumption surveys with 30 of Vectren's largest commercial and industrial customers in order to provide data and guidance for these market sectors that had not formerly received focused DSM program efforts.
3. Performed a market characterization to describe sector-level electricity use for the residential, commercial, and industrial sectors for the base year, 2011. This included using existing information contained in prior Vectren and Indiana studies, new information from the aforementioned onsite surveys with large customers, EnerNOC's own databases and tools, and other secondary data sources such as the American Community Survey (ACS) and the Energy Information Administration (EIA).
4. Developed a baseline electricity forecast by sector, segment, and end use for 2011 through 2023. Results presented in this volume focus on the upcoming implementation years of 2015 through 2019. Results beyond 2019 are available in the Appendices.
5. Identified several hundred measures and estimated their effects in four tiers of measure-level energy efficiency potential: *Technical, Economic, Achievable High,* and *Achievable Low*.
6. Reviewed the current programs offered by Vectren in light of the study findings to make strategic program recommendations for achieving savings.
7. Created detailed program designs and action plans through 2019 representing the program potential for Vectren, basing them on the potential analysis and strategic recommendations developed in the previous steps.

The analysis approach for all these steps is described in further detail throughout the remainder of this chapter.

Figure 2-1 Overview of Analysis Approach



Data Development

A discussion of the data sources used in this study, as well as how they were applied, is found in Chapter 2 of the main body of the report. In general, data were used according to the hierarchy given below and adapted to local conditions whenever possible, for example, by using local sources for measure data and local weather for building simulations.

- Vectren and Indiana specific data first
- EnerNOC's databases and analysis tools
- Other secondary data and reports if necessary

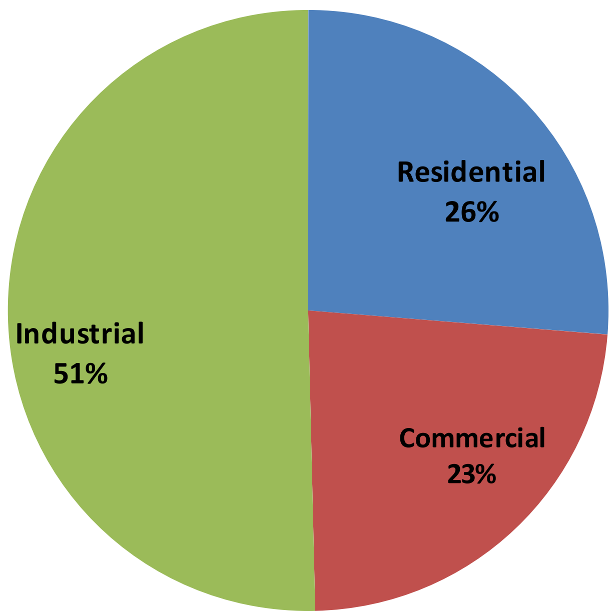
MARKET CHARACTERIZATION AND MARKET PROFILES

In this section, we describe how customers in the Vectren service territory use electricity in the base year of the study, 2011. It begins with a high-level summary of energy use by sector and then delves into each sector in detail.

Energy Use Summary

Total electricity use for the residential, commercial, and industrial sectors for Vectren in 2011 was 5,646 GWh. As shown in Figure 3-1, the largest sector is industrial, accounting for 51% of load at 2,845 GWh. The remaining use is in the residential and commercial sectors, at 1,483 GWh and 1,318 respectively.

Figure 3-1 Sector-Level Electricity Use, 2011



Residential Sector

The total number of households and electric sales for the service territory were obtained from Vectren's customer database. In 2011, there were 122,961 households in the Vectren territory that used a total of 1,483 GWh of electricity. We allocated these totals into the two residential segments based on the Vectren South 2010 baseline survey results.

Figure 3-2 shows the distribution of electric energy consumption by end use for all homes. Three main electricity end uses —appliances, space heating and cooling — account for over 50% of total use. The most energy allocated to any single category is 21% for cooling, which includes central AC, heat pumps, and room AC. Other categories with substantial energy use are space heating and appliances. Appliances include refrigerators, freezers, stoves, clothes washers, clothes dryers, dishwashers, and microwaves. The remainder of the energy falls into the electronics, lighting, water heating and the miscellaneous category – which is comprised of furnace fans, pool pumps, and other "plug" loads (hair dryers, power tools, coffee makers, etc).

Figure 3-2 Residential Electricity by End Use (2011), All Homes

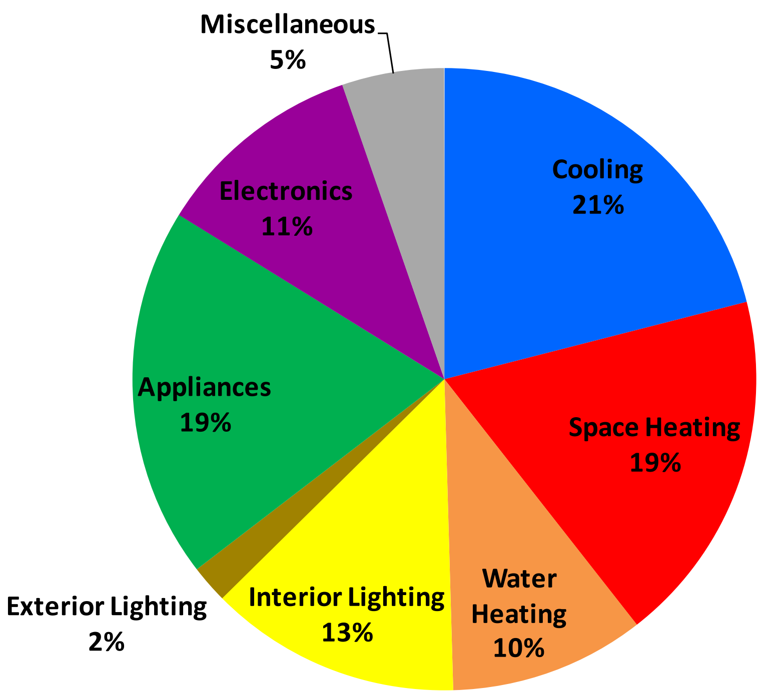
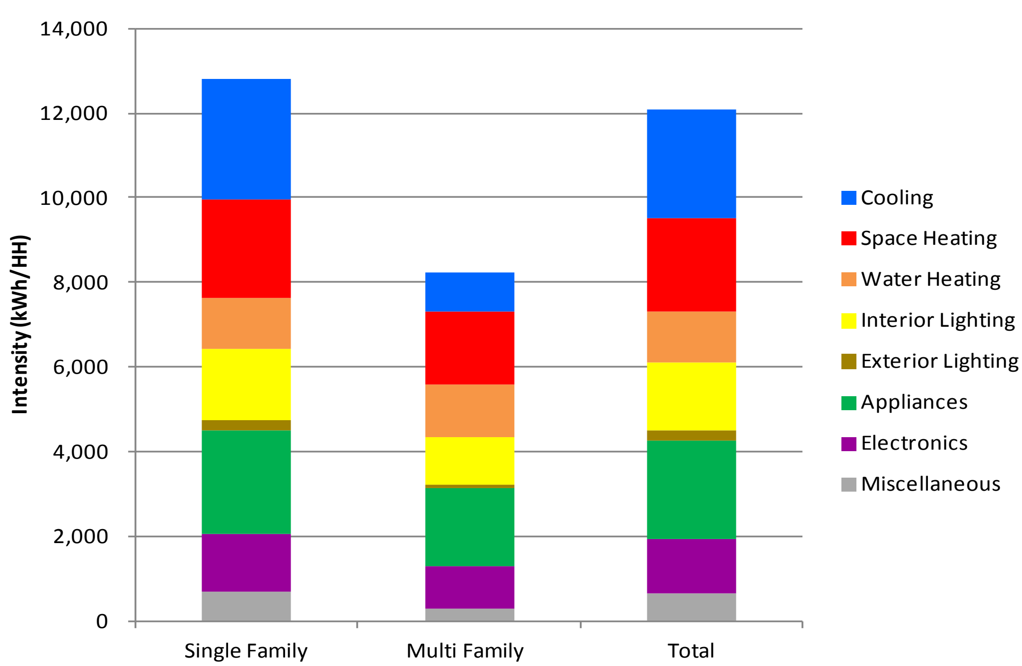


Figure 3-3 presents the electricity intensities by end-use and housing type, as well as all homes on average.

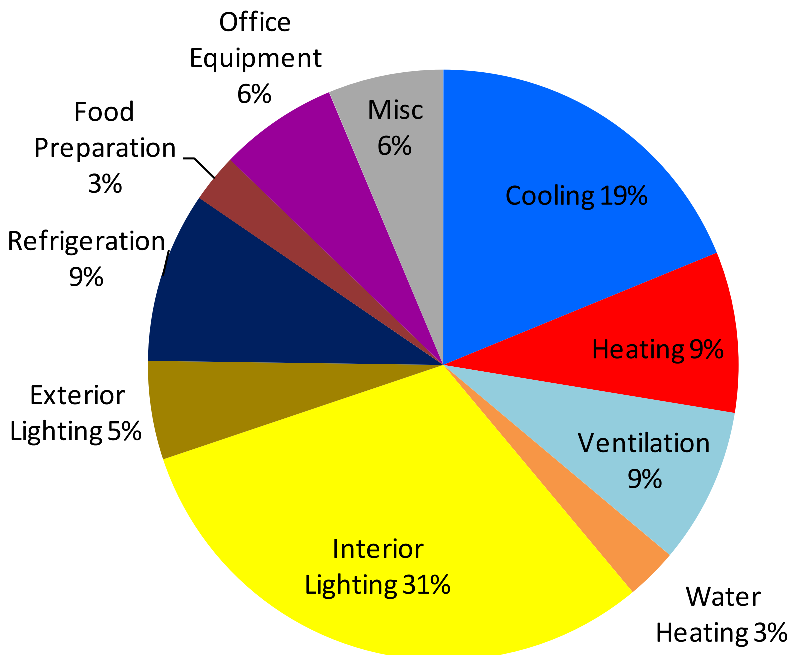
Figure 3-3 Residential Electricity Intensity by End Use and Segment (kWh/household, 2011)



Commercial Sector

The total electric energy consumed by commercial customers in Vectren's service area in 2011 was 1,318 GWh. Figure 3-4 shows the distribution of electricity consumption by end use for all commercial building types. Electric usage is dominated by lighting, with interior and exterior varieties accounting for over one third of consumption. After lighting, the largest end uses are cooling, heating, ventilation, and refrigeration. The remaining end uses comprise 6% or less of total usage: office equipment, miscellaneous, water heating, and food preparation.

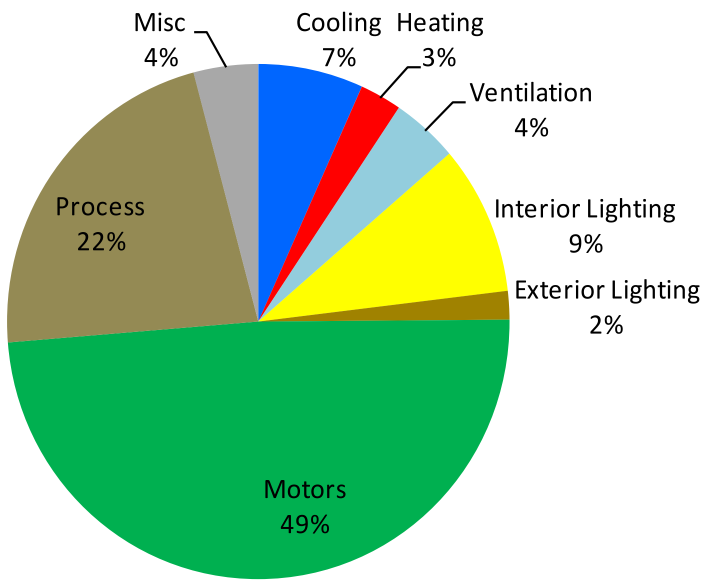
Figure 3-4 Commercial Electricity Consumption by End Use (2011), All Building Types



Industrial Sector

The total electric energy consumed by industrial customers in Vectren in 2011 was 2,845 GWh. Figure 3-5 shows the distribution of electricity energy consumption by end use for all industrial customers. Motors are clearly the largest overall end use for the industrial sector, accounting for 49% of energy use. Note that this end use includes a wide range of industrial equipment, such as air compressors and refrigeration compressors, pumps, conveyor motors, and fans. The process end use accounts for 22% of energy use, which includes heating, cooling, refrigeration, and electro-chemical processes. Lighting is the next highest, followed by cooling, ventilation, miscellaneous, and space heating.

Figure 3-5 Industrial Electricity Use by End Use (2011), All Industries



BASELINE FORECAST

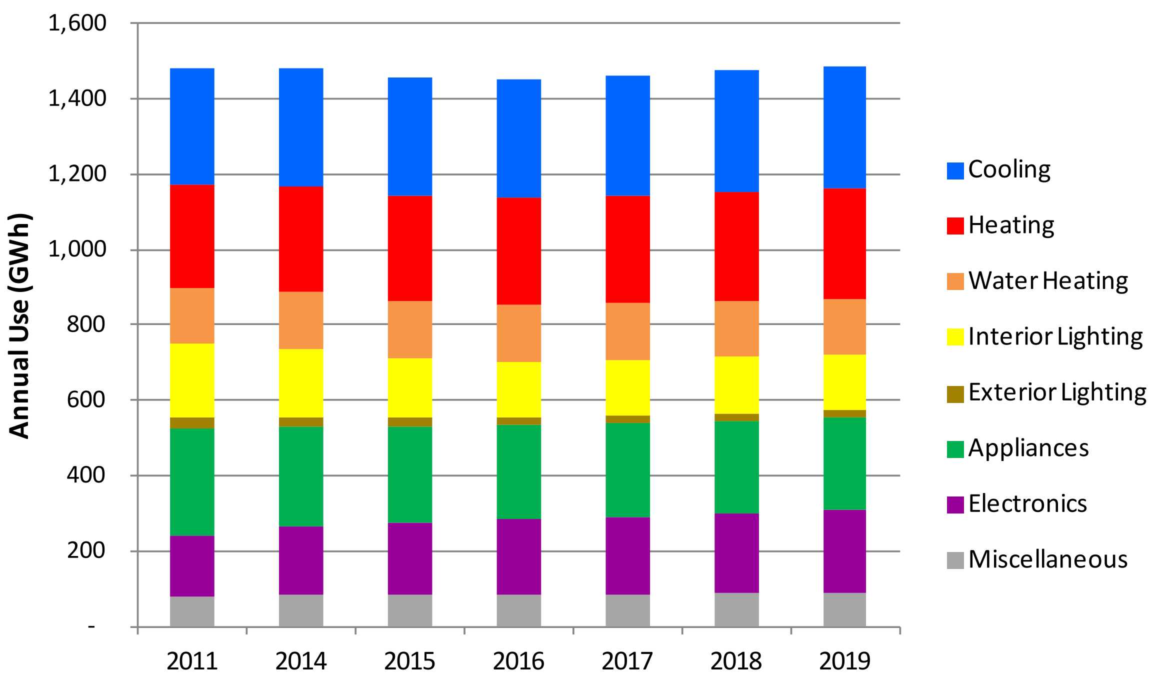
Prior to developing estimates of energy-efficiency potential, a baseline end-use forecast was developed to quantify what the consumption is likely to be in the future in absence of new efficiency programs and naturally occurring efficiency. The baseline forecast serves as the metric against which energy efficiency potentials are measured. This chapter presents the baseline forecast for electricity for each sector.

Residential Sector

The baseline forecast incorporates assumptions about economic growth, electricity prices, and appliance/equipment standards and building codes that are already mandated as described in Chapter 2 of the main report.

Figure 4-1 present the baseline forecast for electricity at the end-use level for the residential sector as a whole. Overall, residential use increases slightly from 1,483 GWh in 2011 to 1,488 GWh in 2019, an increase of only 0.3%, which is essentially a flat forecast year over year. This reflects the impact of the EISA lighting standard, additional appliance standards adopted in 2011, and modest customer growth.

Figure 4-1 Residential Electricity Baseline Forecast by End Use

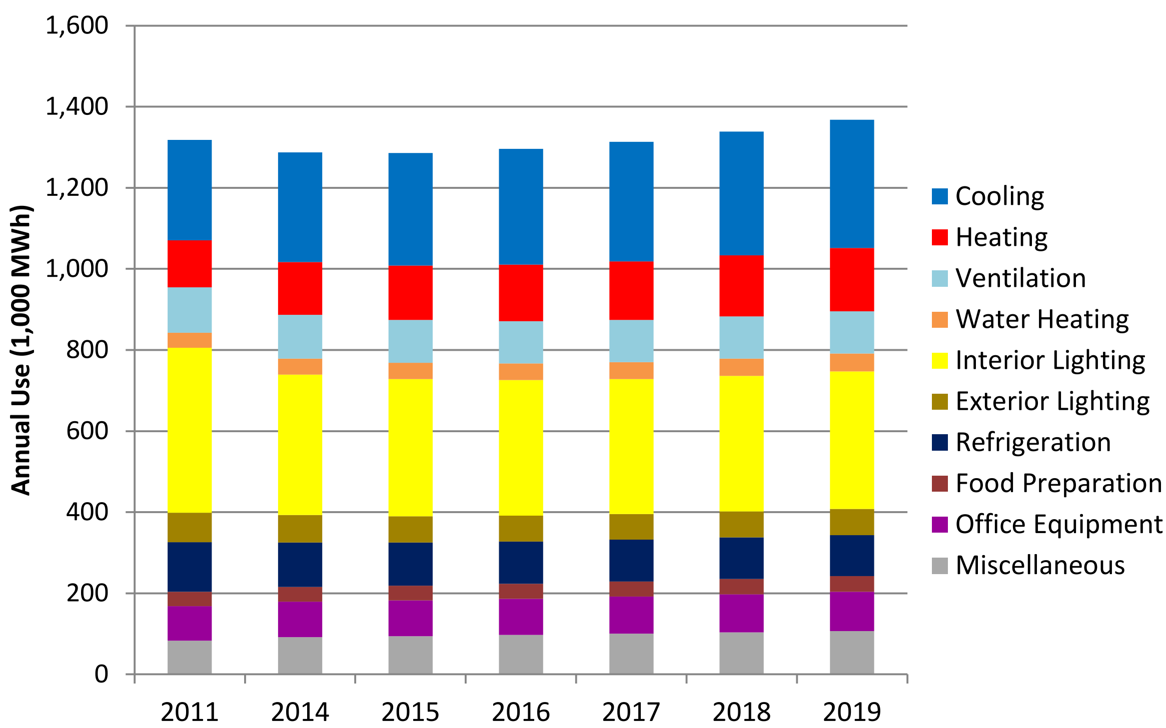


Commercial Sector

Electricity use in the commercial sector grows modestly during the overall forecast horizon, starting at 1,318 GWh in 2011, and increasing to 1,368 GWh in 2019.

Figure 4-2 present the electricity baseline forecast at the end-use level for the commercial sector as a whole. Usage is declining in the early years of the forecast, due largely to the phasing in of codes and standards such as the EISA 2007 lighting standards and EPACT 2005 refrigeration standards.

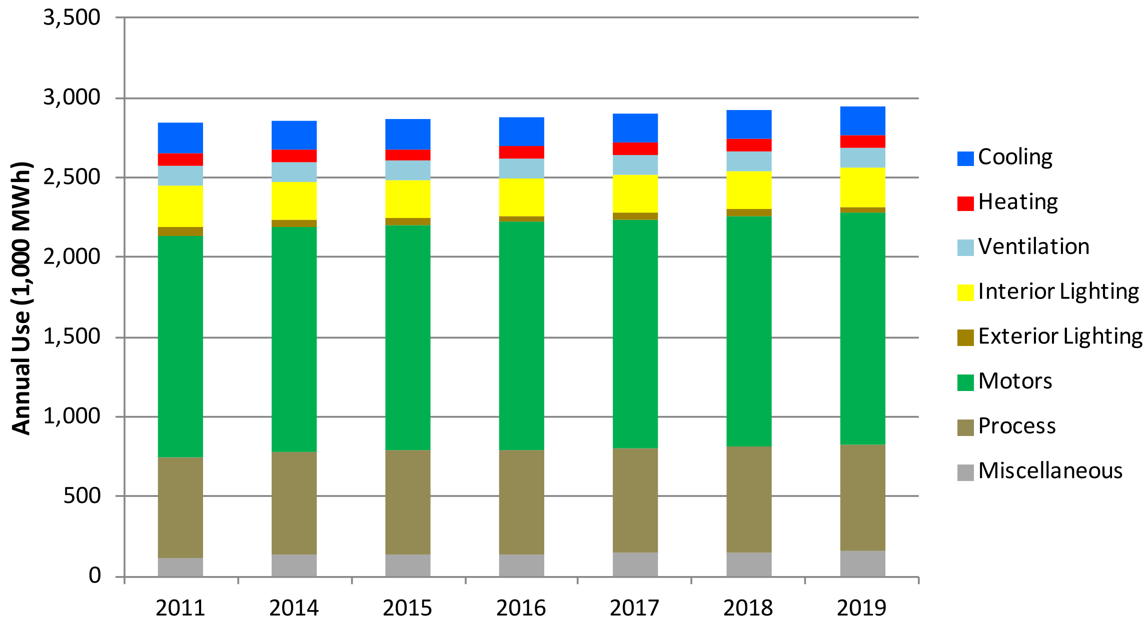
Figure 4-2 Commercial Electricity Baseline Forecast by End Use



Industrial Sector

Figure 4-3 present the electricity baseline forecast at the end-use level for the industrial sector. Overall, industrial annual electricity use increases modestly from 2,845 GWh in 2011 to 2,943 GWh in 2019. This comprises an overall increase of 3.5%, or 0.4% per year, which is colored by slow but recovering economy.

Figure 4-3 Industrial Electricity Baseline Forecast by End Use



Baseline Forecast Summary

Table 4-1 and Figure 4-4 provide a summary of the baseline forecast for electricity by sector for the entire Vectren service territory. Overall, the forecast shows only a slight incline in electricity use, driven primarily by oncoming codes and standards and a challenging macroeconomic environment.

Table 4-1 Electricity Baseline Forecast Summary (GWh)

Sector	2011	2014	2015	2016	2017	2018	2019	% Change	Avg. Growth Rate
Residential	1,483	1,482	1,459	1,453	1,463	1,476	1,488	0.3%	0.0%
Commercial	1,318	1,288	1,286	1,296	1,313	1,339	1,368	3.7%	0.5%
Industrial	2,845	2,861	2,863	2,877	2,896	2,922	2,943	3.5%	0.4%
Total	**5,646**	**5,630**	**5,608**	**5,626**	**5,673**	**5,738**	**5,799**	**2.7%**	**0.3%**

Figure 4-4 Electricity Baseline Forecast Summary (GWh)

ENERGY EFFICIENCY MEASURES

The energy efficiency measures and assumptions used in this analysis are detailed in Chapter 5 of the Volume 2 main report as well as Volume 3 appendices B, C, and D. Table 5-1 summarizes the number of equipment and non-equipment measures evaluated for each segment within each sector.

Table 5-1 Number of Measures Evaluated

	Residential	Commercial	Industrial	Total Number of Measures
Equipment Measures Evaluated	35	40	28	**103**
Non-Equipment Measures Evaluated	45	82	69	**196**
Total Measures Evaluated	**80**	**122**	**97**	**299**

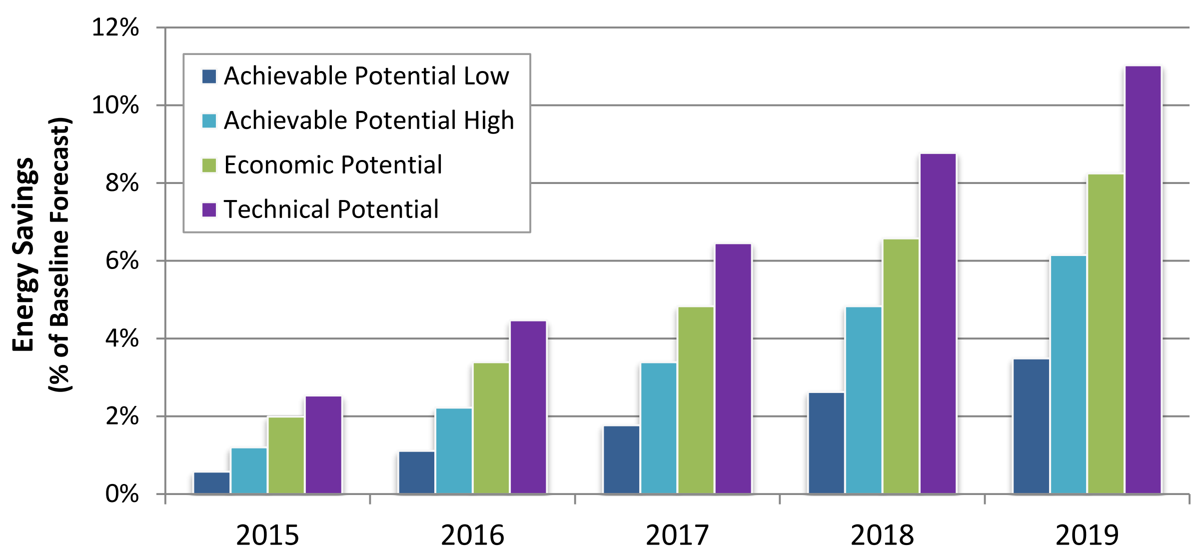
MEASURE-LEVEL ENERGY EFFICIENCY POTENTIAL

Table 6-1 and Figure 6-1 summarize the electric energy-efficiency savings for all measures at the different levels of potential relative to the baseline forecast. Note that the subsequent steps of measure bundling, program design and program delivery will hone and refine these results later in Chapter 8.[2]

Table 6-1 Overall Measure-Level Electricity Efficiency Potential

	2015	2016	2017	2018	2019
Baseline Forecast (GWh)	**5,608**	**5,626**	**5,673**	**5,738**	**5,799**
Cumulative Savings (GWh)					
Achievable Low Potential	32	63	100	151	203
Achievable High Potential	67	125	192	277	357
Economic Potential	112	191	274	377	478
Technical Potential	142	251	366	504	640
Energy Savings (% of Baseline)					
Achievable Low Potential	0.6%	1.0%	1.8%	2.6%	3.5%
Achievable High Potential	1.2%	2.2%	3.4%	4.8%	6.2%
Economic Potential	2.0%	3.4%	4.8%	6.6%	8.2%
Technical Potential	2.5%	4.5%	6.5%	8.8%	11.0%

Figure 6-1 Overall Measure-Level Electricity Efficiency Potential



[2] Utilities typically have a small subset of large commercial and industrial customers that comprise a disproportionate share of load and demand. In Vectren's case, there is one particular industrial customer that comprises a full 24% of the C&I load. If this customer were not to participate in EE programs, the savings potential would drop commensurately in the C&I sectors, which would remove approximately 15% from the overall savings potential in all sectors.

Overview of Measure-Level Energy Efficiency Potential by Sector

Table 6-2, summarize the range of electric achievable potential by sector. The commercial sector accounts for the largest portion of the savings, followed by residential, and then industrial.

Table 6-2 Electric Achievable Potential by Sector (GWh)

	2015	2016	2017	2018	2019
Achievable Low Cumulative Savings (GWh)					
Residential	9.4	15.7	22.1	32.4	43.4
Commercial	12.1	22.8	36.0	53.0	71.8
Industrial	10.7	24.3	42.2	65.4	87.4
Total	**32.2**	**62.7**	**100.3**	**150.9**	**202.6**
Achievable High Cumulative Savings (GWh)					
Residential	20.4	32.0	43.8	60.9	76.8
Commercial	25.3	45.7	69.2	97.9	127.1
Industrial	21.7	47.2	79.4	118.7	152.7
Total	**67.3**	**124.9**	**192.5**	**277.4**	**356.7**

MEASURE-LEVEL ENERGY EFFICIENCY POTENTIAL BY SECTOR

This chapter presents the results of the energy efficiency analysis for all measures at the sector level. First, the residential potential is presented, followed by the commercial, and lastly, industrial. Note that the subsequent steps of measure bundling, program design and program delivery will hone and refine these results later in Chapter 8.

Residential Electricity Potential

Figure 7-1 depicts the residential electricity potential energy savings estimates graphically.

Figure 7-1 Residential Electric Energy Efficiency Potential Savings

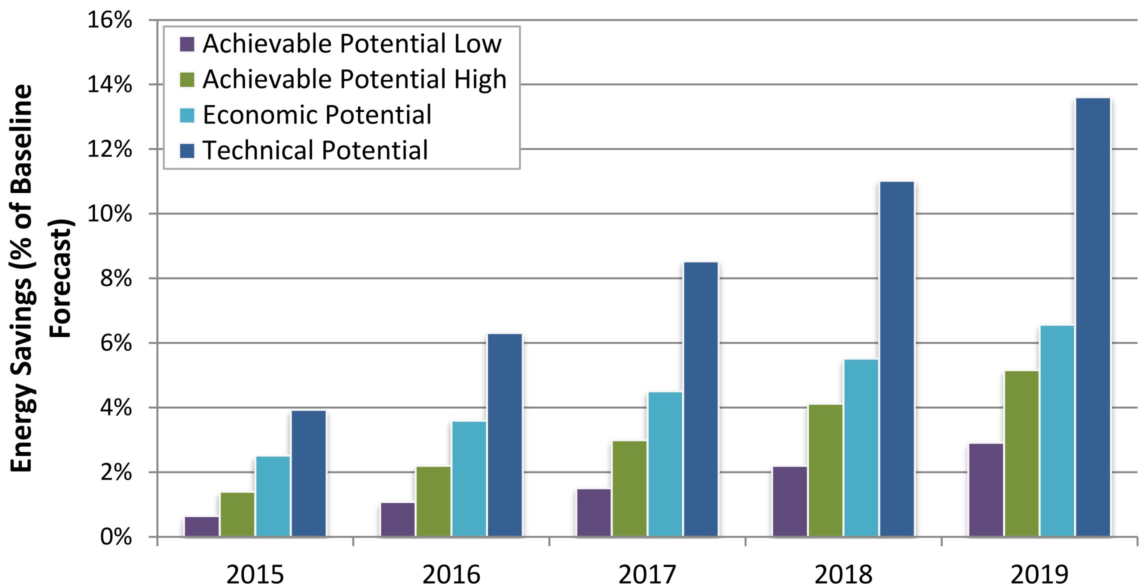
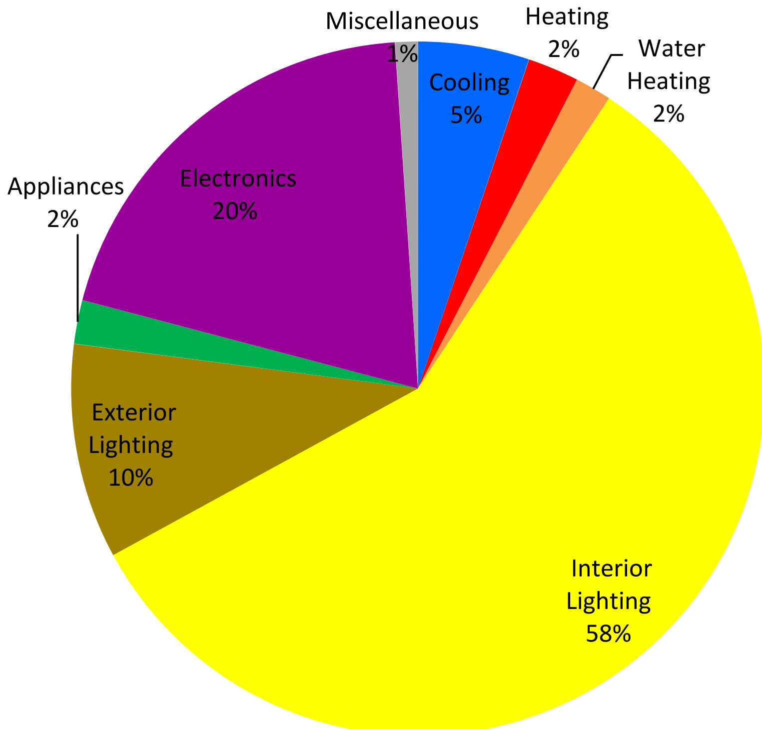


Figure 7-2 focuses on the residential achievable low potential in 2017. Lighting equipment replacement accounts for the highest portion of the savings in the near term as a result of the efficiency gap between CFL lamps and advanced incandescent lamps, even those that will meet the EISA 2007 standard. Electronics, cooling, and appliances also contribute significantly to the savings. Detailed measure information is available in Volume 3 Appendices. The key measures comprising the potential are listed below:

- Lighting: mostly CFL lamps and specialty bulbs
- Electronics (reduce standby wattage, televisions, set top boxes, PCs)
- Second refrigerator/ freezer removal
- HVAC: Removal of second room AC unit, efficient air conditioners, ducting repair/sealing, insulation, home energy management system and programmable thermostats

Figure 7-2 Residential Electric Achievable Low Potential by End Use in 2017



Commercial Electricity Potential

Figure 7-3 depicts these potential energy savings estimates graphically.

Figure 7-3 Commercial Energy Efficiency Potential Savings

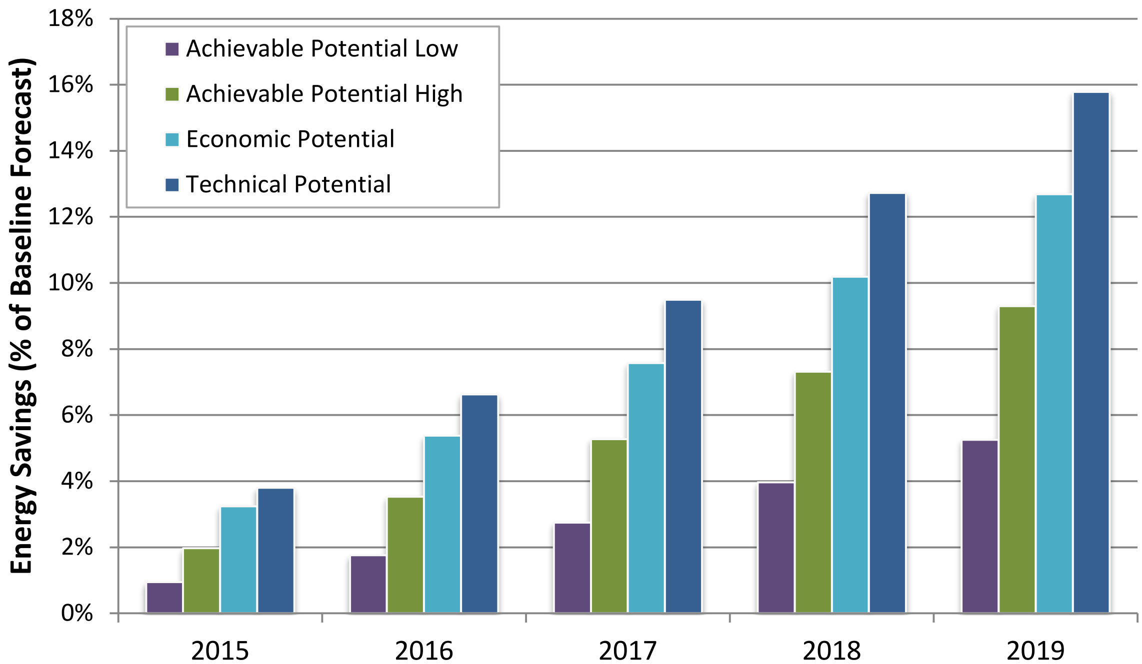
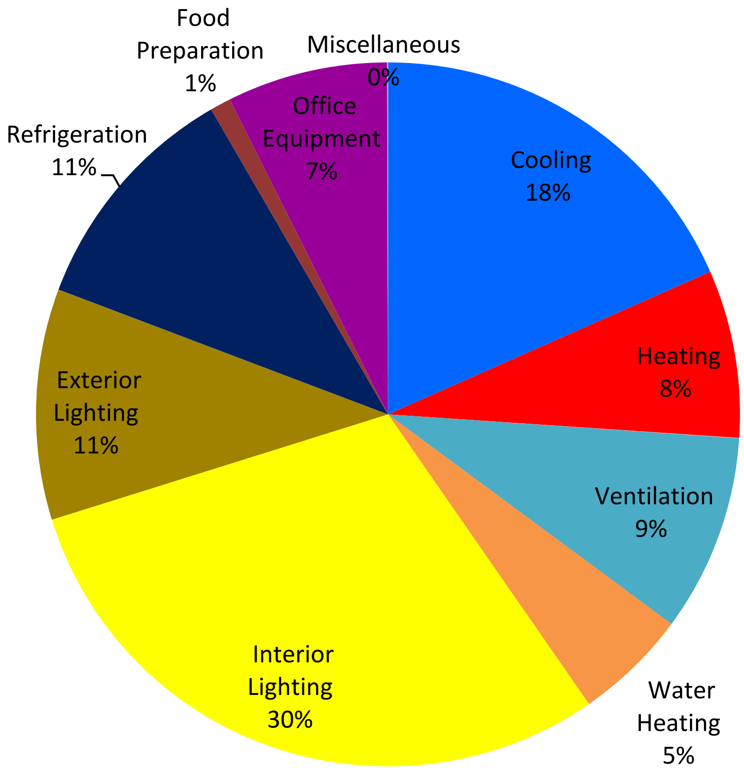


Figure 7-4 focuses on achievable potential savings by end use. Not surprisingly, interior lighting delivers the highest achievable savings throughout the study period. In 2017, Cooling is second, and exterior lighting is third. Regarding refrigeration, it is interesting to point out a relatively new control and sensing technology that vendors such as “eCube” are using to regulate the system energy. The technology consists of a solid, waxy food simulant that is fitted around a thermostat sensor that would otherwise measure air temperature. The refrigeration controls therefore attempt to regulate the temperature of food, which changes more slowly and gradually than air, thereby reducing the frequency of refrigeration on/off cycles. Refrigeration energy savings are then followed in descending order by cooling, ventilation, office equipment, and small amounts of the other end uses. Detailed measure information is available in the Volume 3 Appendices. The key measures comprising the potential are listed below:

- Lighting – CFLs, LED lamps, linear fluorescent, daylighting controls, occupancy sensors, and HID lamps for exterior lighting
- Energy management systems & programmable thermostats
- Ventilation – variable speed control
- Refrigeration – efficient equipment, control systems, decommissioning
- Efficient office equipment – computers, servers

Figure 7-4 Commercial Achievable Low Potential Electricity Savings by End Use in 2017



Industrial Electricity Potential

The Vectren industrial sector accounts for 51% of total energy consumption, making for prime efficiency opportunities. Figure 7-5 present the savings for the various types of potential considered in this study.

Figure 7-5 Industrial Electric Potential Savings

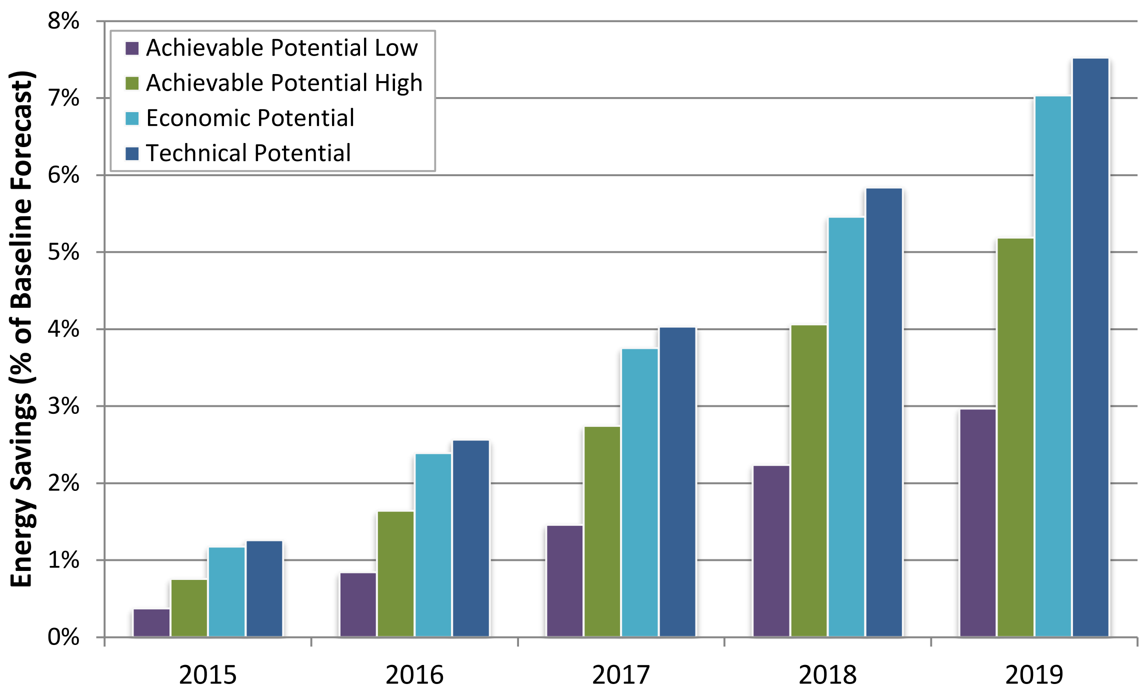
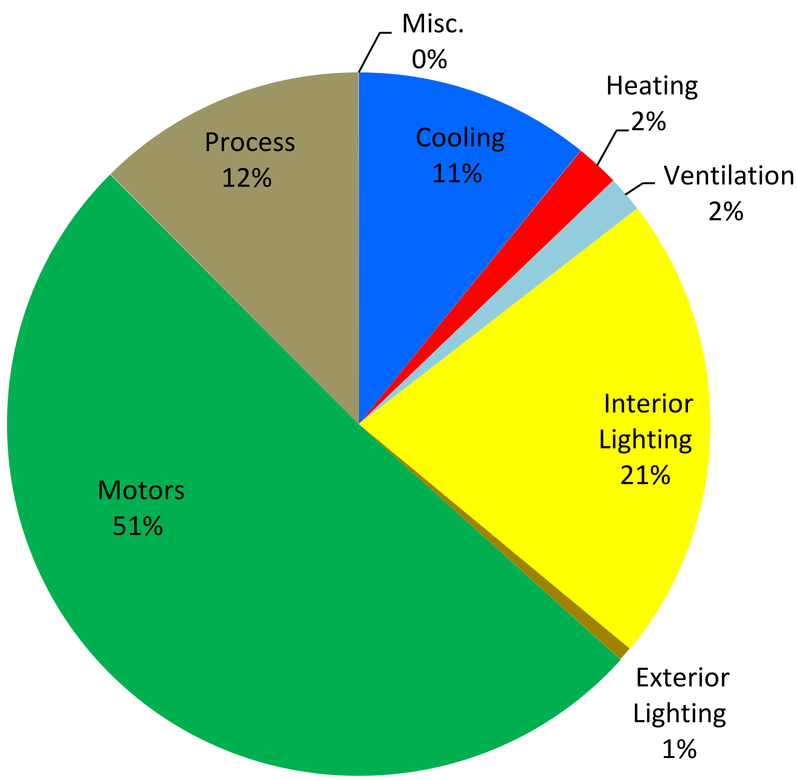


Figure 7-6 illustrates the achievable potential savings by electric end use in 2017 for the industrial sector. The largest shares of savings opportunities are in the motors and machine drives. Potential savings for straight motor equipment change-outs are being eliminated due to the National Electrical Manufacturer's Association (NEMA) standards, which now make premium efficiency motors the baseline efficiency level. As a result, potential savings are incrementally small to upgrade to even more efficient levels. All the savings opportunities in this end use come from controls, timers, and variable speed drives, which improve system efficiencies where motors are utilized. These system-level measures and upgrades are also applicable to a large swath of applications for heating, cooling, and electrochemical processes. Since the plastics industry is so prominent in the Vectren service territory, measures such as injection molding barrel insulation are very promising sources of potential savings.

Beyond motors and processes, there are large opportunities for savings in lighting and cooling; and smaller opportunities in ventilation and space heating. Detailed measure information is available in the Volume 3 Appendices. The key measures comprising the potential are listed below:

- Motors – drives and controls
- Process – timers and controls
- Application optimization and control – fans, pumps, compressed air
- Efficient high bay lighting
- Efficient ventilation systems
- Energy management systems & programmable thermostats

Figure 7-6 Industrial Achievable Low Electricity Potential Savings by End Use in 2017



PROGRAM POTENTIAL AND ACTION PLAN

The Action Plan is the heart of the study. This is where the multitude of energy efficiency measures covered in previous chapters get bundled into delivery mechanisms to take on the form of specific energy efficiency programs. Several changes and adjustments occur in the translation from the market potential assessment to the program designs in the Action Plan, as the measure mix may change due to program delivery considerations. Table 8-1 below lists the distinct programs that emerge from this exercise to deliver an effective and balanced portfolio of energy savings opportunities across all customer segments.

Table 8-1 Portfolio of Energy Efficiency Programs Included in Action Plan

Residential Programs	Commercial & Industrial Programs
Lighting	Prescriptive
Efficient Products	Custom Incentives
Income Qualified Weatherization (IQW)	Schools Program
IQW Plus	Strategic Energy Management (SEM)
New Construction	Business & Multi Family New Construction
Multi Family Direct Install	Small Business Direct Install
Home Energy Assessment	
School Kit	
Whole House Plus	
Appliance Recycling	
Behavioral Feedback Tools	

Programmatic Framework

Each program contemplates and outlines a programmatic framework for administrators and implementers. The items considered and developed for this framework include those listed below. Detailed write-ups delve into the specific recommendations for each program in Volume 4 of this report.

- Target market
- Implementation strategy, including delivery channels, marketing, education and outreach
- Program issues, risks and risk management strategies
- Eligible measures and incentives
- Evaluation, measurement and verification requirements and guidance
- Administrative requirements
- Estimated participation
- Program budget
- Program energy savings and demand reduction
- Cost effectiveness

The state of Indiana has mandated efficiency targets for regulated electric utilities, specifying that they reach certain levels of savings by implementing a required set of programs, known as Core programs, and that they should make up any shortfall between the targets and the Core program savings with a flexible or optional set of Core Plus programs, which can be designed to suit each utility. The Residential Lighting, Income Qualified Weatherization, Home Energy Assessment, School Kit, and Business Prescriptive programs are Core programs; and the remainder are Core Plus. These distinctions are outlined later in the program highlights and descriptions.

The total amount of energy efficiency savings required by the state targets, in gross incremental savings per year, is shown as a percent of the baseline forecast in Table 8-2 below.

Table 8-2 Indiana State Goals, Gross Incremental Electricity Savings as % of Baseline

2015	2016	2017	2018	2019
1.30%	1.50%	1.70%	1.90%	2.00%

Using Achievable High and Achievable Low as Guidelines

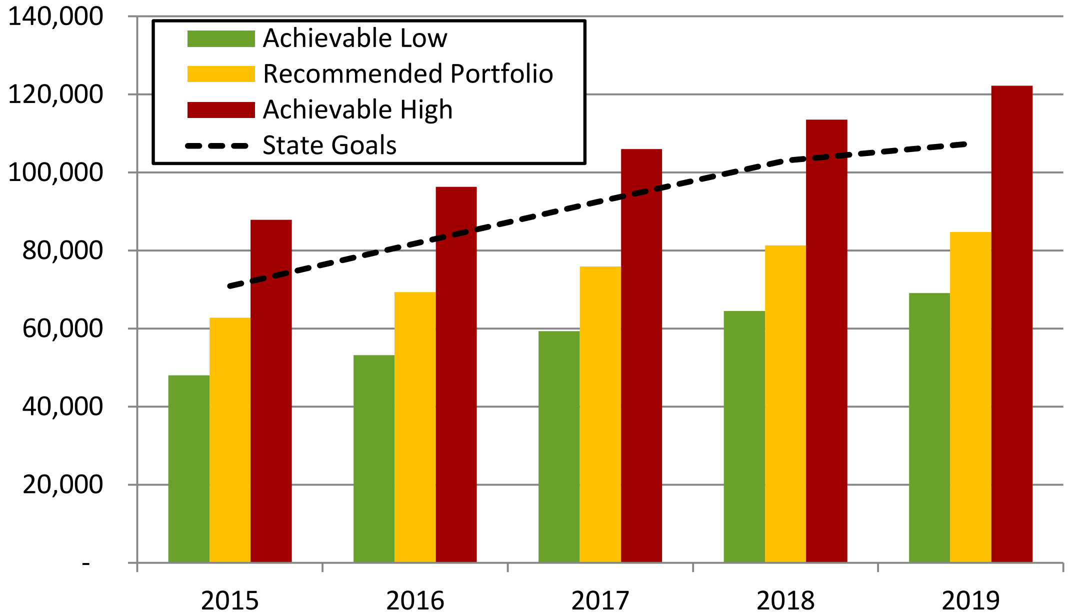
The first step toward creating the recommended Action Plan was to create two separate scenarios that corresponded to the measure-level energy efficiency potentials assessed in the previous chapter: Achievable Low and Achievable High. After applying all the delivery and cost structures, each of the Low and High portfolios resulted in a set of program potential savings and estimated budgets.

These portfolios provided guidelines, allowing us create the Recommended Action Plan by interpolating between Low and High, optimizing to consider the Indiana state goals, past program experience, industry benchmarks, and feedback from Vectren and Stakeholders.

Figure 8-1 below shows the resulting Gross MWh savings per year for the three separate portfolios, along with a black, dotted line indicating the level of the state goals. Note that the recommended portfolio is not able to meet the state goals in any year. Note also that the savings on this chart are in terms of Gross incremental savings since the Indiana goals are expressed as such, and that all other potential savings in this report are given in terms of Net incremental or Net cumulative savings.[3]

[3] Utilities typically have a small subset of large commercial and industrial customers that comprise a disproportionate share of load and demand. In Vectren's case, there is one particular industrial customer that comprises a full 24% of the C&I load. If this customer were not to participate in EE programs, the savings potential would drop commensurately in the C&I sectors, which would remove approximately 15% from the overall savings potential in all sectors.

Figure 8-1 Gross Incremental Electricity Savings (MWh)



The remainder of this report focuses on the delivery of the Recommended Portfolio specifically, and further details of the Achievable Low and Achievable High program portfolios are available in the analysis workpapers.

Recommended Program Action Plan

While the economic potential shown in the Action Plan meets the aggressive Indiana state goals, the recommended program Action Plan falls short. Figure 8-2 shows the net incremental energy savings in each year of the study by program. Figure 8-3 shows the annual budgets for the portfolio. Note again that the savings presented here are Net, and not Gross.

Figure 8-2 Recommended Action Plan - Net Incremental Energy Savings (MWh)

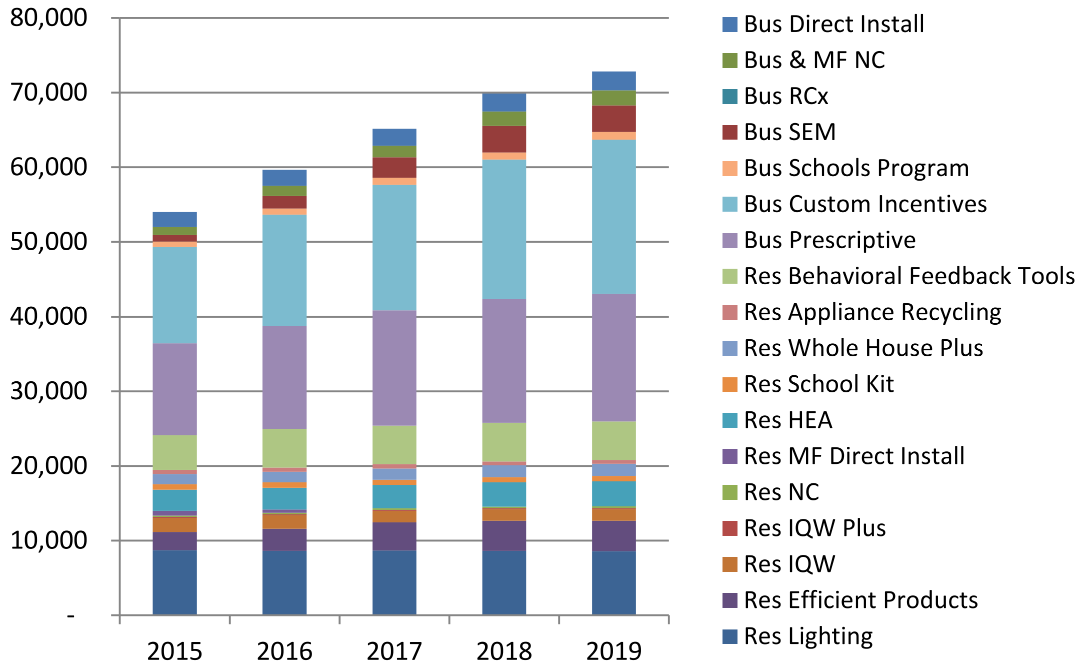


Figure 8-3 Recommended Action Plan - Annual Utility Budgets

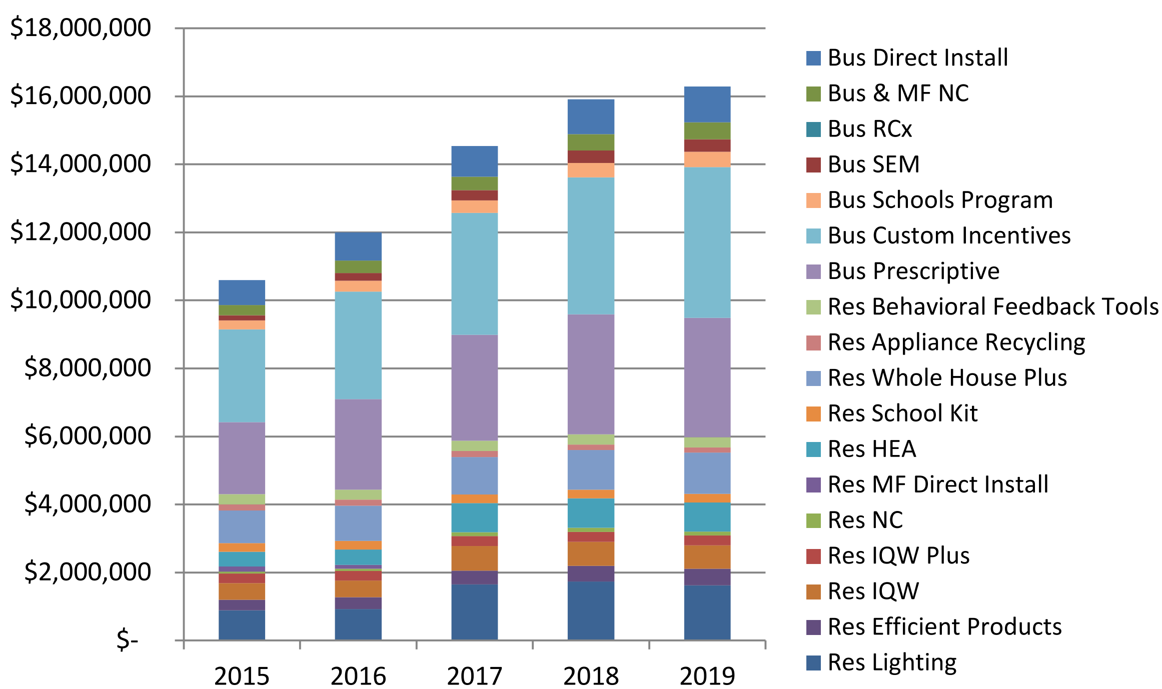


Table 8-3 below shows the detailed annual savings and budgets for the recommended portfolio.

Table 8-3 Vectren Recommended Electric Energy Efficiency Portfolio Summary

Program	Total Utility Costs (000$)					Total Net Incremental Energy Savings (MWh)					Total Net Incremental Demand Savings (kW)				
	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
Res Lighting	891	924	1,648	1,737	1,619	8,738	8,642	8,696	8,621	8,590	525	520	523	518	516
Res Efficient Products	309	349	406	455	496	2,425	2,957	3,773	4,061	4,096	259	310	385	420	438
Res IQW	491	491	728	712	680	1,876	1,799	1,527	1,517	1,518	116	112	95	94	94
Res IQW Plus	282	282	291	291	291	142	141	144	143	142	88	87	87	86	86
Res NC	57	64	107	116	119	193	193	220	236	248	24	26	29	32	35
Res MF Direct Install	146	115	-	-	-	610	448	-	-	-	44	32	-	-	-
Res HEA	434	452	861	872	855	2,846	2,911	3,092	3,218	3,354	138	140	149	155	161
Res School Kit	252	252	252	252	252	741	726	721	715	711	132	131	130	130	130
Res Whole House Plus	966	1,037	1,105	1,163	1,213	1,343	1,426	1,507	1,579	1,646	936	994	1,049	1,100	1,146
Res Appliance Recycling	174	174	174	165	155	561	561	561	528	495	143	143	143	135	126
Res Behavioral Feedback Tools	300	300	300	300	300	4,659	5,177	5,177	5,177	5,177	1,299	1,443	1,443	1,443	1,443
Bus Prescriptive	2,120	2,660	3,119	3,527	3,510	12,310	13,774	15,438	16,535	17,112	8,088	9,683	11,231	14,842	13,627
Bus Custom Incentives	2,725	3,157	3,578	4,025	4,426	12,906	14,891	16,801	18,698	20,595	8,027	9,329	10,587	11,946	13,206
Bus Schools Program	268	324	372	422	454	719	839	919	938	1,027	110	135	155	174	192
Bus SEM	150	225	298	373	373	832	1,663	2,757	3,589	3,589	141	281	495	635	635
Bus & MF NC	298	364	395	479	493	1,109	1,386	1,530	1,902	2,009	587	725	749	960	939
Bus Direct Install	737	826	908	1,025	1,056	1,977	2,134	2,278	2,399	2,526	648	720	797	925	982
Residential Total:	4,301	4,440	5,872	6,062	5,979	24,134	24,981	25,418	25,795	25,977	3,704	3,938	4,034	4,113	4,175
Business Total:	6,298	7,557	8,669	9,851	10,311	29,851	34,686	39,723	44,060	46,857	17,602	20,873	24,013	29,482	29,581
Portfolio Total:	**10,599**	**11,996**	**14,542**	**15,913**	**16,290**	**53,986**	**59,667**	**65,140**	**69,855**	**72,834**	**21,306**	**24,811**	**28,047**	**33,596**	**33,757**

Cost Effectiveness

With the program savings and budgets, we perform the industry standard cost-effectiveness tests to gauge the economic merits of the portfolio. Each test compares the benefits of the EE programs to their costs – using its own unique perspectives and definitions – all defined in terms of net present value of future cash flows. The definitions for the four standard tests most commonly used in EE program design are described below.

- **Total Resource Cost test (TRC).** The benefits in this test are the lifetime avoided energy costs and avoided capacity costs. The costs in this test are the incremental measure costs plus all administrative costs spent by the program administrator.
- **Utility Cost Test (UCT).** The benefits in this test are the lifetime avoided energy costs and avoided capacity costs, the same as the TRC benefits. The costs in this test are the program administrator's incentive costs and administrative costs.
- **Participant Cost Test (PCT).** The benefits in this test are the lifetime value of retail rate savings (which is another way of saying "lost utility revenues"). The costs in this test are those seen by the participant; in other words: the incremental measure costs minus the value of incentives paid out.
- **Rate Impact Measure test (RIM).** The benefits of the RIM test are the same as the TRC benefits. The RIM costs are the same as the UCT, except for the addition of lost revenue. This test attempts to show the effects that EE programs will have on rates, which is almost always to raise them on a per unit basis. Thus, costs typically outweigh benefits from the point of view of this test, but the assumption is that absolute energy use decreases to a greater extent than per-unit rates are increased — resulting in lower average utility bills.

The cost effectiveness results for the Vectren Recommended Portfolio are shown in Table 8-4, sporting lifetime TRC benefits of $177 million dollars and costs of $92 million dollars for a robust TRC ratio of 1.92.

Table 8-4 Vectren Recommended Action Plan Cost Effectiveness summary

	TRC Ratio	TRC Benefits	TRC Costs	UCT Ratio	PCT Ratio	RIM Ratio
Res Lighting	1.47	$12,729,504	$8,638,583	2.33	7.39	0.44
Res Efficient Products	2.31	$5,767,547	$2,494,058	3.55	11.18	0.51
Res IQW	0.99	$2,475,435	$2,503,149	0.99	-	0.35
Res IQW Plus	0.56	$650,864	$1,166,742	0.56	-	0.35
Res NC	1.02	$453,989	$443,548	1.23	9.82	0.42
Res MF Direct Install	1.47	$383,335	$260,561	1.69	20.72	0.41
Res HEA	1.90	$5,286,017	$2,783,242	1.90	-	0.42
Res School Kit	1.14	$1,165,755	$1,024,230	1.14	-	0.38
Res Whole House Plus	1.07	$8,212,627	$7,653,155	1.85	2.47	0.66
Res Appliance Recycling	1.05	$723,032	$686,727	1.05	-	0.40
Res Behavioral Feedback Tools	1.18	$1,442,788	$1,220,290	1.18	-	0.42
Bus Prescriptive	2.06	$50,575,254	$24,584,518	4.21	3.91	0.83
Bus Custom Incentives	2.52	$70,292,200	$27,918,583	4.87	5.25	0.82
Bus Schools Program	0.69	$2,168,631	$3,155,364	1.46	1.96	0.45
Bus SEM	1.61	$1,821,203	$1,133,881	1.61	-	0.43
Bus & MF NC	2.06	$5,972,921	$2,896,189	3.66	5.04	0.75
Bus Direct Install	1.85	$6,808,569	$3,675,085	1.85	-	0.56
Residential Total:	1.36	$39,290,894	$28,874,285	1.83	8.54	0.47
Business Total:	2.17	$137,638,778	$63,363,620	4.00	4.87	0.78
Portfolio Total:	**1.92**	**$176,929,672**	**$92,237,905**	**3.17**	**5.61**	**0.68**

CHAPTER | 9

CONCLUSIONS AND RECOMMENDATIONS

The results of this study reveal that significant energy efficiency opportunities exist for Vectren in Southern Indiana, despite aggressive appliance and efficiency standards and a challenging macroeconomic environment.

Our program analysis shows that Vectren can achieve Net incremental electric energy savings of 53,986 MWh in 2015, increasing to 72,834 MWh in 2019. This equates to Gross incremental savings of 62,818 MWh in 2015 and 84,809 MWh in 2019, all by implementing the programs and measures presented in this report.

Vectren's energy-efficiency programs are relatively young compared to other programs in the nation, but have made significant impacts already and are building appreciable market momentum. Based on our market potential assessment and program design analysis, EnerNOC provides the following high-level recommendations for the portfolio. We fully expect that Vectren, the stakeholders, and the implementers will consider the plans and recommendations in this report now, at the outset of the forthcoming implementation cycle; and that they will adopt the elements that are appropriate, adjust the elements that fit differently when translated into the trenches and front lines of program delivery, and continue to revisit the report as a reference throughout the next years as situations and markets continue to change and evolve.

General Recommendations

- **Increase focus on non-residential programs:** Our study shows that a large portion of the program savings from energy efficiency efforts will come from the commercial and industrial sectors. Vectren has already begun to shift budget and focus toward the C&I sectors, as evidenced by budgeting trends in 2013 and 2014 as well as the primary market research conducted on large C&I customers as part of this study. Increasing program efforts in the C&I sectors will not only lead to harvesting larger EE savings, but to increased business competitiveness and decreased operating costs for customers. Additionally, these sectors offer larger projects, which can be attained and bundled more readily and efficiently.
- **Continued collaboration among stakeholders:** The discourse and information sharing between stakeholders, utilities, and EnerNOC on this study has been effective and transparent. Continuing this trend is of paramount importance to the future success of programs. It is essential to cultivate a mutual understanding of the dynamic nature of the energy efficiency industry due to its intrinsic linkage with human behavior and the customer mind. Ongoing interactions should be marked by an understanding of collaboration, flexibility, and continuous improvement.
- **Deliver electric and natural gas programs jointly when possible:** Vectren also has a broad array of natural gas energy efficiency programs to help its natural gas customers save on their gas bills. Administrative efficiencies and economies of scale can be reached with dual fuel program offerings in applicable programs like HEA and IQW, where both electric and gas savings can be obtained without creating duplicative, administrative cost structures. Further, Indiana's concept of a statewide Therm Bank provides an excellent platform to deliver joint electric and natural gas programs on a straightforward and highly cost-effective basis. In this paradigm, if it proves feasible and appropriate to management and to stakeholders, Vectren could share costs across its electric and gas programs to extend their reach and effectiveness.

Residential Recommendations

- **Focus on lighting:** The largest share of achievable energy efficiency potential in the residential sector continues to come from CFLs. This is in spite of the forthcoming EISA standards that will reduce their per-unit savings compared to the new baseline. Also, Vectren should focus strong attention on specialty lamps, as they are not affected by the EISA standard, and prepare for the entrance of LED lamps into their programs in the later years of the portfolio.
- **Implement and monitor behavioral feedback programs:** The behavioral modification program to be implemented by OPower is shown in the program plans to comprise a significant amount of Vectren's portfolio savings. This initiative was added at the program design stage, and was not included in our bottom-up, measure level potential analysis. This is due to the fact that it is not a specific action or piece of equipment, per se, as well as the fact that it does not go through the typical customer-adoption model that other measures encounter. The program is simply delivered to as many participants as the planners deem appropriate, and produces a statistically measured energy reduction effect in a treatment group (vs. a control group that does not receive the program treatment). It should be monitored carefully, however, as it is a new and emerging opportunity. Relatively little is known about the specific actions that customers perform to reduce their energy usage in this program, and it may undergo meaningful change in customer responsiveness and evaluation paradigms in the coming years. Additionally, savings under this program will not persist after the program is ended, and must be continually renewed each year with additional cost and effort, whereas the savings from a capital equipment measure can last 10 to 20 years.
- **Develop deeper, follow-on measures in existing programs:** Some current Vectren program delivery structures are pursuing low-cost measures through rapid customer touches with direct-install components only. We have recommended the addition of more deep, involved measures to capitalize on customer touches as much as possible. While you are in the home of a customer, it makes better sense to cross-sell these other measures and harvest as many energy savings as you can. This would include major equipment replacements and shell measures such as duct sealing and insulation.
- **Consider social media avenues for targeted program delivery:** As internet social media paradigms become the norm in today's wired society, companies like Groupon, Amazon Local Deals, and Living Social have assembled a nationwide network of businesses into a well-oiled, rebate-issuing machine. Vectren should consider if there are opportunities to link their energy efficiency trade ally network to one of these companies to facilitate the target marketing, processing, and delivery of rebates. These vendors have sophisticated tracking systems and databases that may facilitate EM&V reporting on the back end as well.

Commercial & Industrial Recommendations

- **Aggressively pursue lighting savings:** The commercial sector in particular has significant savings potential in lighting equipment, both interior and exterior. Notably, LED lamps are showing as cost effective in the commercial sector due to aggressive forecasts of cost reductions, as well as higher hours of operation than their non-economic counterparts in residential settings. Savings are also available through occupancy sensors, timers, and energy management systems. Vectren should strongly pursue lighting savings to accelerate the phase out of T12 fluorescent lighting. In particular, program efforts can help intercept building operators before they make purchase and stocking decisions that could lead to the hoarding of T12 lamps.
- **Focus industrial program efforts on motor controls and system optimizations**: The savings for the industrial sector are all about control and optimization of motors and processes. Low-cost retrofits can often have significant energy impacts with minimal disruption of (and often times improvement of) business processes.

- **Target niches with segment specific programs**: There are specific business segments that offer considerable savings potential, but will not typically be reached by standard rebates and generic business programs. Consider initiating specifically targeted sub-programs within business standard and custom for areas such as: hotels and lodging, food preparation equipment in restaurants, and refrigeration equipment in grocery stores.
- **Implement new programs:** We have identified additional programs that show promise to expand Vectren's portfolio of programs to address Indiana's aggressive statewide savings goals. These programs are as follows:
    1. *Strategic Energy Management*. For large customers, SEM initiatives can deliver substantial savings over long time horizons. This means coming alongside the larger customers to create a customized, multi-year plan, identify metrics, set goals, and provide technical assistance and attention from dedicated account executives or energy coaches.
    2. *Business and Multifamily New Construction*. A program to encourage more rapid adoption of efficient building design practices is a very relevant addition to the Vectren portfolio.

About EnerNOC

EnerNOC's Utility Solutions Consulting team is part of EnerNOC's Utility Solutions, which provides a comprehensive suite of demand-side management (DSM) services to utilities and grid operators worldwide. Hundreds of utilities have leveraged our technology, our people, and our proven processes to make their energy efficiency (EE) and demand response (DR) initiatives a success. Utilities trust EnerNOC to work with them at every stage of the DSM program lifecycle – assessing market potential, designing effective programs, implementing those programs, and measuring program results.

EnerNOC's Utility Solutions deliver value to our utility clients through two separate practice areas – Implementation and Consulting.

- Our Implementation team leverages EnerNOC's deep "behind-the-meter expertise" and world-class technology platform to help utilities create and manage DR and EE programs that deliver reliable and cost-effective energy savings. We focus exclusively on the commercial and industrial (C&I) customer segments, with a track record of successful partnerships that spans more than a decade. Through a focus on high quality, measurable savings, EnerNOC has successfully delivered hundreds of thousands of MWh of energy efficiency for our utility clients, and we have thousands of MW of demand response capacity under management.
- The Consulting team provides expertise and analysis to support a broad range of utility DSM activities, including: potential assessments; end-use forecasts; integrated resource planning; EE, DR, and smart grid pilot and program design and administration; load research; technology assessments and demonstrations; evaluation, measurement and verification; and regulatory support.

The team has decades of combined experience in the utility DSM industry. The staff is comprised of professional electrical, mechanical, chemical, civil, industrial, and environmental engineers as well as economists, business planners, project managers, market researchers, load research professionals, and statisticians. Utilities view EnerNOC's experts as trusted advisors, and we work together collaboratively to make any DSM initiative a success.

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ELECTRIC DEMAND SIDE MANAGEMENT: MARKET POTENTIAL STUDY AND ACTION PLAN

Volume 2: Report

Report Number 1432

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INTRODUCTION

Background

Energy efficiency (EE) efforts are increasing in magnitude and gaining traction in Indiana, building on the momentum of recently established statewide electric energy efficiency targets. Vectren Energy Delivery of Indiana (Vectren) is investigating the electric energy efficiency potential for their service territory. The findings of this investigation will lead directly into the development of a portfolio of energy efficiency programs to be delivered to customers over the time period 2015 to 2019.

Toward this end, Vectren has contracted with EnerNOC Utility Solutions (EnerNOC) to conduct a Market Potential Study and assemble an Action Plan that considers all metered electric customers in the residential, commercial, and industrial sectors for this time period.

EnerNOC conducted a detailed, bottom-up assessment of the Vectren market in the Evansville metropolitan area to deliver forecasts of electric energy use, forecasts of the energy savings achievable through efficiency measures, and program designs and strategies to optimally deliver those savings. This report describes the study approach and results.

Report Organization

This report is presented in 4 volumes as outlined below. This document is **Volume 2: Market Potential and Action Plan Report**.

- Volume 1, Executive Summary
- Volume 2, Market Potential and Action Plan Report
- Volume 3, Detailed Appendices: Market Potential Study
- Volume 4, Detailed Appendices: Action Plan & Program Write-ups

Definitions of Potential

In this study, we estimate the potential for energy efficiency savings. The savings estimates represent net savings[1] developed into three types of potential: technical potential, economic potential, and achievable potential. Technical and economic potential are both theoretical limits to efficiency savings. Achievable potential embodies a set of assumptions about the decisions consumers make regarding the efficiency of the equipment they purchase, the maintenance activities they undertake, the controls they use for energy-consuming equipment, and the elements of building construction. Because estimating achievable potential involves the inherent uncertainty of predicting human behaviors and responses to market conditions, we developed low and high achievable potential as boundaries for a likely range. The various levels are described below.

- **Technical potential** is defined as the theoretical upper limit of energy efficiency potential. It assumes that customers adopt all feasible measures regardless of their cost. At the time of existing equipment failure, customers replace their equipment with the most efficient option available. In new construction, customers and developers also choose the most efficient

[1] Savings in "net" terms instead of "gross" means that the baseline forecast includes naturally occurring efficiency. In other words, the baseline assumes that natural early adopters continue to make purchases of equipment and measures at efficiency levels higher than the minimum standard.

equipment option. Examples of measures that make up technical potential for electricity in the residential sector include:

- o Ductless mini-split air conditioners with variable refrigerant flow
- o Ground source (or geothermal) heat pumps
- o LED lighting

Technical potential also assumes the adoption of every other available measure, where applicable. For example, it includes installation of high-efficiency windows in all new construction opportunities and furnace maintenance in all existing buildings with furnace systems. These retrofit measures are phased in over a number of years, which is longer for higher-cost and complex measures.

- **Economic potential** represents the adoption of all ***cost-effective*** energy efficiency measures. In this analysis, the cost effectiveness is measured by the total resource cost (TRC) test, which compares lifetime energy and capacity benefits to the incremental cost of the measure. If the benefits outweigh the costs (that is, if the TRC ratio is greater than 1.0), a given measure is considered in the economic potential. Customers are then assumed to purchase the most cost-effective option applicable to them at any decision juncture.
- **Achievable High potential** estimates customer adoption of economic measures when delivered through efficiency programs under ideal market, implementation, and customer preference conditions. Information channels are assumed to be established and efficient for marketing, educating consumers, and coordinating with trade allies and delivery partners. Achievable High potential establishes a maximum target for the EE savings that an administrator can hope to achieve through its EE programs and involves incentives that represent a substantial portion of the incremental cost combined with high administrative and marketing costs.
- **Achievable Low potential** reflects expected program participation given significant barriers to customer acceptance, non-ideal implementation conditions, and limited program budgets. This represents a lower bound on achievable potential.

Abbreviations and Acronyms

Throughout the report we use several abbreviations and acronyms. Table 1-1 shows the abbreviation or acronym, along with an explanation.

Table 1-1 Explanation of Abbreviations and Acronyms

Acronym	Explanation
ACS	American Community Survey
AEO	Annual Energy Outlook forecast developed annual by the Energy Information Administration of the DOE
AHAM	Association of Home Appliance Manufacturers
B/C Ratio	Benefit to cost ratio
BEST	EnerNOC's Building Energy Simulation Tool
CAC	Central air conditioning
C&I	Commercial and industrial
CFL	Compact fluorescent lamp
DEEM	EnerNOC's Database of Energy Efficiency Measures
DEER	State of California Database for Energy-Efficient Resources
DSM	Demand side management
DR	Demand response
EE	Energy efficiency
EIA	Energy Information Administration
EISA	Energy Efficiency and Security Act of 2007
EPACT	Energy Policy Act of 2005
EPRI	Electric Power Research Institute
EUEA	Efficient Use of Energy Act
EUI	Energy-use index
HH	Household
HID	High intensity discharge lamps
HPWH	Heat pump water heater
IURC	Indiana Utility Regulatory Commission
LED	Light emitting diode lamp
LoadMAP	EnerNOC's Load Management Analysis and Planning™ tool
OUCC	Indiana Office of Utility Consumer Counselor
NWPCC	Northwest Power and Conservation Council
RTU	Roof top unit
Sq. ft.	Square feet
TRC	Total resource cost
UEC	Unit energy consumption

ANALYSIS APPROACH AND DATA DEVELOPMENT

This section describes the analysis approach taken for the study and the data sources used to develop the potential estimates.

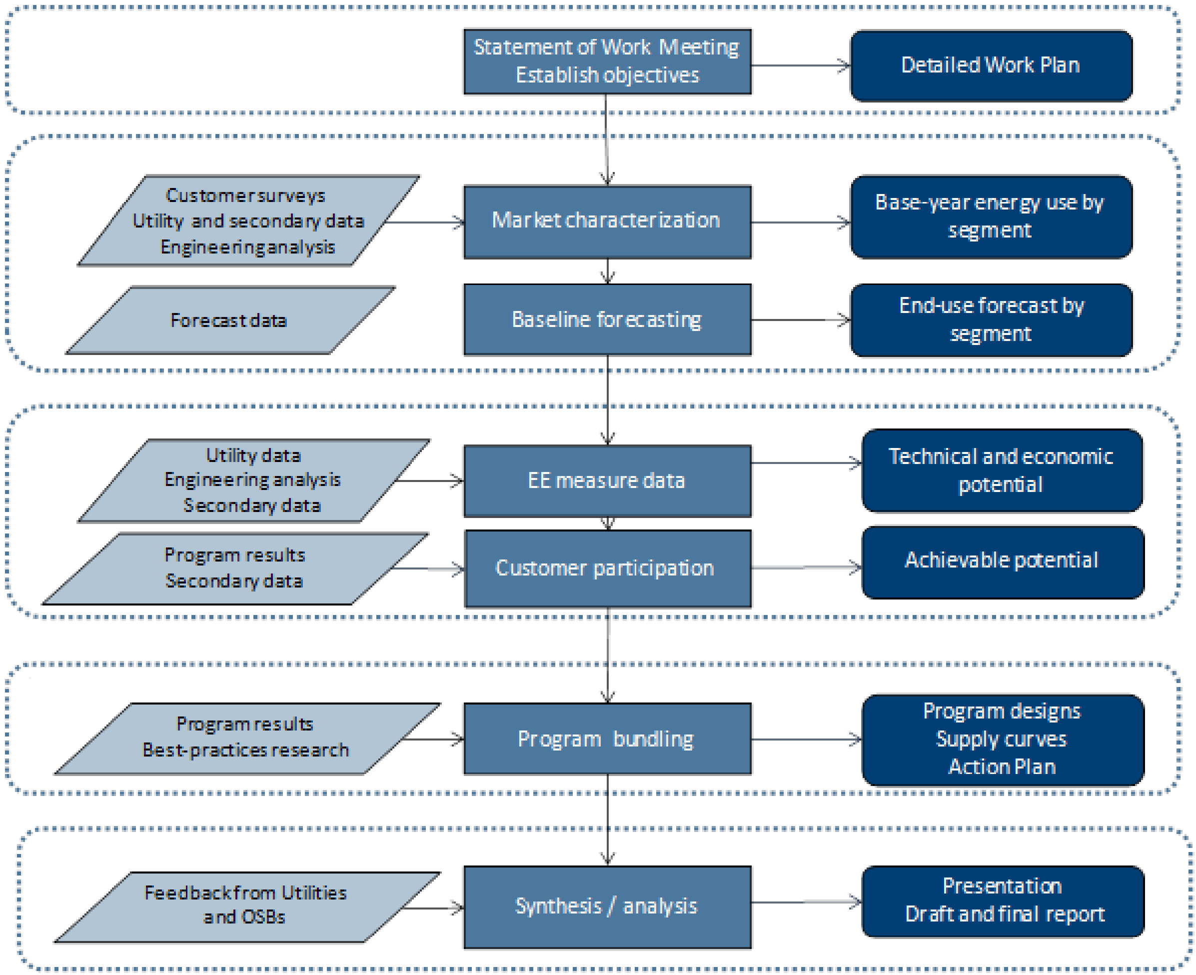
Analysis Approach

To perform the energy efficiency analysis, EnerNOC used a bottom-up analysis approach as shown in Figure 2-1. This involved the following steps.

1. Held a meeting with the client project team to refine the objectives of the project in detail. This resulted in a work plan for the study.
2. Conducted onsite energy consumption surveys with 30 of Vectren's largest commercial and industrial customers in order to provide data and guidance for these market sectors that had not formerly received focused DSM program efforts.
3. Performed a market characterization to describe sector-level electricity use for the residential, commercial, and industrial sectors for the base year, 2011. This included using existing information contained in prior Vectren and Indiana studies, new information from the aforementioned onsite surveys with large customers, EnerNOC's own databases and tools, and other secondary data sources such as the American Community Survey (ACS) and the Energy Information Administration (EIA).
4. Developed a baseline electricity forecast by sector, segment, and end use for 2011 through 2023. Results presented in this volume focus on the upcoming implementation years of 2015 through 2019. Results beyond 2019 are available in the Appendices.
5. Identified several hundred measures and estimated their effects in four tiers of measure-level energy efficiency potential: *Technical, Economic, Achievable High,* and *Achievable Low*.
6. Reviewed the current programs offered by Vectren in light of the study findings to make strategic program recommendations for achieving savings.
7. Created detailed program designs and action plans through 2019 representing the program potential for Vectren, basing them on the potential analysis and strategic recommendations developed in the previous steps.

The analysis approach for all these steps is described in further detail throughout the remainder of this chapter.

Figure 2-1 Overview of Analysis Approach



LoadMAP Model

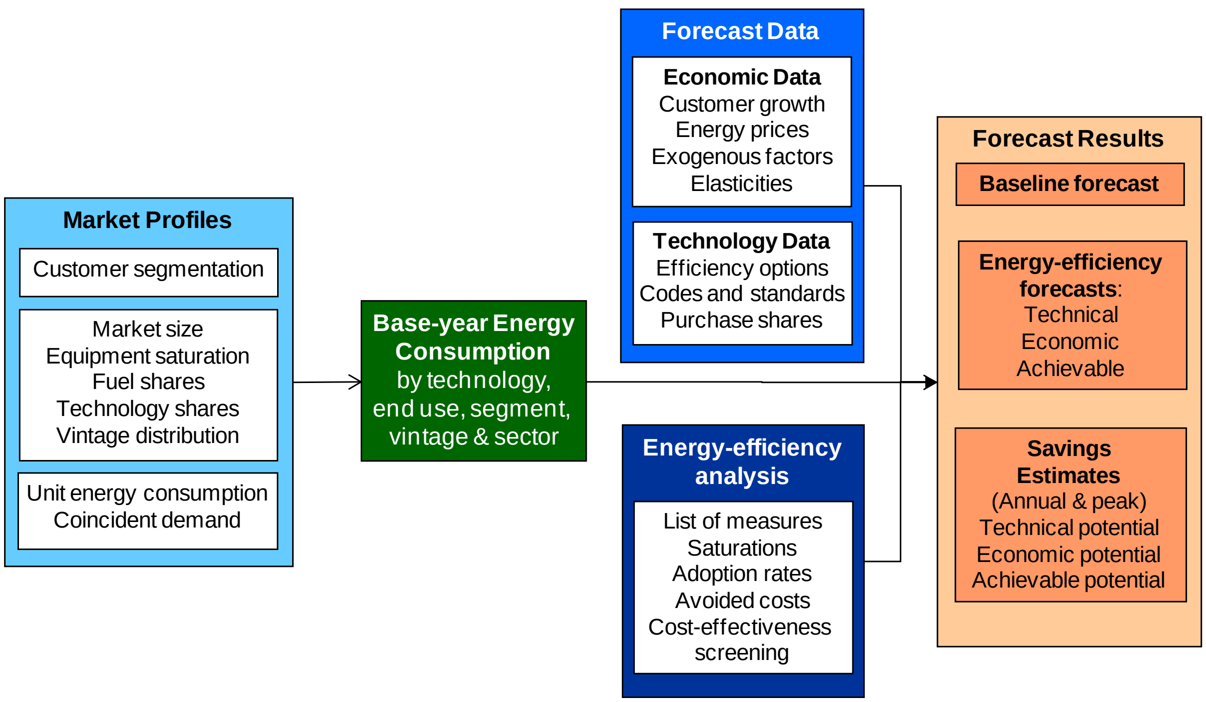
We used EnerNOC's Load Management Analysis and Planning tool (LoadMAP™) version 3.0 to develop both the baseline forecast and the estimates of energy efficiency potential. EnerNOC developed LoadMAP in 2007 and has enhanced it over time, using it for the EPRI National Potential Study and numerous utility-specific forecasting and potential studies. Built in Excel, the LoadMAP framework (see Figure 2-1) is both accessible and transparent and has the following key features.

- Embodies the basic principles of rigorous end-use models (such as EPRI's REEPS and COMMEND) but in a more simplified, accessible form.
- Includes stock-accounting algorithms that treat older, less efficient appliance/equipment stock separately from newer, more efficient equipment. Equipment is replaced according to the measure life and appliance vintage distributions defined by the user.
- Balances the competing needs of simplicity and robustness by incorporating important modeling details related to equipment saturations, efficiencies, vintage, and the like, where market data are available, and treats end uses separately to account for varying importance and availability of data resources.
- Isolates new construction from existing equipment and buildings and treats purchase decisions for new construction and existing buildings separately.

- Uses a simple logic for appliance and equipment decisions. Other models available for this purpose embody complex decision choice algorithms or diffusion assumptions, and the model parameters tend to be difficult to estimate or observe and sometimes produce anomalous results that require calibration or even overriding. The LoadMAP approach allows the user to drive the appliance and equipment choices year by year directly in the model. This flexible approach allows users to import the results from diffusion models or to input individual assumptions. The framework also facilitates sensitivity analysis.
- Includes appliance and equipment models customized by end use. For example, the logic for lighting is distinct from refrigerators and freezers.
- Can accommodate various levels of segmentation. Analysis can be performed at the sector level (e.g., total residential) or for customized segments within sectors (e.g., housing type or income level).

Consistent with the segmentation scheme and the market profiles we describe below, the LoadMAP model provides forecasts of baseline energy use by sector, segment, end use, and technology for existing and new buildings. It also provides forecasts of total energy use and energy-efficiency savings associated with the four types of potential.[2]

Figure 2-2 LoadMAP Analysis Framework



Market Characterization

In order to estimate the savings potential from energy-efficient measures, it is necessary to understand how much energy is used today and what equipment is currently being used. This characterization begins with a segmentation of Vectren's energy footprint to quantify energy use by sector, segment, fuel, end-use application, and the current set of technologies used. We incorporate information from the secondary research sources to advise the market characterization.

[2] The model computes energy and peak-demand forecasts for each type of potential for each end use as an intermediate calculation. Annual-energy and peak-demand savings are calculated as the difference between the value in the baseline forecast and the value in the potential forecast (e.g., the technical potential forecast).

Segmentation for Modeling Purposes

The market assessment first defined the market segments (building types, end uses and other dimensions) that are relevant in the Vectren service territory. The segmentation scheme for this project is presented in Table 2-1.

Table 2-1 Overview of Segmentation Scheme for Potentials Modeling

Market Dimension	Segmentation Variable	Dimension Examples
1	Sector	Residential, commercial, industrial
2	Building type	Residential (single family, multi family) Commercial (office, restaurant, retail, etc.) Industrial (plastics, chemicals, transportation , and other)
3	Vintage	Existing and new construction
4	Fuel	Electricity
5	End uses	Cooling, lighting, water heat, motors, etc. (as appropriate by sector)
6	Appliances/end uses and technologies	Technologies such as lamp type, air conditioning equipment, motors by application, etc.
7	Equipment efficiency levels for new purchases	Baseline and higher-efficiency options as appropriate for each technology

Following this scheme, the residential sector was segmented as described below, starting with customer segments by building type:

- Single family
- Multi family

In addition to segmentation by housing type, we identified the set of end uses and technologies that are appropriate for Vectren. These are shown in Table 2-2 and Table 2-3

Table 2-2 Residential Electric End Uses and Technologies

End Use	Technology
Cooling	Central Air Conditioning (CAC)
Cooling	Room Air Conditioning (RAC)
Cooling/Heating	Air-Source Heat Pump
Cooling/Heating	Geothermal Heat Pump
Space Heating	Electric Resistance
Space Heating	Electric Furnace
Water Heating	Water Heater <= 55 gal
Water Heating	Water Heater > 55 gal
Interior Lighting	Screw-in Lamps
Interior Lighting	Linear Fluorescent Lamps
Interior Lighting	Specialty
Exterior Lighting	Screw-in Lamps
Appliances	Clothes Washer
Appliances	Clothes Dryer
Appliances	Dishwasher
Appliances	Refrigerator
Appliances	Freezer
Appliances	Second Refrigerator
Appliances	Stove
Appliances	Microwaves
Electronics	Personal Computers
Electronics	Monitor
Electronics	Laptops
Electronics	TVs
Electronics	Printer/Fax/Copier
Electronics	Set-top Boxes/DVR
Electronics	Devices and Gadgets
Miscellaneous	Pool Pump
Miscellaneous	Pool Heater
Miscellaneous	Hot Tub / Spa
Miscellaneous	Well Pump
Miscellaneous	Furnace Fan
Miscellaneous	Miscellaneous

For the commercial sector, it is useful to analyze the segments based on the unique characteristics of the building type. For this study, we used the following segments.

- Small Office—all types of offices, including medical/dental offices
- Large Office—all types of offices, including large government facilities
- Restaurant—fast-food, sit-down and cafeteria-style restaurants
- Retail—retail establishments such as small boutiques, and large box retailers
- Grocery—convenience stores, small markets, and supermarkets
- College—colleges, universities and technical colleges
- School—primary and secondary schools
- Health—hospitals and nursing homes
- Lodging—motels, hotels, resorts and small inns
- Warehouse—storage facilities, refrigerated and unrefrigerated

- Miscellaneous—all remaining building types, such as police stations, parking garages, public assembly, amusement parks, etc.
- Traffic Signals—encompasses traffic lights and crosswalk lights.

In addition to segmentation by building type, we identified the set of end uses and technologies that are appropriate for Vectren. Table 2-3 lists the end uses and technologies used in this study.

Table 2-3 Commercial Electric End Uses and Technologies

End Use	Technology
Cooling	Air-Cooled Chiller
Cooling	Water-Cooled Chiller
Cooling	Roof top AC
Cooling	Other Cooling
Cooling/Heating	Air-Source Heat Pump
Cooling/Heating	Geothermal Heat Pump
Heating	Electric Room Heat
Heating	Electric Furnace
Ventilation	Ventilation
Water Heating	Water Heater
Interior Lighting	Screw-in
Interior Lighting	High-Bay Fixtures
Interior Lighting	Linear Fluorescent
Exterior Lighting	Screw-in
Exterior Lighting	HID
Exterior Lighting	Linear Fluorescent
Exterior Lighting	Traffic Lights
Exterior Lighting	Crosswalk Lights
Refrigeration	Walk-in Refrigerator
Refrigeration	Reach-in Refrigerator
Refrigeration	Glass Door Display
Refrigeration	Open Display Case
Refrigeration	Icemaker
Refrigeration	Vending Machine
Food Preparation	Oven
Food Preparation	Fryer
Food Preparation	Dishwasher
Food Preparation	Hot Food Container
Office Equipment	Desktop Computer
Office Equipment	Laptop
Office Equipment	Server
Office Equipment	Monitor
Office Equipment	Printer/Copier/Fax
Office Equipment	POS Terminal
Miscellaneous	Non-HVAC Motors
Miscellaneous	Pool Pump
Miscellaneous	Pool Heater
Miscellaneous	Miscellaneous

For the industrial sector, the study isolated the top three industries in Vectren by energy consumption, which accounted for 71% of the total 2011 industrial load. The remaining group of industrial customers is considered in aggregate as “other industrial.” While the commercial sector has a relatively small set of building types that have relatively uniform characteristics, the sheer number of unique industry types makes it infeasible to perform a deep dive into all but the largest ones. This results in a larger "other" or "miscellaneous" segment than that which exists in the commercial sector. Nonetheless, these "other" industries typically have energy use characteristics that are similar enough to perform an accurate potential assessment.

The resulting segmentation is as follows:

- Chemical
- Plastics
- Transportation
- Other Industrial

In addition to segmentation by industry, we identified the set of end uses and technologies that are appropriate for Vectren. These are shown in Table 2-4.

Table 2-4 Industrial Electric End Uses and Technologies

End Use	Technology
Cooling	Air-Cooled Chiller
Cooling	Water-Cooled Chiller
Cooling	Roof top AC
Cooling	Other Cooling
Cooling/Heating	Air-Source Heat Pump
Cooling/Heating	Geothermal Heat Pump
Heating	Electric Room Heat
Heating	Electric Furnace
Ventilation	Ventilation
Interior Lighting	Screw-in
Interior Lighting	High-Bay Fixtures
Interior Lighting	Linear Fluorescent
Exterior Lighting	Screw-in
Exterior Lighting	HID
Exterior Lighting	Linear Fluorescent
Motors	Pumps
Motors	Fans & Blowers
Motors	Compressed Air
Motors	Material Handling
Motors	Material Processing
Motors	Other Motors
Process	Process Heating
Process	Process Cooling and Refrigeration
Process	Electro-Chemical Processes
Process	Other Process
Miscellaneous	Miscellaneous

With the segmentation scheme defined, we then performed a high-level market characterization of electricity sales in the base year to allocate sales to each customer segment. We used various data sources to identify the annual sales in each customer segment, as well as the market size for each segment. This information provided control totals at a sector level for calibrating the LoadMAP model to known data for the base-year.

Market Profiles

The next step was to develop market profiles for each sector, customer segment, end use, and technology. A market profile includes the following elements:

- **Market size** is a representation of the number of customers in the segment. For the residential sector, it is number of households. In the commercial sector, it is floor space measured in square feet. For the industrial sector, it is number of employees.
- **Saturations** define the fraction of homes and square feet with the various technologies. (e.g., homes with electric space heating).
- **UEC (unit energy consumption) or EUI (energy-use index)** describes the amount of energy consumed in 2011 by a specific technology in buildings that have the technology. For electricity, UECs are expressed in kWh/household for the residential sector, and EUIs are expressed in kWh/square foot or kWh/employee for the commercial and industrial sectors, respectively.
- **Intensity** for the residential sector represents the average energy use for the technology across all homes in 2011. It is computed as the product of the saturation and the UEC and is defined as kWh/household for electricity. For the commercial and industrial sectors, intensity, computed as the product of the saturation and the EUI, represents the average use for the technology across all floor space or all employees in 2011.
- **Usage** is the annual energy use by an end use technology in the segment. It is the product of the market size and intensity and is quantified in GWh. The market assessment results and the market profiles are presented in Chapter 3.

Baseline Forecast

The next step was to develop the baseline forecast of annual electricity usage for 2011 through 2017 by customer segment and end use without new utility programs or naturally occurring efficiency. The end-use forecast does include the relatively certain impacts of codes and standards that will unfold over the study timeframe. All such mandates that were defined as of January 2012 are included in the baseline. The baseline forecast is the foundation for the analysis of savings from future EE efforts as well as the metric against which potential savings are measured.

Inputs to the baseline forecast include:

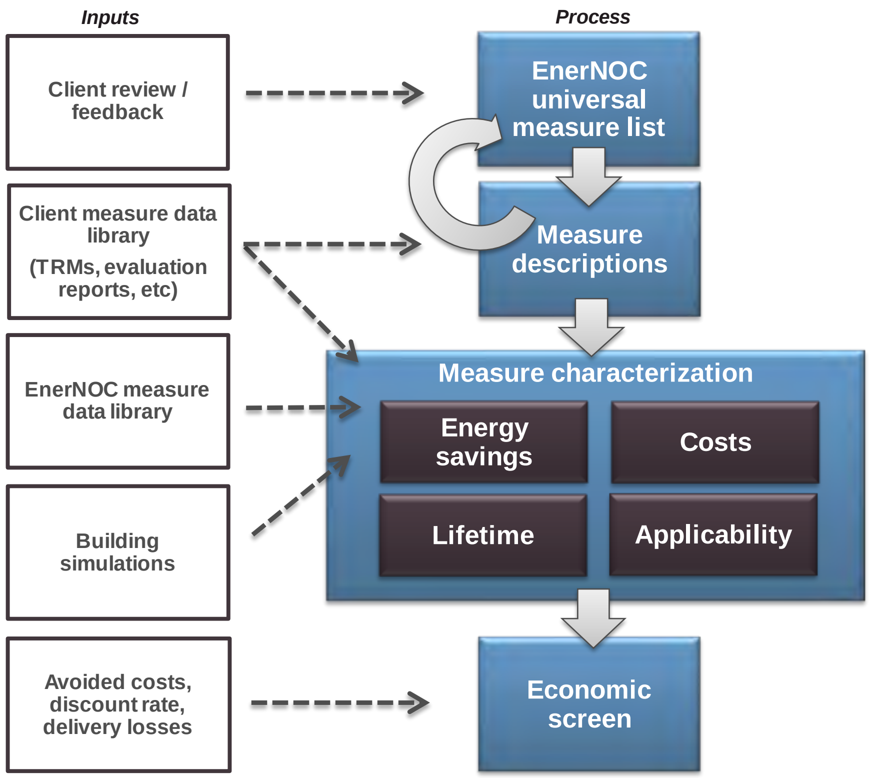
- Current economic growth forecasts (i.e., customer growth, income growth)
- Electricity price forecasts
- Trends in fuel shares and equipment saturations
- Existing and approved changes to building codes and equipment standards

We present the results of the baseline forecast development in Chapter 4.

Energy Efficiency Measure Analysis

This section describes the framework used to assess the savings, costs, and other attributes of energy-efficiency measures. These characteristics form the basis for measure-level cost-effectiveness analyses as well as for determining measure-level savings. For all measures, EnerNOC assembled information to reflect equipment performance, incremental costs, and equipment lifetimes. We used this information, along with Vectren's avoided costs data, in the economic screen to determine economically feasible measures. Figure 2-3 outlines the framework for measure analysis.

Figure 2-3 Approach for Measure Assessment



The framework for assessing savings, costs, and other attributes of energy efficiency measures involves identifying the list of energy efficiency measures to include in the analysis, determining their applicability to each market sector and segment, fully characterizing each measure, and performing cost-effectiveness screening.

We compiled a robust list of energy efficiency measures for each customer sector, drawing upon the Vectren program experience and protocols, EnerNOC's own measure databases and building simulation models, and secondary sources. This universal list of EE measures covers all major types of end-use equipment, as well as devices and actions to reduce energy consumption. If considered today, some of these measures would not pass the economic screens initially, but may pass in future years as a result of lower projected equipment costs or higher avoided costs.

The selected measures are categorized into two types according to the LoadMAP taxonomy: equipment measures and non-equipment measures.

- **Equipment measures** are efficient energy-consuming pieces of equipment that save energy by providing the same service with a lower energy requirement than a standard unit. An example is an ENERGY STAR refrigerator that replaces a standard efficiency refrigerator. For equipment measures, many efficiency levels may be available for a given technology, ranging from the baseline unit (often determined by code or standard) up to the most efficient product commercially available. For instance, in the case of central air conditioners, this list begins with the current federal standard SEER 13 unit and spans a broad spectrum up to a maximum efficiency of a SEER 21 unit.
- **Non-equipment measures** save energy by reducing the need for delivered energy, but do not involve replacement or purchase of major end-use equipment (such as a refrigerator or air conditioner). An example would be a programmable thermostat that is pre-set to run heating and cooling systems only when people are home. Non-equipment measures can apply to more than one end use. For instance, addition of wall insulation will affect the

energy use of both space heating and cooling. Non-equipment measures typically fall into one of the following categories:

- o Building shell (windows, insulation, roofing material)
- o Equipment controls (thermostat, energy management system)
- o Equipment maintenance (cleaning filters, changing setpoints)
- o Whole-building design (building orientation, passive solar lighting)
- o Lighting retrofits (included as a non-equipment measure because retrofits are performed prior to the equipment's normal end of life)
- o Displacement measures (ceiling fan to reduce use of central air conditioners)
- o Commissioning and retrocommissioning

We developed a preliminary list of EE measures, which was distributed to Vectren for review. The list was finalized after incorporating comments, and can be found in Chapter 5 of this report.

Once we assembled the list of EE measures, the project team assessed their energy-saving characteristics. For each measure we also characterized incremental cost, service life, and other performance factors. Following the measure characterization, we performed an economic screening of each measure, which serves as the basis for developing the economic and achievable potential.

Representative Measure Data Inputs

To provide an example of the measure data, Table 2-5 and Table 2-6 present examples of the detailed data inputs behind both equipment and non-equipment measures, respectively, for the case of residential CAC in single-family homes. Table 2-5 displays the various efficiency levels available as equipment measures, as well as the corresponding useful life, energy usage, and cost estimates. The columns labeled On Market and Off Market reflect equipment availability due to codes and standards or the entry of new products to the market.

Table 2-5 Example Equipment Measures for Central Air Conditioning – Single Family Home

Efficiency Level	Useful Life	Equipment Cost	Energy Usage(kWh/yr)	On Market	Off Market
SEER 13	15	$ 2,778	2,841	2011	n/a
SEER 14 (ENERGY STAR)	15	$ 3,205	2,605	2011	n/a
SEER 15 (CEE Tier 2)	15	$ 3,846	2,507	2011	n/a
SEER 16 (CEE Tier 3)	15	$ 3,900	2,424	2011	n/a
SEER 17 (Ductless Mini-split)	15	$ 6,544	2,353	2011	n/a
SEER 21	15	$ 6,410	1,905	2011	n/a

Table 2-6 lists some of the non-equipment measures applicable to CAC in an existing single-family home. All measures are evaluated for cost effectiveness based on the lifetime benefits relative to the cost of the measure. The total savings and costs are calculated for each year of the study and depend on the base year saturation of the measure, the applicability[3] of the measure, and the savings as a percentage of the relevant energy end uses.

[3] The applicability factors take into account whether the measure is applicable to a particular building type and whether it is feasible to install the measure. For instance, attic fans are not applicable to homes where there is insufficient space in the attic or there is no attic at all.

Table 2-6 Example Non-Equipment Measures – Single Family Home, Existing

End Use	Measure	Saturation in 2011[4]	Applica-bility	Lifetime (yrs)	Measure Installed Cost	Energy Savings (%)
Cooling	Central AC - Maintenance	15%	100%	2	$175	10.1%
Cooling	Repair and Sealing – Ducting	12%	50%	18	$500	11.0%
Cooling	Insulation - Ceiling	16%	38%	20	$375	4.0%
Cooling	Windows – Install Reflective Film	5%	45%	10	$1025	33.3%
Cooling	Windows - ENERGY STAR	24%	90%	20	$7200	32.0%
Cooling	Thermostat - Clock/Programmable	46%	56%	5	$30	9.7%

Screening Measures for Cost-Effectiveness

Only measures that are cost-effective are included in economic and achievable potential. Therefore, for each individual measure, LoadMAP performs an economic screen. This study uses the TRC test that compares the lifetime energy benefits (and peak demand for electricity) of each applicable measure with its incremental installed cost, including material and labor. There is no program administration cost considered in this analysis, and therefore, no specific program delivery methods or mechanisms are assumed. The lifetime benefits are calculated by multiplying the annual energy and demand savings for each measure by all appropriate avoided costs for each year, and discounting the dollar savings to the present value equivalent. The analysis uses each measure's values for savings, costs, and lifetimes that were developed as part of the measure characterization process described above.

The LoadMAP model performs this screening dynamically, taking into account changing savings and cost data over time. Thus, some measures pass the economic screen for some — but not all — of the years in the forecast.

It is important to note the following about the economic screen:

- The economic evaluation of every measure in the screen is conducted relative to a baseline condition. For instance, in order to determine the kilowatt-hour (kWh) savings potential of a measure, kWh consumption with the measure applied must be compared to the kWh consumption of a baseline condition.
- The economic screening was conducted only for measures that are applicable to each building type and vintage; thus if a measure is deemed to be irrelevant to a particular building type and vintage, it is excluded from the respective economic screen.

Table 2-7 shows the results of the economic screen, highlighting the economic unit for a central air-source heat pump and select other measures. In 2014, the federal minimum standard efficiency for heat pumps changes from SEER 13 to SEER 14. Before this change, the cost is prohibitive to improve from a SEER 13 baseline. After 2014, however, the incremental cost to go from a SEER 14 to a SEER 15 is proportionally less, thereby making this measure cost-effective. For pool heaters, a heat pump unit is cost effective in all years. For refrigerators, the AHAM federal efficiency standards cause existing Energy Star units to become obsolete in 2014. Units compliant with AHAM 2014 thus become the new minimum efficiency baseline. Since there is not a more efficient, cost-effective unit available, they become both the baseline unit and the economic unit by default. If the measure passes the screen (has a B/C ratio greater than or equal to 1), the measure is included in economic potential. Otherwise, it is screened out for that

[4] Note that saturation levels reflected for the base year change over time as more measures are adopted.

year. If multiple equipment measures have B/C ratios greater than or equal to 1.0, the most efficient technology is selected by the economic screen.

Table 2-7 Economic Screen Results for Selected Residential Equipment Measures

Technology	2013	2014	2015	2016	2017	2018	2019
Air Source Heat Pump	SEER 13	SEER 13	SEER 15	SEER 15	SEER 15	SEER 15	SEER 15
Pool Heater	Heat Pump (COP = 5.0)	Heat Pump (COP = 5.0)	Heat Pump (COP = 5.0)	Heat Pump (COP = 5.0)	Heat Pump (COP = 5.0)	Heat Pump (COP = 5.0)	Heat Pump (COP = 5.0)
Refrigerator	Energy Star	AHAM (2014)	AHAM (2014)	AHAM (2014)	AHAM (2014)	AHAM (2014)	AHAM (2014)

Energy-Efficiency Potential

The approach we used for this study adheres to the approaches and conventions outlined in the National Action Plan for Energy-Efficiency (NAPEE) Guide for Conducting Potential Studies (November 2007).[5] The NAPEE Guide represents the most credible and comprehensive industry practice for specifying energy-efficiency potential. As described in Chapter 1, four types of potentials were developed as part of this effort: Technical potential, Economic potential, Achievable High potential and Achievable Low potential.

The calculation of Technical and Economic potential is a straightforward algorithm. To develop estimates for **Achievable potential**, we develop market adoption rates for each measure that specify the percentage of customers that will select the highest–efficiency economic option. The Achievable High adoption rates are based on the ramp rates from the Northwest Power & Conservation Council's Sixth Plan as a starting point. The NWPCC has been running programs in the Pacific Northwest for many years, and the portfolio of programs reflects a similar profile of market maturity. The ramp rates are then adjusted downward by 10% to account for a generally younger program history and then adjusted specifically as needed based on information from program evaluations. The Achievable Low adoption rates start with the Achievable High rates and decrement them by 40% to 60% based on where measures lie in the time horizon of the study or whether they are already familiar inclusions in existing programs. Finally, reasonableness checks are applied by comparing the adoption rates to those from other relevant potential studies and market research.

The overall energy efficiency potential results are available in Chapter 6, and the results by sector are given in Chapter 7.

Program Action Plan

We then developed energy efficiency action plans where we map the cost effective measures into a specific set of programs. We describe the programs in terms of costs, savings, strategy, and delivery mechanism. Incentive strategies are set and quantified in terms of the appropriate portion of incremental measure costs. In turn, the various program costs (implementation, marketing & education, evaluation, and administration) are added to the incentive budget using best practice research, industry benchmarks, and market trends.

We first created a separate Vectren portfolio action plan that corresponded with both of the measure-level potential estimates: Achievable Low and Achievable High. Then, considering the Indiana state goals, industry benchmarks, and feedback from Vectren and stakeholders, we made a set of recommendations between those two guideposts to ultimately arrive at the recommended portfolio of programs. The resulting action plan is described in detail in Chapter 8, with supporting documentation and a deep-dive into each program in the Volume 4 appendix.

[5] National Action Plan for Energy Efficiency (2007). *National Action Plan for Energy Efficiency Vision for 2025: Developing a Framework for Change*. www.epa.gov/eeactionplan.

Conclusions and Recommendations

In this final step, we review the action plan and potential estimates from a high level to develop a set of overarching conclusions and recommendations to guide program efforts toward optimal attainment of the energy efficiency savings. This is presented in Chapter 9.

Data Development

This section details the data sources used in this study, followed by a discussion of how these sources were applied. In general, data were adapted to local conditions, for example, by using local sources for measure data and local weather for building simulations.

Data Sources

The data sources are organized into the following categories:

- Vectren and Indiana-specific data
- EnerNOC's databases and analysis tools
- Other secondary data and reports

Indiana Data

Our highest priority data sources for this study were those that were specific to Vectren.

- **Vectren customer data:** Vectren provided number of customers and total electric usage by sector from the customer billing database. Vectren also had a recent residential and commercial saturation survey that was leveraged heavily. Finally, primary onsite research was conducted with 30 of Vectren's largest C&I customers to obtain energy usage characteristics in this segment that had not been covered as well by prior market research efforts.
- **Vectren program implementation and evaluation data**: Program reports that outline the details of energy efficiency programs, program goals and achievements to date.
- **Residential Energy Consumption Survey (RECS).** In the most recent RECS survey conducted by the U.S. DOE, Indiana data was combined with Ohio data in a sample indicative of the two Midwest states. We used these data extensively to develop residential market profiles as described below. http://www.eia.gov/consumption/residential/data/2009/
- **Commercial Buildings Energy Consumption Survey (CBECS).** We used state and regional data extensively to develop commercial market profiles.
- **Manufacturing Energy Consumption Survey (MECS).** We used state and regional data extensively to develop industrial market profiles.
- **American Community Survey:** The US Census American Community Survey is an ongoing survey that provides data every year on household characteristics. Data for Vectren were available for this study. http://www.census.gov/acs/www/
- **Indiana Weather Data:** Weather from NOAA's National Climatic Data Center for Indiana was used as the basis for building simulations.

EnerNOC Databases, Analysis Tools, and Reports

EnerNOC maintains several databases and modeling tools that we use for forecasting and potential studies.

- **EnerNOC Energy Market Profiles**: For more than 10 years, EnerNOC staff have maintained profiles of end-use consumption for the residential, commercial, and industrial sectors. These profiles include market size, fuel shares, unit consumption estimates, and annual energy use by fuel (electricity and natural gas), customer segment and end use for 10 regions in the U.S. The Energy Information Administration surveys (RECS, CBECS and MECS) as well as state-level statistics and local customer research provide the foundation for these regional profiles.

- **Building Energy Simulation Tool (BEST)**. EnerNOC's BEST is a derivative of the DOE 2.2 building simulation model, used to estimate base-year UECs and EUIs, as well as measure savings for the HVAC-related measures.
- **EnerNOC's EnergyShape™:** This database of load shapes includes the following: Residential – electric load shapes for 10 regions, 3 housing types, 13 end uses; Commercial – electric load shapes for 9 regions, 54 building types, 10 end uses; Industrial – electric load shapes, whole facility only, 19 2-digit SIC codes, as well as various 3-digit and 4-digit SIC codes
- **EnerNOC's Database of Energy Efficiency Measures (DEEM):** EnerNOC maintains an extensive database of measure data for our studies. Our database draws upon reliable sources including the California Database for Energy Efficient Resources (DEER), the EIA Technology Forecast Updates – Residential and Commercial Building Technologies – Reference Case, RS Means cost data, and Grainger Catalog Cost data**.**
- **Recent studies**. EnerNOC has conducted numerous studies of EE potential in the last five years. We checked our input assumptions and analysis results against the results from these other studies, which include Indianapolis Power & Light, Tennessee Valley Authority, Ameren Illinois, Ameren Missouri, Los Angeles Department of Water and Power, Consolidated Edison of New York, Avista Utilities, the State of New Mexico, and Seattle City Light. In addition, we used the information about impacts of building codes and appliance standards from a recent report for the Institute for Energy Efficiency.[6]

Other Secondary Data and Reports

Finally, a variety of secondary data sources and reports were used for this study. The main sources are identified below.

- **Indiana and regional data from past EnerNOC projects:** EnerNOC referenced data from our project with MISO, as well as regional data from similar studies for Indianapolis Power & Light, Ameren Illinois, and Ameren Missouri.
- **California Statewide Surveys**. The Residential Appliance Saturation Survey (RASS) and the Commercial End Use Survey (CEUS) are comprehensive market research studies conducted by the California Energy Commission. These databases provide a wealth of information on appliance use in homes and businesses. RASS is based on information from almost 25,000 homes and CEUS is based on information from a stratified random sample of almost 3,000 businesses in California.
- **Annual Energy Outlook**. The Annual Energy Outlook (AEO), conducted each year by the U.S. Energy Information Administration (EIA), presents yearly projections and analysis of energy topics. For this study, we used data from the 2011 AEO.
- **Electric Power Research Institute – Assessment of Achievable Potential from Energy Efficiency and Demand Response Programs in the U.S.**, also known as the EPRI National Potential Study (2009). In 2009, EPRI hired EnerNOC to conduct an assessment of the national potential for energy efficiency, with estimates derived for the four DOE regions.
- **EPRI End-Use Models (REEPS and COMMEND)**. These models provide the elasticities we apply to electricity prices, household income, home size and heating and cooling.

[6] "Assessment of Electricity Savings in the U.S. Achievable through New Appliance/Equipment Efficiency Standards and Building Efficiency Codes (2010 – 2025)." Global Energy Partners, LLC for the Institute for Electric Efficiency, May 2011. http://www.edisonfoundation.net/iee/reports/IEE_CodesandStandardsAssessment_2010-2025_UPDATE.pdf

- **Database for Energy Efficient Resources (DEER).** The California Energy Commission and California Public Utilities Commission (CPUC) sponsor this database, which is designed to provide well-documented estimates of energy and peak demand savings values, measure costs, and effective useful life (EUL) for the state of California. We used the DEER database to cross check the measure savings we developed using BEST and DEEM.
- **Northwest Power and Conservation Council Sixth Plan workbooks.** To develop its Power Plan, the Council maintains workbooks with detailed information about measures.
- **Other relevant regional sources:** These include reports from the Consortium for Energy Efficiency, the EPA, and the American Council for an Energy-Efficient Economy.

Data Application

We now discuss how the data sources described above were used for each step of the study.

Data Application for Market Characterization

To construct the high-level market characterization of electricity use and households/floor space for the residential, commercial, and industrial sectors, we applied the following data sources:

- Vectren internal data, RECS 2009 and the American Community Survey to allocate residential customers by housing type
- Vectren internal data, EIA, AEO 2011 and our Energy Market Profiles Database to allocate sales and square footage by building type for the commercial sector
- Vectren internal data, EIA data on energy use by industry type, Bureau of Labor Statistics and AEO 2011 data to allocate sales and employment for the industrial sector

Data Application for Market Profiles

The specific data elements for the market profiles, together with the key data sources, are shown in Table 2-8. To develop the market profiles for each segment, we used the following approach:

1. Developed control totals for each segment. These include market size, segment-level annual electricity use, and annual intensity.
2. Used Vectren saturation surveys, RECS 2009, and the American Housing Survey to incorporate information on existing appliance saturations, appliance and equipment characteristics, and building characteristics.
3. Incorporated secondary data sources to supplement and corroborate the data from items 1 and 2 above.
4. Compared and cross-checked with regional data obtained as part of the EPRI National Potential Study and with the Energy Market Profiles Database.
5. Ensured calibration to control totals for annual electricity sales in each sector and segment.
6. Worked with Vectren staff to vet the data against their knowledge and experience.

Table 2-8 Data Applied for the Market Profiles

Model Inputs	Description	Key Sources
Market size	Base-year residential dwellings commercial floor space, and industrial employment	Vectren customer data American Community Survey Energy Market Profiles AEO
Annual intensity	Residential: Annual energy use (kWh/household) Commercial: Annual energy use (kWh/sq ft) Industrial: Annual energy use (kWh/employee)	Energy Market Profiles AEO Previous studies
Appliance/equipment saturations	Fraction of dwellings with an appliance/technology Percentage of C&I floor space/employment with equipment/technology	Vectren survey data RECS 2009 Energy Market Profiles
UEC/EUI for each end-use technology	UEC: Annual electricity use for a technology in dwellings that have the technology EUI: Annual electricity use per square foot/employee for a technology in floor space that has the technology	HVAC uses: BEST simulations using prototypes developed for Indiana Engineering analysis DEEM Previous EnerNOC studies California RASS and CEUS
Appliance/equipment vintage distribution	Age distribution for each technology	RECS 2009 Previous EnerNOC studies
Efficiency options for each technology	List of available efficiency options and annual energy use for each technology	DEEM DEER NWPCC workbooks Annual Energy Outlook Previous studies
Peak factors	Share of technology energy use that occurs during the peak hour	EnergyShape database

Data Application for Baseline Forecast

Table 2-9 summarizes the LoadMAP model inputs required for the baseline forecast. These inputs are required for each segment within each sector, as well as for new construction and existing dwellings/buildings.

Table 2-9 Data Needs for the Baseline Forecast and Potentials Estimation in LoadMAP

Model Inputs	Description	Key Sources
Customer growth forecasts	Forecasts of new construction in residential and C&I sectors	AEO 2011 growth forecast US BLS
Equipment purchase shares for baseline forecast	For each equipment/technology, purchase shares for each efficiency level; specified separately for existing equipment replacement and new construction	Shipments data from AEO AEO 2011 regional forecast assumptions[7] Appliance/efficiency standards analysis Vectren program results and evaluation reports
Electricity prices	Forecast of average energy and capacity avoided costs and retail prices	Vectren projections AEO 2011
Utilization model parameters	Price elasticities, elasticities for other variables (income, weather)	EPRI's REEPS and COMMEND models AEO 2011 NOAA data for normal cooling & heating degree days for Indiana.

In addition, we implemented assumptions for known future equipment standards as of January, 2012, as shown in the tables below.

[7] We developed baseline purchase decisions using the Energy Information Agency's *Annual Energy Outlook* report (2011), which utilizes the National Energy Modeling System (NEMS) to produce a self-consistent supply and demand economic model. We calibrated equipment purchase options to match manufacturer shipment data for recent years and then held values constant for the study period. This removes any effects of naturally occurring conservation or effects of future DSM programs that may be embedded in the AEO forecasts.

Table 2-10 Residential Electric Equipment Standards Applicable to Indiana

Legend: Today's Efficiency or Standard Assumption; 1st Standard (relative to today's standard); 2nd Standard (relative to today's standard)

End Use	Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Cooling	Central AC	SEER 13														
	Room AC	EER 9.8			EER 11.0											
	Evaporative Central AC	Conventional														
	Evaporative Room AC	Conventional														
Cooling/Heating	Heat Pump	SEER 13.0/HSPF 7.7				SEER 14.0/HSPF 8.0										
Space Heating	Electric Resistance	Electric Resistance														
Water Heating	Water Heater (<=55 gallons)	EF 0.90				EF 0.95										
	Water Heater (>55 gallons)	EF 0.90				Heat Pump Water Heater										
Lighting	Screw-in/Pin Lamps	Incandescent			Advanced Incandescent - tier 1						Advanced Incandescent - tier 2					
	Linear Fluorescent	T8														
Appliances	Refrigerator/2nd Refrigerator	NAECA Standard			25% more efficient											
	Freezer	NAECA Standard			25% more efficient											
	Dishwasher	Conventional (355		14% more efficient (307 kWh/yr)												
	Clothes Washer	Conventional (MEF 1.26 for top loader)				MEF 1.72 for top loader			MEF 2.0 for top loader							
	Clothes Dryer	Conventional (EF 3.01)				5% more efficient (EF 3.17)										
	Range/Oven	Conventional														
	Microwave	Conventional														
Electronics	Personal Computer	Conventional/Energy Star														
	Monitor	Conventional														
	Laptop Computer	Conventional/Energy Star														
	TV	Conventional/Energy Star														
	Copier/Printer/Fax	Conventional														
	DVD/VCR/Audio	Conventional														
	Devices and Gadgets	Conventional														
Miscellaneous	Pool Pump	Conventional														
	Well Pump	Conventional														
	Furnace Fan	Conventional														

Table 2-11 Commercial Electric Equipment Standards Applicable to Indiana

Legend: Today's Efficiency or Standard Assumption; 1st Standard (relative to today's standard); 2nd Standard (relative to today's standard)

<table>
<tr><th>End Use</th><th>Technology</th><th>2011</th><th>2012</th><th>2013</th><th>2014</th><th>2015</th><th>2016</th><th>2017</th><th>2018</th><th>2019</th><th>2020</th><th>2021</th><th>2022</th><th>2023</th><th>2024</th><th>2025</th></tr>
<tr><td rowspan="3">Cooling</td><td>Chillers</td><td colspan="15">2007 ASHRAE 90.1</td></tr>
<tr><td>Roof Top Units</td><td colspan="15">EER 11.0/11.2</td></tr>
<tr><td>Packaged Terminal AC/HP</td><td>EER 9.8</td><td colspan="14">EER 11.0</td></tr>
<tr><td>Cooling/Heating</td><td>Heat Pump</td><td colspan="15">EER 11.0/COP 3.3</td></tr>
<tr><td rowspan="2">Space Heating</td><td>Electric Resistance</td><td colspan="15">Electric Resistance</td></tr>
<tr><td>Electric Furnace</td><td colspan="15">Electric Furnace</td></tr>
<tr><td>Ventilation</td><td>Ventilation</td><td colspan="15">Constant Air Volume/Variable Air Volume</td></tr>
<tr><td rowspan="3">Lighting</td><td>Screw-in/Pin Lamps</td><td colspan="3">Incandescent</td><td colspan="6">Advanced Incandescent - tier 1</td><td colspan="6">Advanced Incandescent - tier 2</td></tr>
<tr><td>Linear Fluorescent</td><td>T12</td><td colspan="14">T8</td></tr>
<tr><td>High Intensity Discharge</td><td colspan="15">Metal Halide</td></tr>
<tr><td>Water Heating</td><td>Water Heater</td><td colspan="15">EF 0.97</td></tr>
<tr><td rowspan="6">Refrigeration</td><td>Walk-in Refrigerator/Freezer</td><td colspan="15">EISA 2007 Standard</td></tr>
<tr><td>Reach-in Refrigerator</td><td colspan="15">EPACT 2005 Standard</td></tr>
<tr><td>Glass Door Display</td><td>EPACT 2005 Standard</td><td colspan="14">42% more efficient</td></tr>
<tr><td>Open Display Case</td><td>EPACT 2005 Standard</td><td colspan="14">18% more efficient</td></tr>
<tr><td>Vending Machines</td><td>EPACT 2005 Standard</td><td colspan="14">33% more efficient</td></tr>
<tr><td>Icemaker</td><td colspan="15">2010 Standard</td></tr>
<tr><td rowspan="2">Office Equipment</td><td>Desktop Computer</td><td colspan="15">Conventional/Energy Star</td></tr>
<tr><td>Laptop Computer</td><td colspan="15">Conventional/Energy Star</td></tr>
<tr><td rowspan="2">Miscellaneous</td><td>Non-HVAC Motors</td><td colspan="4">62.3% Efficiency</td><td colspan="11">70% Efficiency</td></tr>
<tr><td>Commercial Laundry</td><td colspan="2">MEF 1.26</td><td colspan="13">MEF 1.6</td></tr>
</table>

Energy Efficiency Measure Data Application

Table 2-12 details the data sources used for measure characterization.

Table 2-12 Data Needs for the Measure Characteristics in LoadMAP

Model Inputs	Description	Key Sources
Energy Impacts	The annual reduction in consumption attributable to each specific measure. Savings were developed as a percentage of the energy end use that the measure affects.	Vectren program results and evaluation reports BEST DEEM DEER NWPCC workbooks Other secondary sources
Peak Demand Impacts	Savings during the peak demand periods are specified for each electric measure. These impacts relate to the energy savings and depend on the extent to which each measure is coincident with the system peak.	Vectren program results and evaluation reports BEST EnergyShape
Costs	Equipment Measures: Includes the full cost of purchasing and installing the equipment on a per-household, per-square-foot, or per employee basis for the residential, commercial, and industrial sectors, respectively. Non-equipment measures: Existing buildings – full installed cost. New Construction - the costs may be either the full cost of the measure, or as appropriate, it may be the incremental cost of upgrading from a standard level to a higher efficiency level.	Vectren program results and evaluation reports DEEM DEER NWPCC workbooks RS Means Other secondary sources
Measure Lifetimes	Estimates derived from the technical data and secondary data sources that support the measure demand and energy savings analysis.	Vectren program results and evaluation reports DEEM DEER NWPCC workbooks Other secondary sources
Applicability	Estimate of the percentage of either dwellings in the residential sector or square feet/employment in the C&I sectors where the measure is applicable and where it is technically feasible to implement.	DEEM DEER NWPCC workbooks Other secondary sources
On Market and Off Market Availability	Expressed as years for equipment measures to reflect when the equipment technology is available or no longer available in the market.	EnerNOC appliance standards and building codes analysis

Data Application for Cost-effectiveness Screening

To perform the cost-effectiveness screening, a number of economic assumptions were needed. All cost and benefit values were analyzed as real 2011 dollars. A discount rate of 7.29% in nominal terms was used, as provided by Vectren. This is equivalent to a 4.25% discount rate in real terms when adjusting for 2.92% inflation.[8] Avoided costs were provided by Vectren. Also, energy savings at the meter reduce system needs by that amount plus the avoided line losses, so benefits are increased by a factor equivalent to Vectren's average electric delivery losses, or 5.0%.

[8] Inflation adjuster of 2.92% based on the average annual growth forecast in US Consumer Price Index from the 2012 Annual Energy Outlook for 2010-2035.

Achievable Potential Estimation

To estimate achievable potentials, three sets of parameters were required to account for the decision making behavior of humans in the efficiency marketplace.

- **Adoption curves for non-equipment measures**. Equipment measures are installed when existing units fail. Non-equipment measures do not have this natural periodicity, so rather than installing all available non-equipment measures in the first year of the forecast (instantaneous potential), they are phased in according to adoption schedules that vary based on cost and complexity. The adoption rates used in this analysis take several factors into account to determine how quickly the market can absorb these measures. Typically, measures that cause disruption to the building, such as wall insulation in existing buildings, receive longer adoption curves, while those with drop-in installations, such as programmable thermostats in new buildings, receive shorter ones. High capital cost measures will also receive longer adoption curves than ones with low capital cost. These adoption rates are used within LoadMAP to generate the Technical and Economic potentials. In general, the rates align with the diffusion of similar equipment measures.
- **Achievable High adoption rates**. These factors are applied to Economic potential to estimate the upper bound: Achievable High. These estimate customer adoption of economic measures when delivered through efficiency programs under ideal market, implementation, and customer preference conditions. Information channels are assumed to be established and efficient for marketing, educating consumers, and coordinating with trade allies and delivery partners. The Achievable High adoption rates are based on the ramp rates from the Northwest Power & Conservation Council's Sixth Plan as a starting point. The NWPCC has been running programs in the Pacific Northwest for many years, so the portfolio of programs reflects a more mature profile of market maturity. Because of this, the ramp rates are adjusted downward by 10%, and then further adjusted with actual Vectren program history and information from program evaluations. Achievable High potential establishes a maximum target for the EE savings that an administrator can hope to achieve through its EE programs and involves incentives that represent a substantial portion of the incremental cost combined with high administrative and marketing costs.
- **Achievable Low adoption rates**. These factors are applied to Achievable High potential to calculate Achievable Low potential, decrementing them by a range of 40% to 75% based on where measures lie in the time horizon of the study or whether they are already familiar inclusions in existing programs. These rates reflect expected program participation given significant barriers to customer acceptance, non-ideal implementation conditions, and limited program budgets. This represents a lower bound on achievable potential.

Achievable Low and Achievable High adoption rates are presented in Volume 3, Appendix E.

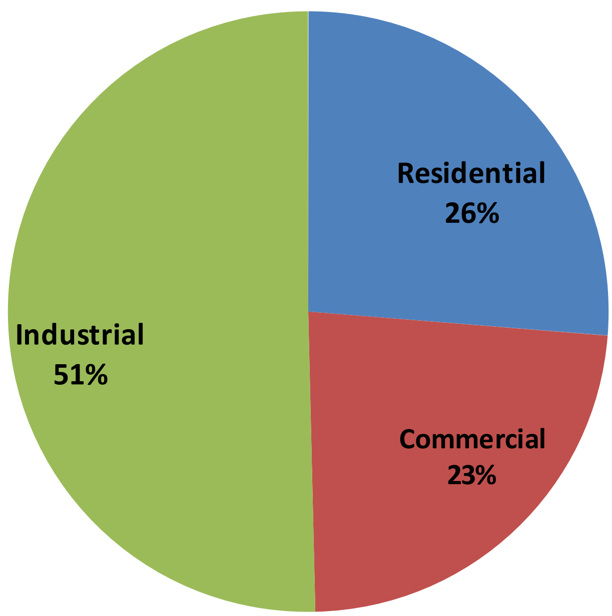
MARKET CHARACTERIZATION AND MARKET PROFILES

In this section, we describe how customers in the Vectren service territory use electricity in the base year of the study, 2011. It begins with a high-level summary of energy use by sector and then delves into each sector in detail.

Energy Use Summary

Total electricity use for the residential, commercial, and industrial sectors for Vectren in 2011 was 5,646 GWh. As shown in Figure 4-1, the largest sector is industrial, accounting for 51% of load at 2,845 GWh. The remaining use is in the residential and commercial sectors, at 1,483 GWh and 1,318 respectively.

Figure 4-1 Sector-Level Electricity Use, 2011



Residential Sector

The total number of households and electric sales for the service territory were obtained from Vectren's customer database. In 2011, there were 122,961 households in the Vectren territory that used a total of 1,483 GWh of electricity. We allocated these totals into the two residential segments based on the Vectren South 2010 baseline survey results. The values are shown in Table 4-1 below, and referred to throughout the study as the *control totals* to which all energy usage is calibrated in the base year of the study.

Table 4-1 Residential Sector Energy Usage and Intensity by Segment Type, 2011

Segment	No. of Households	Intensity (kWh/HH)	2011 Electricity Use (GWh)
Single Family	103,287	12,792	1,321
Multi Family	19,674	8,246	162
Total	**122,961**	**12,065**	**1,483**

Composite Electric Profile

As we describe in the previous chapter, the market profiles provide the foundation upon which we develop the baseline forecast. The average market profile for the residential sector is presented in Table 4-2. Segment specific market profiles are presented in Volume 3, Appendix A.

Table 4-2 Average Electric Market Profile for the Residential Sector, 2011

Residential :	Total
Total Households:	122,961
GWh:	1,483

Average Market Profiles - Electricity

End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)
Cooling	Central AC	80.2%	2,764	2,218	272.7
Cooling	Room AC	9.0%	1,049	95	11.6
Cooling	Air-Source Heat Pump	10.0%	2,179	219	26.9
Cooling	Geothermal Heat Pump	0.1%	1,921	2	0.2
Cooling	Evaporative AC	0.0%	0	0	0.0
Space Heating	Electric Resistance	8.6%	6,528	558	68.6
Space Heating	Electric Furnace	15.4%	7,109	1,094	134.5
Space Heating	Air-Source Heat Pump	10.0%	5,673	569	70.0
Space Heating	Geothermal Heat Pump	0.1%	3,311	3	0.4
Water Heating	Water Heater <= 55 gal	37.8%	2,883	1,090	134.0
Water Heating	Water Heater > 55 gal	4.2%	3,073	129	15.9
Interior Lighting	Screw-in	100.0%	1,010	1,010	124.2
Interior Lighting	Linear Fluorescent	100.0%	120	120	14.8
Interior Lighting	Specialty	100.0%	445	445	54.7
Exterior Lighting	Screw-in	100.0%	237	237	29.1
Appliances	Clothes Washer	89.0%	69	61	7.5
Appliances	Clothes Dryer	84.0%	532	447	55.0
Appliances	Dishwasher	68.0%	291	198	24.4
Appliances	Refrigerator	100.0%	756	756	93.0
Appliances	Freezer	34.4%	602	207	25.5
Appliances	Second Refrigerator	27.4%	787	216	26.5
Appliances	Stove	71.0%	470	334	41.0
Appliances	Microwave	95.0%	112	107	13.1
Electronics	Personal Computers	69.0%	262	181	22.3
Electronics	Monitor	69.0%	52	36	4.4
Electronics	Laptops	57.0%	113	64	7.9
Electronics	TVs	268.8%	213	573	70.5
Electronics	Printer/Fax/Copier	92.0%	40	37	4.5
Electronics	Set-top Boxes/DVR	268.8%	135	364	44.8
Electronics	Devices and Gadgets	100.0%	55	55	6.8
Miscellaneous	Pool Pump	9.0%	1,500	135	16.6
Miscellaneous	Pool Heater	1.0%	4,981	50	6.1
Miscellaneous	Hot Tub / Spa	4.3%	950	41	5.0
Miscellaneous	Well Pump	5.0%	561	28	3.4
Miscellaneous	Furnace Fan	73.5%	486	357	43.9
Miscellaneous	Miscellaneous	100.0%	28	28	3.5
Total				**12,065**	**1,483.5**

Figure 4-2 shows the distribution of electric energy consumption by end use for all homes. Three main electricity end uses —appliances, space heating and cooling — account for over 50% of total use. The most energy allocated to any single category is 21% for cooling, which includes central AC, heat pumps, and room AC. Other categories with substantial energy use are space heating and appliances. Appliances include refrigerators, freezers, stoves, clothes washers, clothes dryers, dishwashers, and microwaves. The remainder of the energy falls into the electronics, lighting, water heating and the miscellaneous category – which is comprised of furnace fans, pool pumps, and other “plug” loads (hair dryers, power tools, coffee makers, etc).

Figure 4-2 Residential Electricity by End Use (2011), All Homes

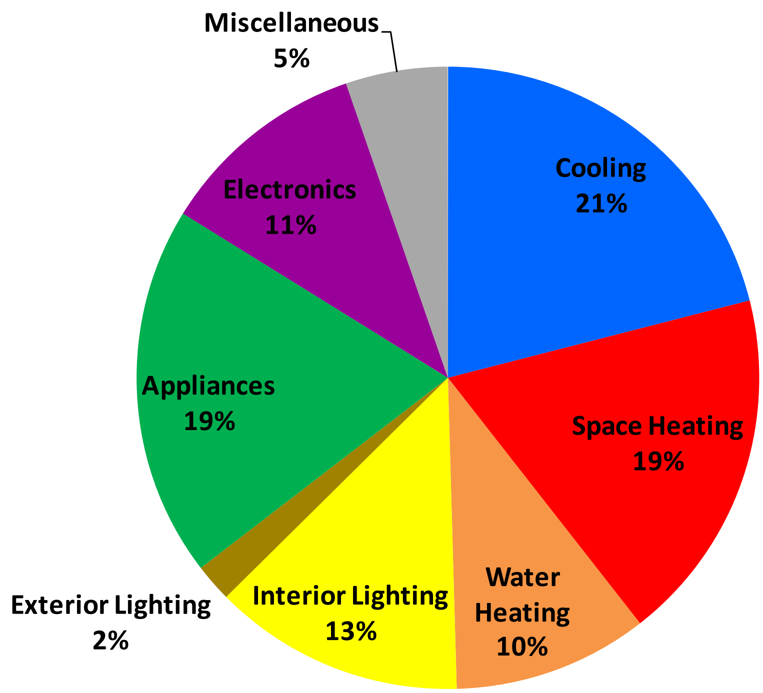


Figure 4-3 and Table 4-3 present the electricity intensities by end-use and housing type, as well as all homes on average. Figure 4-4 shows the same data as a percentage of total energy use.

Figure 4-3 Residential Electricity Intensity by End Use and Segment (kWh/household, 2011)

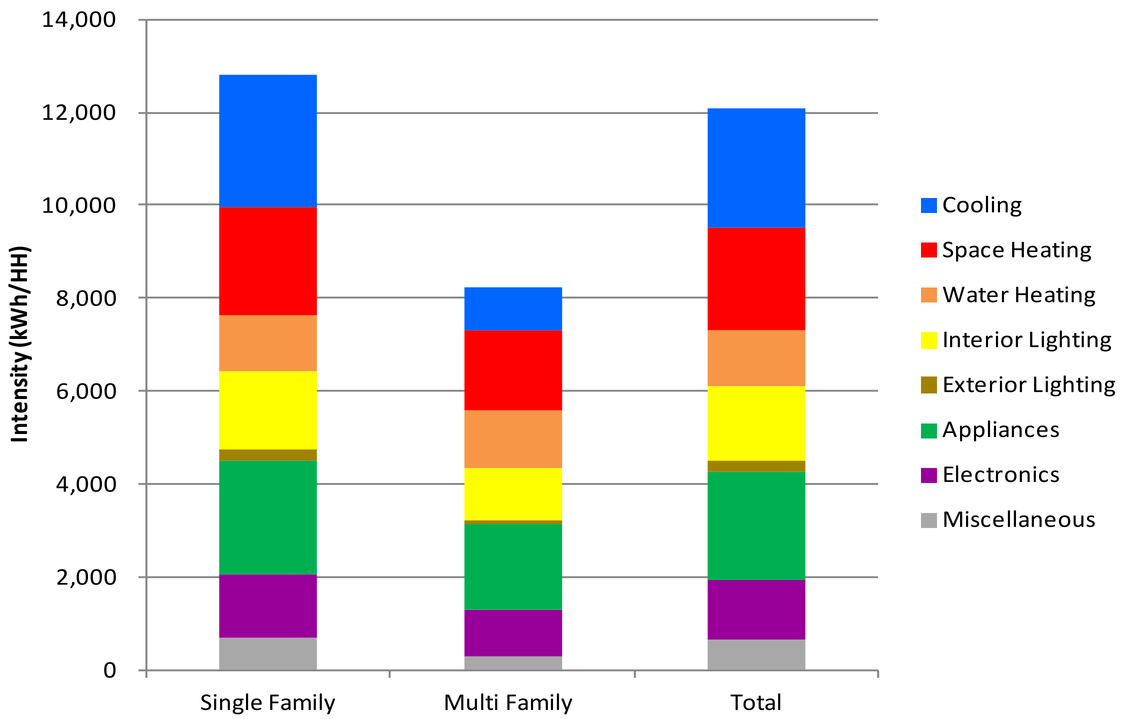
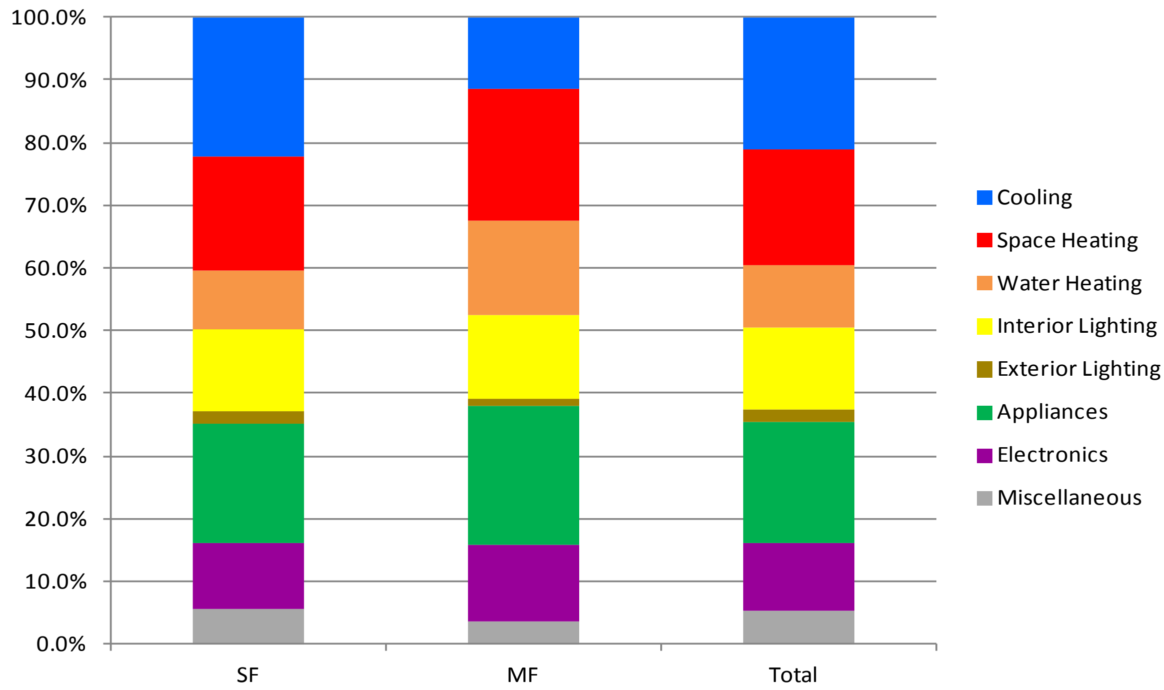


Table 4-3 Residential Electricity Use by End Use and Segment (kWh/HH/year, 2011)

End Use	Single Family	Multi Family	Total
Cooling	2,838	934	2,533
Space Heating	2,318	1,733	2,225
Water Heating	1,214	1,244	1,219
Interior Lighting	1,666	1,099	1,575
Exterior Lighting	260	113	238
Appliances	2,423	1,817	2,326
Electronics	1,369	1,006	1,311
Misc.	704	299	639
Total	**13,070**	**7,552**	**12,065**

Figure 4-4 Percentage of Residential Electricity Use by End Use and Segment (2011)



Commercial Sector

To develop a Baseline Forecast for Vectren's commercial sector, the first step was to determine the characteristics of energy use in the study's base year, 2011, for eleven building-type segments agreed upon for the study: Small Office, Large Office, Restaurant, Retail, Grocery, College, School, Health, Lodging, Warehouse, and Miscellaneous.

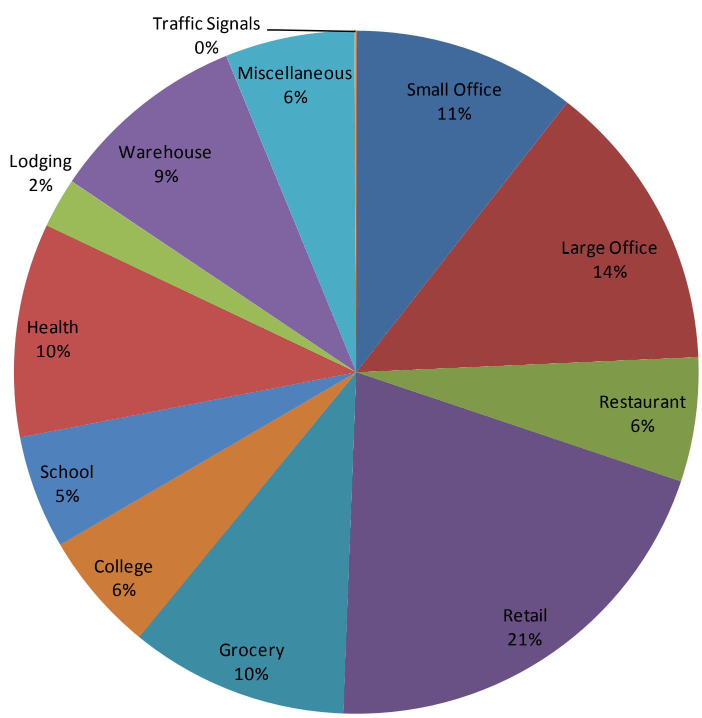
The total electric energy consumed by commercial customers in Vectren's service area in 2011 was 1,318 GWh. We used our internal database of Energy Market Profiles for both Central Industrial and Upper Southeast regions and consumption data from Vectren's customer database to allocate energy usage to building types and to develop estimates of energy intensity (annual kWh/square foot). Using the electricity use and intensity estimates, we infer floor space which is the unit of analysis in LoadMAP for the commercial sector. The values are shown in Table 4-4 below, and referred to throughout the study as the *control totals* to which all energy usage is calibrated in the base year of the study.

Table 4-4 Commercial Electricity Use by End Use and Segment (kWh/SqFt/year, 2011)

Segment	Electricity Use (GWh)	Intensity (kWh/SqFt)	Floor Space (million SqFt)
Small Office	139	16.66	8
Large Office	181	19.22	9
Restaurant	78	40.88	2
Retail	269	15.15	18
Grocery	136	50.80	3
College	75	13.04	6
School	71	8.56	8
Health	133	25.74	5
Lodging	31	14.95	2
Warehouse	124	6.85	18
Miscellaneous	81	8.16	10
Traffic Signals	1	n/a	n/a
Total	**1,318**	**14.75**	**89**

Figure 4-5 shows the size of each of the building-types as a percentage of commercial sector energy sales.

Figure 4-5 Commercial Market Segmentation by Building Type – Percentage of Electricity Use



Composite Electric Profile

Table 4-5 shows the average market profile for electricity of the commercial sector as a whole, representing a composite of all the building types. Market profiles for each building type are presented in Volume 3, Appendix A.

Table 4-5 Average Electric Market Profile for the Commercial Sector, 2011

Average Market Profiles - Electricity

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Sqft)	Usage (GWh)
Cooling	Air-Cooled Chiller	4.5%	3.95	0.18	16
Cooling	Water-Cooled Chiller	10.5%	3.61	0.38	34
Cooling	Roof top AC	45.7%	4.23	1.93	173
Cooling	Air-Source Heat Pump	2.9%	4.10	0.12	11
Cooling	Geothermal Heat Pump	0.7%	2.73	0.02	2
Cooling	Other Cooling	5.4%	2.74	0.15	13
Heating	Air-Source Heat Pump	2.9%	4.60	0.13	12
Heating	Geothermal Heat Pump	0.7%	3.07	0.02	2
Heating	Electric Room Heat	1.7%	6.17	0.10	9
Heating	Electric Furnace	19.3%	5.38	1.04	93
Ventilation	Ventilation	100.0%	1.25	1.25	112
Water Heating	Water Heating	40.2%	1.04	0.42	37
Interior Lighting	Screw-in	100.0%	1.83	1.83	163
Interior Lighting	High-Bay Fixtures	100.0%	0.40	0.40	36
Interior Lighting	Linear Fluorescent	100.0%	2.33	2.33	208
Exterior Lighting	Screw-in	100.0%	0.20	0.20	18
Exterior Lighting	HID	100.0%	0.55	0.55	49
Exterior Lighting	Linear Fluorescent	100.0%	0.04	0.04	4
Refrigeration	Walk-in Refrigerator	51.6%	0.84	0.43	38
Refrigeration	Reach-in Refrigerator	51.6%	0.08	0.04	4
Refrigeration	Glass Door Display	51.6%	0.97	0.50	45
Refrigeration	Open Display Case	51.6%	0.44	0.23	20
Refrigeration	Icemaker	51.6%	0.17	0.09	8
Refrigeration	Vending Machine	51.6%	0.17	0.09	8
Food Preparation	Oven	21.4%	0.40	0.09	8
Food Preparation	Fryer	21.4%	0.58	0.12	11
Food Preparation	Dishwasher	21.4%	0.66	0.14	13
Food Preparation	Hot Food Container	21.4%	0.19	0.04	4
Office Equipment	Desktop Computer	100.0%	0.48	0.48	43
Office Equipment	Laptop	100.0%	0.07	0.07	7
Office Equipment	Server	100.0%	0.22	0.22	20
Office Equipment	Monitor	100.0%	0.09	0.09	8
Office Equipment	Printer/Copier/Fax	100.0%	0.07	0.07	6
Office Equipment	POS Terminal	46.9%	0.04	0.02	2
Misc	Non-HVAC Motors	53.0%	0.40	0.21	19
Misc	Pool Pump	1.6%	0.01	0.00	0
Misc	Pool Heater	0.4%	0.02	0.00	0
Misc	Misc	100.0%	0.72	0.72	65
Total				**14.75**	**1,318**

Commercial Electricity Consumption

Figure 4-6 shows the distribution of electricity consumption by end use for all commercial building types. Electric usage is dominated by lighting, with interior and exterior varieties accounting for over one third of consumption. After lighting, the largest end uses are cooling, heating, ventilation, and refrigeration. The remaining end uses comprise 6% or less of total usage: office equipment, miscellaneous, water heating, and food preparation.

Figure 4-6 Commercial Electricity Consumption by End Use (2011), All Building Types

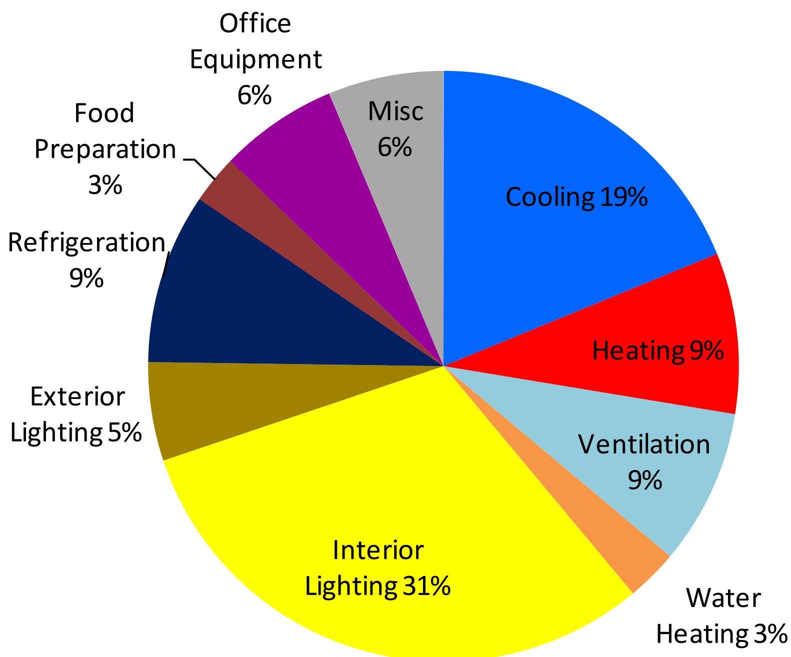


Figure 4-7 shows the electricity intensity by end use and building type in terms of kWh per square foot of building floor space. Figure 4-8 and Table 4-6 present the electricity usage in GWh by end use and building type. Figure 4-9 shows the same data as a percentage of total energy use for each segment.

Figure 4-7 Commercial Electricity Intensity by End Use and Segment (kWh/SqFt, 2011)

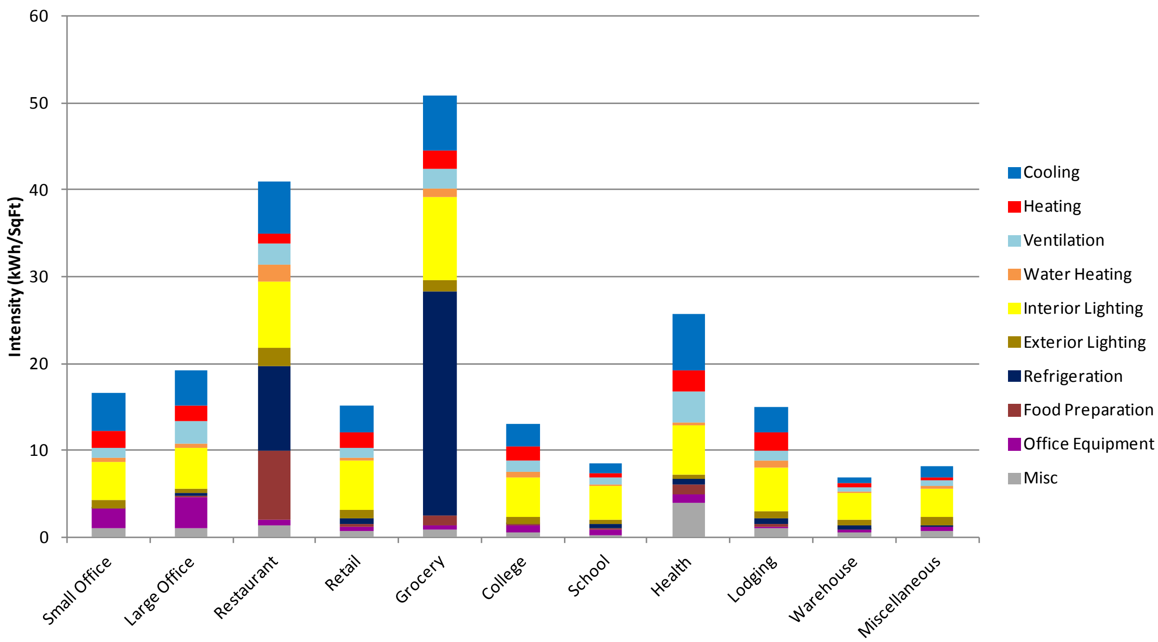


Figure 4-8 Commercial Electricity Usage by End Use Segment (GWh, 2011)

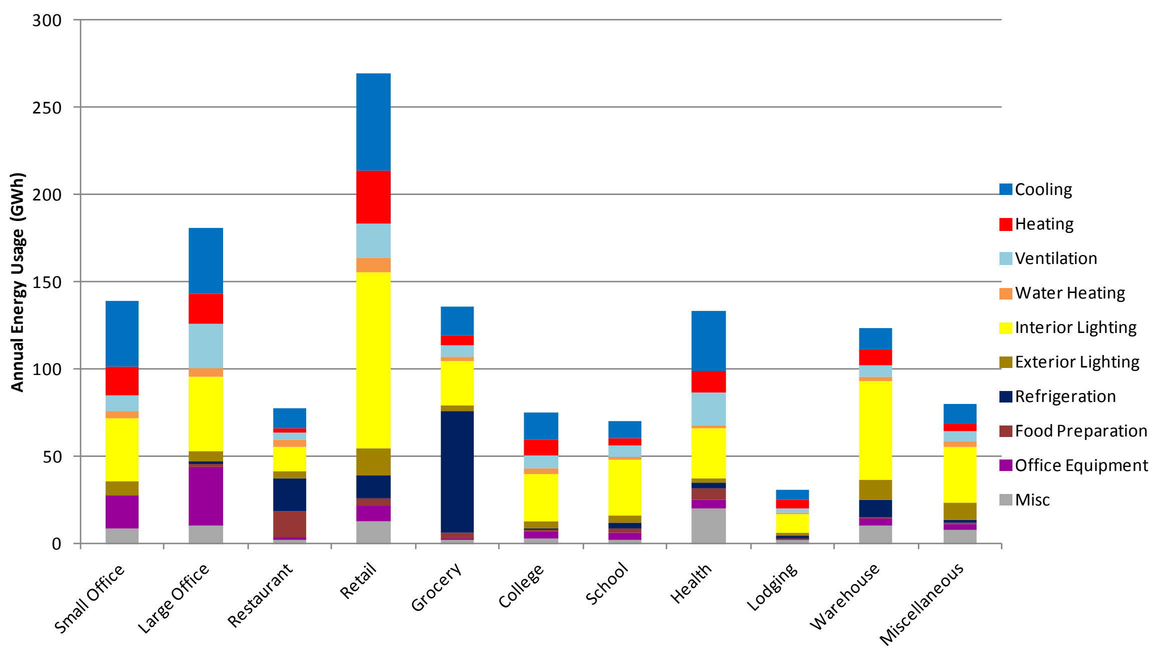
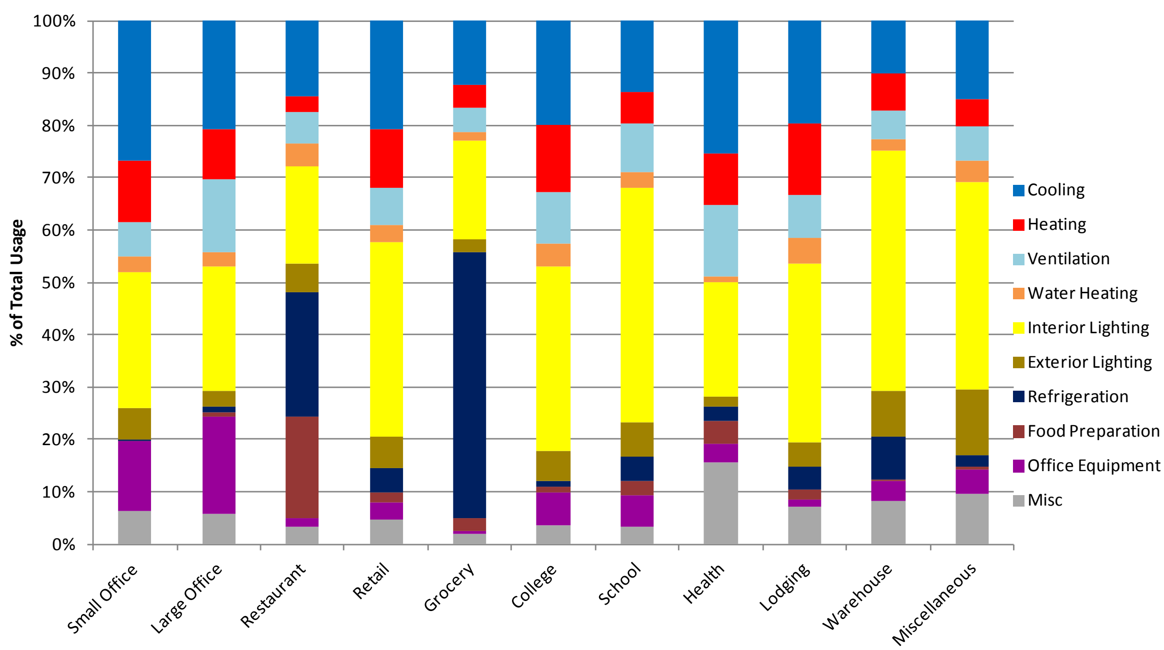


Table 4-6 Commercial Electricity Consumption by End Use (GWh, 2011)

Enduse	Small Office	Large Office	Restaurant	Retail	Grocery	College	School	Health	Lodging	Warehouse	Misc	Total
Cooling	37	38	11	56	17	15	10	34	6	12	12	248
Heating	16	17	2	30	6	10	4	13	4	9	4	116
Ventilation	9	25	5	20	6	7	7	18	3	7	5	112
Water Heating	4	5	3	8	2	3	2	1	1	3	3	37
Interior Lighting	36	43	14	101	26	26	32	29	11	57	32	407
Exterior Lighting	8	5	4	16	3	4	5	3	1	11	10	71
Refrigeration	0	2	18	12	69	1	3	3	1	10	2	123
Food Preparation	0	1	15	5	3	1	2	6	1	0	1	35
Office Equipment	18	34	1	9	1	5	4	5	0	5	4	85
Misc	9	10	3	13	2	3	2	21	2	10	9[9]	84
Total	**139**	**181**	**78**	**269**	**136**	**75**	**71**	**133**	**31**	**124**	**82**	**1,318**

Figure 4-9 Commercial Electricity Use by End Use and Segment (2011)



[9] 1 GWh of consumption for traffic signals has been rolled up into the Miscellaneous end use of the Miscellaneous segment in this table.

Industrial Sector

To develop a Baseline Forecast for Vectren's industrial sector, the first step was to determine the characteristics of energy use in the study's base year, 2011. We agreed upon a segmentation strategy for the study that would highlight the top few industries in Vectren by energy consumption. After reviewing the billing data by NAICS code and conducting market research with Vectren's largest customers, we determined that there were three key segments to highlight: Chemicals, Plastics, and Transportation; with the remaining customers classified as "Other Industrial". These "other" industries typically have energy use characteristics that are similar enough that further granularity does not meaningfully affect the study results.

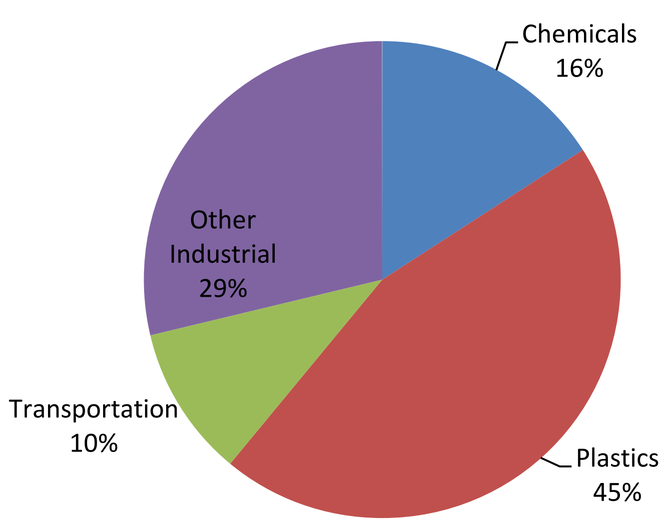
The total electric energy consumed by industrial customers in Vectren in 2011 was 2,845 GWh. To allocate this energy usage to the various industry types, we used data from our internal database of Energy Market Profiles for the Central Industrial region, consumption data from Vectren's customer database, and data from primary market research surveys administered onsite at 30 of Vectren's largest energy using customers. The energy usage is mapped to an estimated number of employees in each industry, based on data from the U.S. Economic Census, to enable benchmarking and expression of data in terms of energy per employee, which is the unit used in our LoadMAP modeling. The resulting allocations are shown in Table 4-7, and referred to throughout the study as the *control totals* to which all energy usage is calibrated in the base year of the study.

Table 4-7 Industrial Market Segmentation by Industry Type, Base Year 2011

Segment	Electricity Use (GWh)	Number of Employees
Chemicals	451	3,230
Plastics	1,284	12,939
Transportation	291	6,633
Other Industrial	818	21,091
Total	**2,845**	**43,894**

Figure 4-10 shows the size of each of the segments as a percentage of industrial sector electricity use.

Figure 4-10 Industrial Market Segmentation – Percentage of Electricity Use



Composite Electric Profile

As with the residential and commercial sectors, the industrial market profiles characterize electricity use in terms of end use and technology for the base year 2011. Table 4-8 shows the composite market profile for the industrial sector.

Table 4-8 Average Electric Market Profile for the Industrial Sector, 2011

	Total
Employees:	43,894
Control Total (GWh):	2,844.5
Intensity (kWh/employee):	64,805

Average Market Profiles

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Employee)	Usage (GWh)
Cooling	Air-Cooled Chiller	2.5%	17,863	447	19.6
Cooling	Water-Cooled Chiller	2.6%	17,133	451	19.8
Cooling	Roof top AC	12.1%	27,476	3,318	145.6
Cooling	Air Source Heat Pump	0.1%	27,770	40	1.7
Cooling	Geothermal Heat Pump	0.0%	18,522	7	0.3
Cooling	Other Cooling	0.7%	18,136	119	5.2
Heating	Air Source Heat Pump	0.1%	69,380	99	4.4
Heating	Geothermal Heat Pump	0.0%	46,276	17	0.7
Heating	Electric Room Heat	0.2%	72,596	168	7.4
Heating	Electric Furnace	1.9%	76,226	1,448	63.6
Ventilation	Ventilation	100.0%	2,785	2,785	122.2
Interior Lighting	Screw-in	100.0%	1,471	1,471	64.6
Interior Lighting	High-Bay Fixtures	100.0%	313	313	13.7
Interior Lighting	Linear Fluorescent	100.0%	4,286	4,286	188.1
Exterior Lighting	Screw-in	100.0%	3	3	0.1
Exterior Lighting	HID	100.0%	1,159	1,159	50.9
Exterior Lighting	Linear Fluorescent	100.0%	0	0	0.0
Motors	Pumps	100.0%	6,687	6,687	293.5
Motors	Fans & Blowers	100.0%	3,241	3,241	142.3
Motors	Compressed Air	100.0%	5,090	5,090	223.4
Motors	Matl Handling	100.0%	2,793	2,793	122.6
Motors	Matl Processing	100.0%	12,798	12,798	561.8
Motors	Other Motors	100.0%	1,020	1,020	44.8
Process	Process Heating	100.0%	8,134	8,134	357.0
Process	Process Cooling and Refrigeration	100.0%	4,852	4,852	213.0
Process	Electro-Chemical Processes	100.0%	635	635	27.9
Process	Other Process	100.0%	732	732	32.1
Misc	Misc	100.0%	2,691	2,691	118.1
	Total			**64,805**	**2,844.5**

Figure 4-11 shows the distribution of electricity energy consumption by end use for all industrial customers. Motors are clearly the largest overall end use for the industrial sector, accounting for 49% of energy use. Note that this end use includes a wide range of industrial equipment, such as air compressors and refrigeration compressors, pumps, conveyor motors, and fans. The process end use accounts for 22% of energy use, which includes heating, cooling, refrigeration, and electro-chemical processes. Lighting is the next highest, followed by cooling, ventilation, miscellaneous, and space heating.

Figure 4-11 Industrial Electricity Use by End Use (2011), All Industries

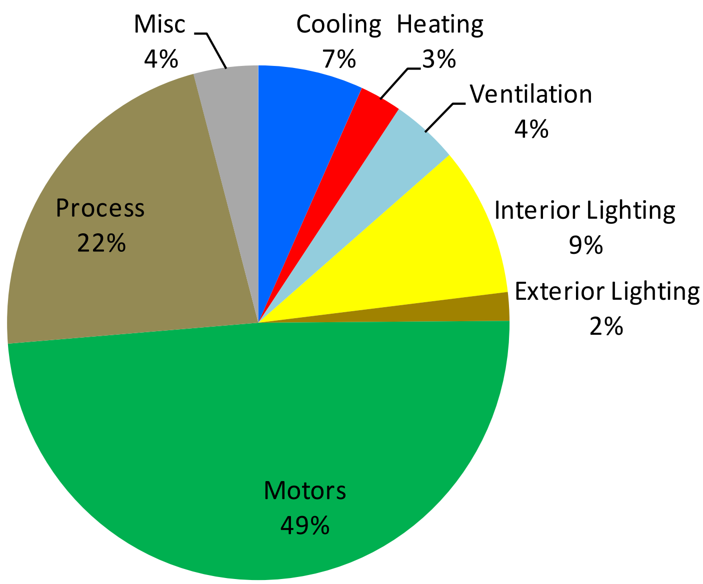


Figure 4-12 presents the electricity consumption by end-use and industry type. Figure 4-13 shows the same data as a percentage of total energy use for each segment.

Figure 4-12 Industrial Electricity Consumption by End Use and Segment (GWh, 2011)

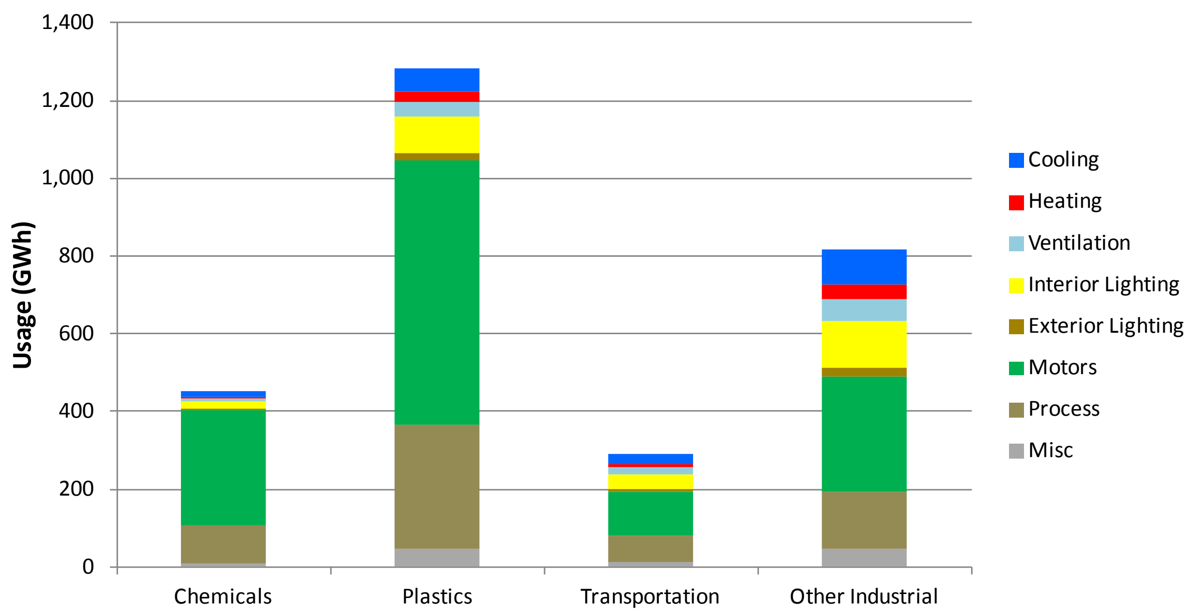
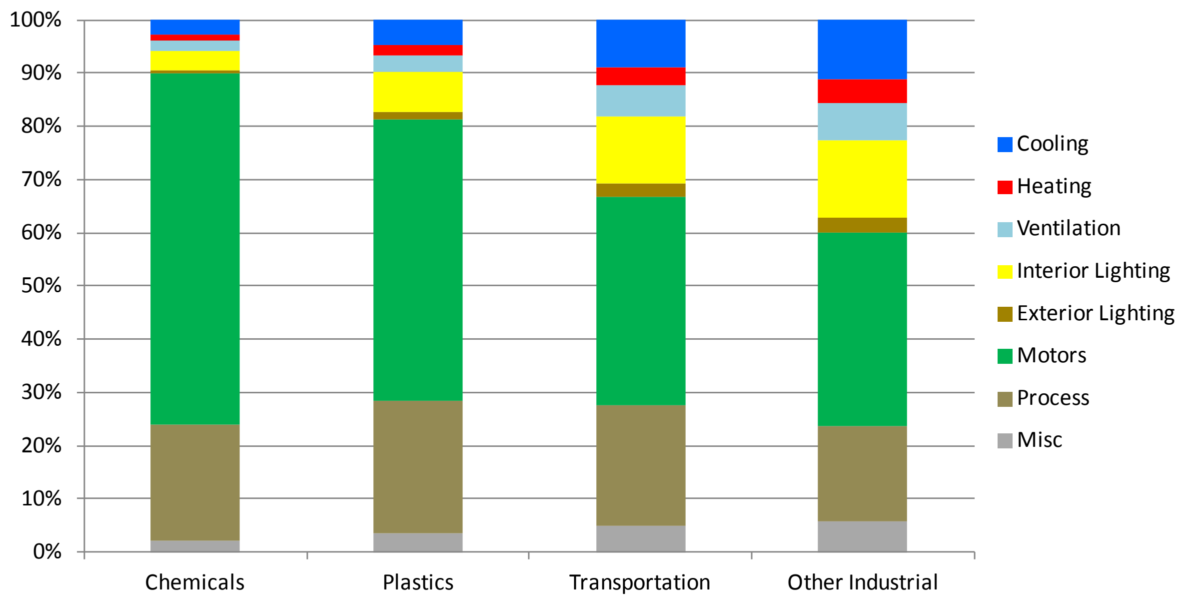


Table 4-9 Industrial Electricity Use by End Use and Segment (GWh, 2011)

End Use	Chemicals	Plastics	Transportation	Other Industrial	Total
Cooling	13.0	62.1	25.9	91.2	192.3
Heating	5.2	24.6	10.2	36.1	76.0
Ventilation	8.3	39.5	16.5	58.0	122.2
Interior Lighting	16.3	94.6	37.0	118.5	266.5
Exterior Lighting	3.1	18.1	7.1	22.7	51.0
Motors	297.2	679.4	114.3	297.4	1,388.3
Process	98.0	318.6	66.0	147.5	630.0
Misc.	10.1	47.1	14.4	46.6	118.1
Total	**451.1**	**1,284.0**	**291.4**	**818.0**	**2,844.5**

Figure 4-13 Percentage of Industrial Electricity Use by End Use and Segment (2011)



BASELINE FORECAST

Prior to developing estimates of energy-efficiency potential, a baseline end-use forecast was developed to quantify what the consumption is likely to be in the future in absence of new efficiency programs and naturally occurring efficiency. The baseline forecast serves as the metric against which energy efficiency potentials are measured. This chapter presents the baseline forecast for electricity for each sector.

Residential Sector

The baseline forecast incorporates assumptions about economic growth, electricity prices, and appliance/equipment standards and building codes that are already mandated as described in Chapter 2.

Table 5-1 and Figure 5-1 present the baseline forecast for electricity at the end-use level for the residential sector as a whole. Overall, residential use increases slightly from 1,483 GWh in 2011 to 1,488 GWh in 2019, an increase of only 0.3%, which is essentially a flat forecast year over year. This reflects the impact of the EISA lighting standard, additional appliance standards adopted in 2011, and modest customer growth. Figure 5-2 presents the forecast of use per household. Most noticeable is that lighting use decreases significantly throughout the time period as the lighting efficiency standards from EISA come into effect.

Table 5-1 Residential Electricity Consumption by End Use (GWh)

End Use	2011	2014	2015	2016	2017	2018	2019	% Change	Avg. Growth Rate
Cooling	311	315	315	316	319	322	325	4%	0.5%
Heating	274	281	282	284	288	291	294	7%	0.9%
Water Heating	150	151	150	150	150	150	149	0%	0.0%
Int. Lighting	194	179	159	149	148	149	147	-24%	-3.4%
Ext. Lighting	29	25	21	19	19	19	19	-35%	-5.3%
Appliances	286	264	257	252	248	245	242	-15%	-2.1%
Electronics	161	185	191	199	207	215	224	39%	4.1%
Miscellaneous	79	82	83	84	85	87	88	12%	1.4%
Total	**1,483**	**1,482**	**1,459**	**1,453**	**1,476**	**1,476**	**1,488**	**0.3%**	**0.04%**

Figure 5-1 Residential Electricity Baseline Forecast by End Use

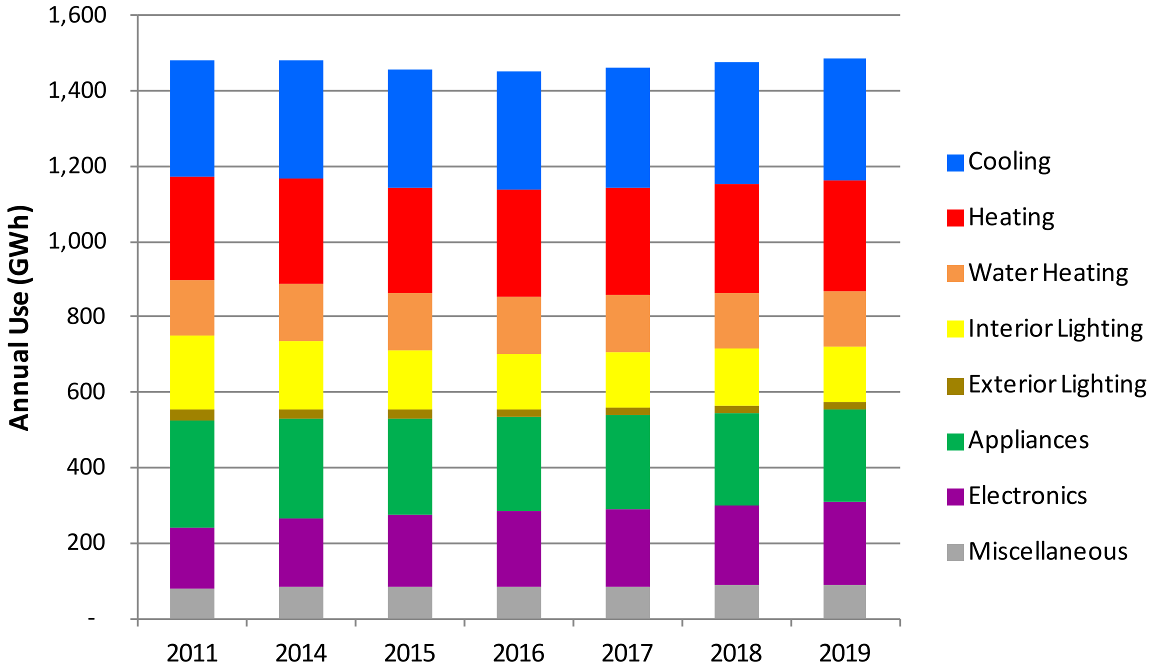


Figure 5-2 Residential Baseline Electricity Use per Household by End Use

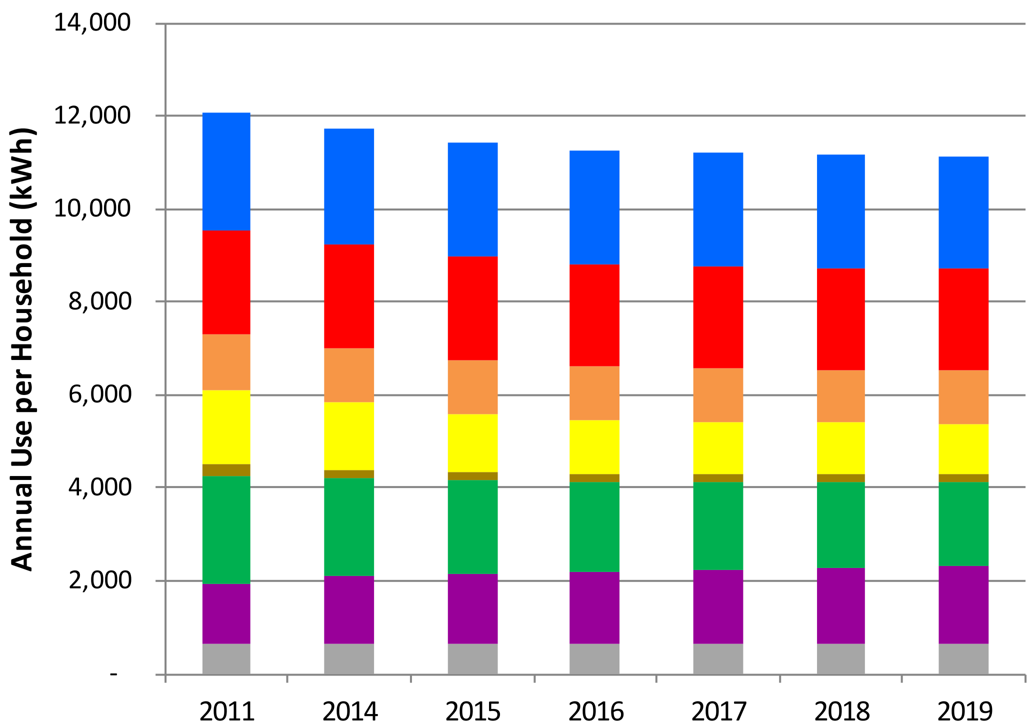


Table 5-2 shows the end-use forecast at the technology level for select years. Specific observations include:

1. The primary reason for the reduction in the baseline forecast beginning in 2012 is the federal lighting standards. The standard phases general service incandescent lamps out of the market over a three-year period, causing a decline in interior screw-in lighting use by 44.5% over the forecast period.
2. Appliance energy use decreases markedly, reflecting efficiency gains from standards.
3. Growth in use in electronics is substantial and reflects an increase in the saturation of electronics and the trend toward higher-powered computers.
4. Growth in miscellaneous use is also substantial. This use includes various plug loads not elsewhere classified (e.g., hair dryers, power tools, coffee makers, etc.). This end use has grown consistently in the past and we incorporate future growth assumptions that are consistent with the Annual Energy Outlook.

Table 5-2 Residential Electricity Baseline Forecast by End Use and Technology (GWh)

End Use	Technology	2011	2014	2015	2017	2019	% Change	Avg. Growth Rate
Cooling	Central AC	273	276	276	280	285	4.6%	0.6%
	Room AC	12	11	11	11	11	-4.9%	-0.6%
	Air-Source Heat Pump	27	27	27	27	28	5.0%	0.6%
	Geothermal Heat Pump	0	0	0	0	0	5.0%	0.6%
Heating	Furnace	135	140	141	143	146	8.5%	1.0%
	Air-Source Heat Pump	70	69	70	71	73	4.2%	0.5%
	Geothermal Heat Pump	0	0	0	0	0	9.1%	1.1%
	Electric Resistance	69	71	72	73	75	8.6%	1.0%
Water Heating	Water Heater > 55 gal	16	16	16	15	14	-14.8%	-2.0%
	Water Heater <= 55 gal	134	135	134	135	136	1.4%	0.2%
Interior Lighting	Screw-in	124	105	84	71	69	-44.5%	-7.4%
	Linear Fluorescent	15	16	16	16	17	12.9%	1.5%
	Specialty	55	59	59	60	62	12.8%	1.5%
Exterior Lighting	Screw-in	29	25	21	19	19	-34.7%	-5.3%
Appliances	Clothes Washer	8	7	6	6	5	-30.9%	-4.6%
	Clothes Dryer	55	51	50	48	47	-14.3%	-1.9%
	Dishwasher	24	21	20	19	18	-25.6%	-3.7%
	Refrigerator	93	84	80	75	71	-23.7%	-3.4%
	Freezer	25	22	21	20	19	-25.0%	-3.6%
	Second Refrigerator	27	23	23	21	21	-21.7%	-3.1%
	Stove	41	43	44	45	47	14.0%	1.6%
	Microwave	13	14	14	14	14	9.3%	1.1%
Electronics	Personal Computers	22	25	26	27	29	31.9%	3.5%
	Monitor	4	5	5	5	6	26.9%	3.0%
	Laptops	8	9	9	10	10	31.8%	3.5%
	TVs	70	82	85	93	101	42.9%	4.5%
	Printer/Fax/Copier	5	5	5	5	5	2.1%	0.3%
	Set-top Boxes/DVR	45	52	54	59	64	41.9%	4.4%
	Devices and Gadgets	7	8	8	9	9	37.9%	4.0%
Miscellaneous	Pool Pump	17	17	18	18	18	10.8%	1.3%
	Pool Heater	6	6	6	6	6	3.0%	0.4%
	Hot Tub / Spa	5	5	5	5	6	11.0%	1.3%
	Well Pump	3	4	4	4	4	11.1%	1.3%
	Furnace Fan	44	46	46	48	49	11.1%	1.3%
	Miscellaneous	3	4	4	5	5	43.2%	4.5%
Total		**1,483**	**1,482**	**1,459**	**1,463**	**1,488**	0.3%	0.0%

Commercial Sector

Electricity use in the commercial sector grows modestly during the overall forecast horizon, starting at 1,318 GWh in 2011, and increasing to 1,368 GWh in 2019. Table 5-3 and Figure 5-3 present the electricity baseline forecast at the end-use level for the commercial sector as a whole. Usage is declining in the early years of the forecast, due largely to the phasing in of codes and standards such as the EISA 2007 lighting standards and EPACT 2005 refrigeration standards.

Table 5-3 Commercial Electricity Consumption by End Use (GWh)

End Use	2011	2014	2015	2016	2017	2018	2019	% Change	Avg. Growth Rate
Cooling	248	271	277	285	295	305	316	28%	3.0%
Heating	116	131	135	139	145	151	156	35%	3.7%
Ventilation	112	108	106	104	104	104	104	-7%	-0.9%
Water Heating	37	39	40	41	42	43	44	17%	2.0%
Interior Lighting	407	347	338	334	333	335	339	-17%	-2.3%
Ext. Lighting	72	67	65	64	63	64	64	-11%	-1.5%
Refrigeration	123	110	107	105	103	102	101	-17%	-2.4%
Food Prep	35	36	36	37	37	38	39	11%	1.3%
Office Equip	85	88	88	90	92	94	96	13%	1.5%
Miscellaneous	83	92	94	97	100	104	107	29%	3.2%
Total	**1,318**	**1,288**	**1,286**	**1,296**	**1,313**	**1,339**	**1,368**	**4%**	**0.5%**

Figure 5-3 Commercial Electricity Baseline Forecast by End Use

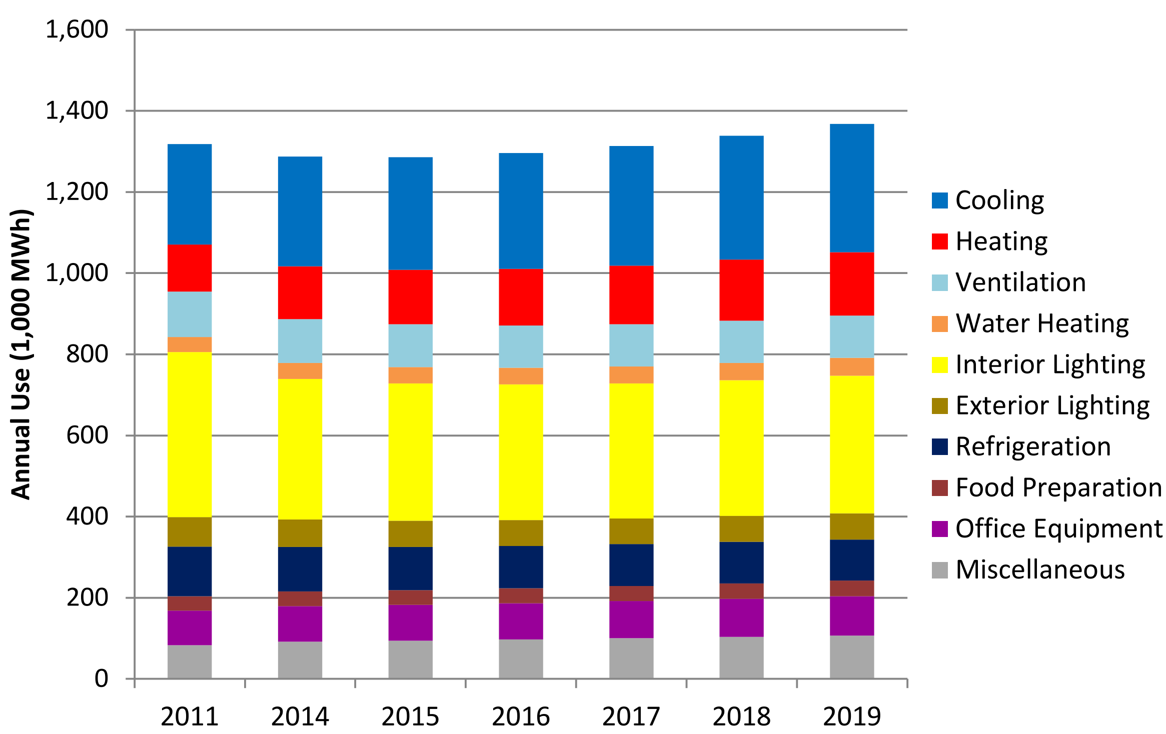


Table 5-4 presents the commercial sector electricity forecast by technology for select years. Interior screw-in lighting and refrigeration decrease significantly over the forecast period as a result of efficiency standards.

Table 5-4 Commercial Baseline Electricity Forecast by End Use and Technology (GWh)

End Use	Technology	2011	2014	2015	2017	2019	% Change	Avg. Growth Rate
Cooling	Air-Cooled Chiller	16	20	22	25	28	77.5%	7.2%
	Water-Cooled Chiller	34	38	39	42	45	33.6%	3.6%
	Roof top AC	173	175	175	177	182	5.3%	0.6%
	Geothermal Heat Pump	2	5	7	9	12	585.8%	24.1%
	Other Cooling	13	17	18	21	24	84.4%	7.6%
	Air Source Heat Pump	11	16	17	21	25	133.2%	10.6%
Heating	Geothermal Heat Pump	2	7	8	12	16	690.9%	25.8%
	Electric Room Heat	9	9	9	9	10	5.6%	0.7%
	Electric Furnace	93	95	95	96	98	5.6%	0.7%
	Air Source Heat Pump	12	19	22	27	33	179.9%	12.9%
Ventilation	Ventilation	112	108	106	104	104	-6.8%	-0.9%
Water Heating	Water Heating	37	39	40	42	44	17.4%	2.0%
Interior Lighting	Screw-in	163	110	104	99	103	-37.1%	-5.8%
	High-Bay Fixtures	36	27	25	23	22	-37.3%	-5.8%
	Linear Fluorescent	208	210	209	211	214	3.2%	0.4%
Exterior Lighting	Screw-in	18	18	17	16	17	-6.7%	-0.9%
	HID	49	45	43	42	42	-14.3%	-1.9%
	Linear Fluorescent	4	4	4	4	5	28.0%	3.1%
	Traffic Lights	1	1	0	0	0	-61.2%	-11.8%
	Crosswalk Lights	0	0	0	0	0	-73.0%	-16.3%
Refrigeration	Walk-in Refrigerator	38	32	30	29	28	-26.8%	-3.9%
	Reach-in Refrigerator	4	3	3	3	3	-30.3%	-4.5%
	Glass Door Display	45	40	39	37	36	-19.7%	-2.7%
	Open Display Case	20	20	21	21	21	5.1%	0.6%
	Icemaker	8	8	8	8	8	3.0%	0.4%
	Vending Machine	8	7	7	6	5	-31.0%	-4.6%
Food Preparation	Oven	8	8	8	9	9	22.4%	2.5%
	Fryer	11	12	12	13	13	19.6%	2.2%
	Dishwasher	13	12	12	12	12	-3.3%	-0.4%
	Hot Food Container	4	4	4	4	4	10.7%	1.3%
Office Equipment	Desktop Computer	43	45	45	46	49	13.0%	1.5%
	Laptop	7	7	7	8	8	24.3%	2.7%
	Server	20	20	20	21	23	12.9%	1.5%
	Monitor	8	8	8	9	9	14.8%	1.7%
	Printer/Copier/Fax	6	6	6	6	6	0.0%	0.0%
	POS Terminal	2	2	2	2	2	-7.5%	-1.0%
Miscellaneous	Non-HVAC Motors	19	19	19	20	20	5.2%	0.6%
	Pool Pump	0	0	0	0	0	9.9%	1.2%
	Pool Heater	0	0	0	0	0	13.2%	1.6%
	Miscellaneous	64	73	75	81	87	35.8%	3.8%
Total		**1,318**	**1,288**	**1,286**	**1,313**	**1,368**	**3.7%**	**0.5%**

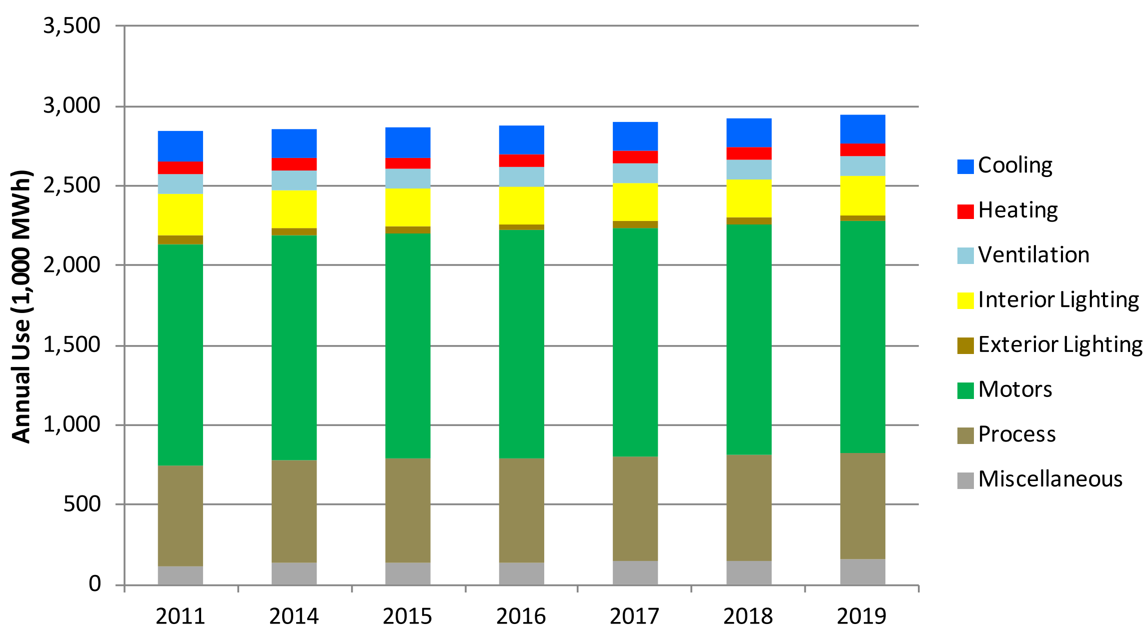
Industrial Sector

Table 5-5 and Figure 5-4 present the electricity baseline forecast at the end-use level for the industrial sector. Overall, industrial annual electricity use increases modestly from 2,845 GWh in 2011 to 2,943 GWh in 2019. This comprises an overall increase of 3.5%, or 0.4% per year, which is colored by slow but recovering economy.

Table 5-5 Industrial Electricity Consumption by End Use (GWh)

End Use	2011	2014	2015	2016	2017	2018	2019	% Change	Avg. Growth Rate
Cooling	192	186	184	182	182	181	181	-6%	-0.8%
Heating	76	78	78	78	79	79	80	5%	0.6%
Ventilation	122	121	119	119	118	118	118	-4%	-0.5%
Int. Lighting	266	245	240	240	241	246	249	-6%	-0.8%
Ext. Lighting	51	38	37	38	38	38	38	-25%	-3.6%
Motors	1,388	1,416	1,420	1,427	1,436	1,448	1,456	5%	0.6%
Process	630	646	649	653	657	663	667	6%	0.7%
Miscellaneous	118	132	136	140	145	150	154	31%	3.4%
Total	**2,845**	**2,861**	**2,863**	**2,877**	**2,896**	**2,922**	**2,943**	**3.5%**	**0.4%**

Figure 5-4 Industrial Electricity Baseline Forecast by End Use



Baseline Forecast Summary

Table 5-6 and Figure 5-5 provide a summary of the baseline forecast for electricity by sector for the entire Vectren service territory. Overall, the forecast shows only a slight incline in electricity use, driven primarily by oncoming codes and standards and a challenging macroeconomic environment.

Table 5-6 Electricity Baseline Forecast Summary (GWh)

Sector	2011	2014	2015	2016	2017	2018	2019	% Change	Avg. Growth Rate
Residential	1,483	1,482	1,459	1,453	1,463	1,476	1,488	0.3%	0.0%
Commercial	1,318	1,288	1,286	1,296	1,313	1,339	1,368	3.7%	0.5%
Industrial	2,845	2,861	2,863	2,877	2,896	2,922	2,943	3.5%	0.4%
Total	**5,646**	**5,630**	**5,608**	**5,626**	**5,673**	**5,738**	**5,799**	**2.7%**	**0.3%**

Figure 5-5 Electricity Baseline Forecast Summary (GWh)

ENERGY EFFICIENCY MEASURES

List of Energy Efficiency Measures

The first step of the energy efficiency measure analysis is to identify the list of all relevant energy efficiency measures that should be considered for the Vectren potential assessment.

For this study, EnerNOC prepared a preliminary list of measures for Vectren staff and stakeholders to review. After incorporating feedback, we populated the full databases for the three sectors.

Sources for the measure assumptions were drawn from past Vectren program and evaluation experience, EnerNOC's building simulation tool (BEST), EnerNOC's measure database (DEEM), TRM's from neighboring states of Illinois and Ohio, the California DEER, NWPCC workbooks, other secondary sources, and other data from EnerNOC's previous studies and program work.[10]

- **Residential Measures**. The residential measures span all end uses and vary significantly in the manner in which they impact energy consumption. All residential measures considered for this study are listed and described in Volume 3 Appendix B.
- **Commercial Measures**. All commercial measures considered for this study are listed and described in Volume 3 Appendix C.
- **Industrial Measures**. All industrial measures considered for this study are listed and described in Volume 3 Appendix D.

Results of the Economic Screen

Table 6-1 summarizes the number of equipment and non-equipment measures evaluated for each segment within each sector.

Table 6-1 Number of Measures Evaluated

	Residential	Commercial	Industrial	Total Number of Measures
Equipment Measures Evaluated	35	40	28	**103**
Non-Equipment Measures Evaluated	45	82	69	**196**
Total Measures Evaluated	**80**	**122**	**97**	**299**

The Volume 3 Appendices mentioned above give results for the economic screening process by segment, vintage, end use and measure for all sectors.

[10] The Indiana TRM being developed by the Indiana DSMCC EM&V subcommittee was not finalized and available at the time this study was being performed.

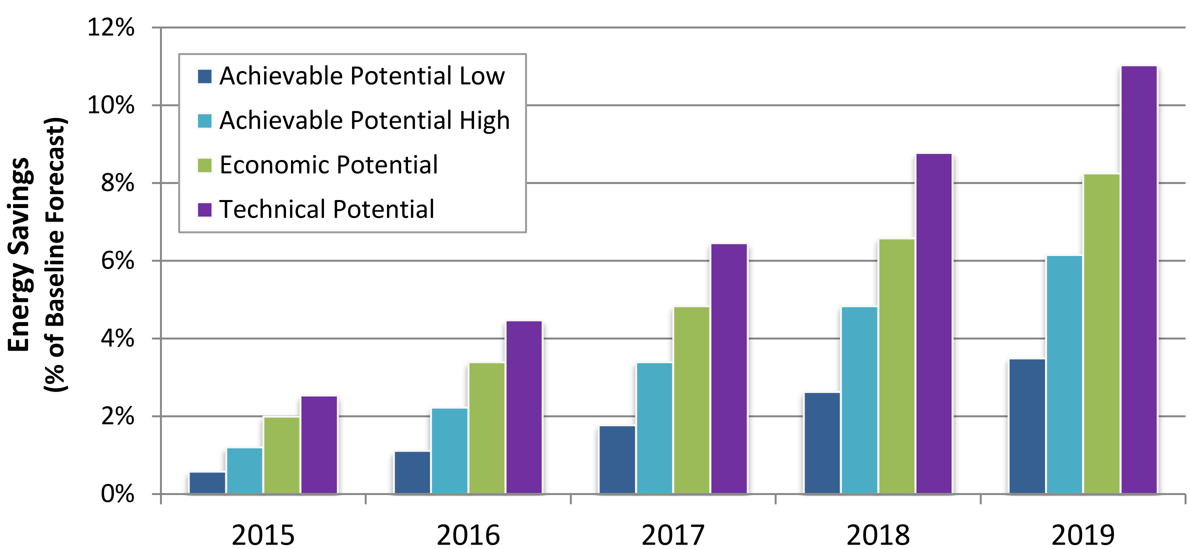
MEASURE-LEVEL ENERGY EFFICIENCY POTENTIAL

Table 7-1 and Figure 7-1 summarize the electric energy-efficiency savings for all measures at the different levels of potential relative to the baseline forecast. Figure 7-2 displays the electric energy-efficiency forecasts. Note that the subsequent steps of measure bundling, program design, and program delivery will hone and refine these results later in Chapter 8.[11]

Table 7-1 Overall Measure-Level Electricity Efficiency Potential

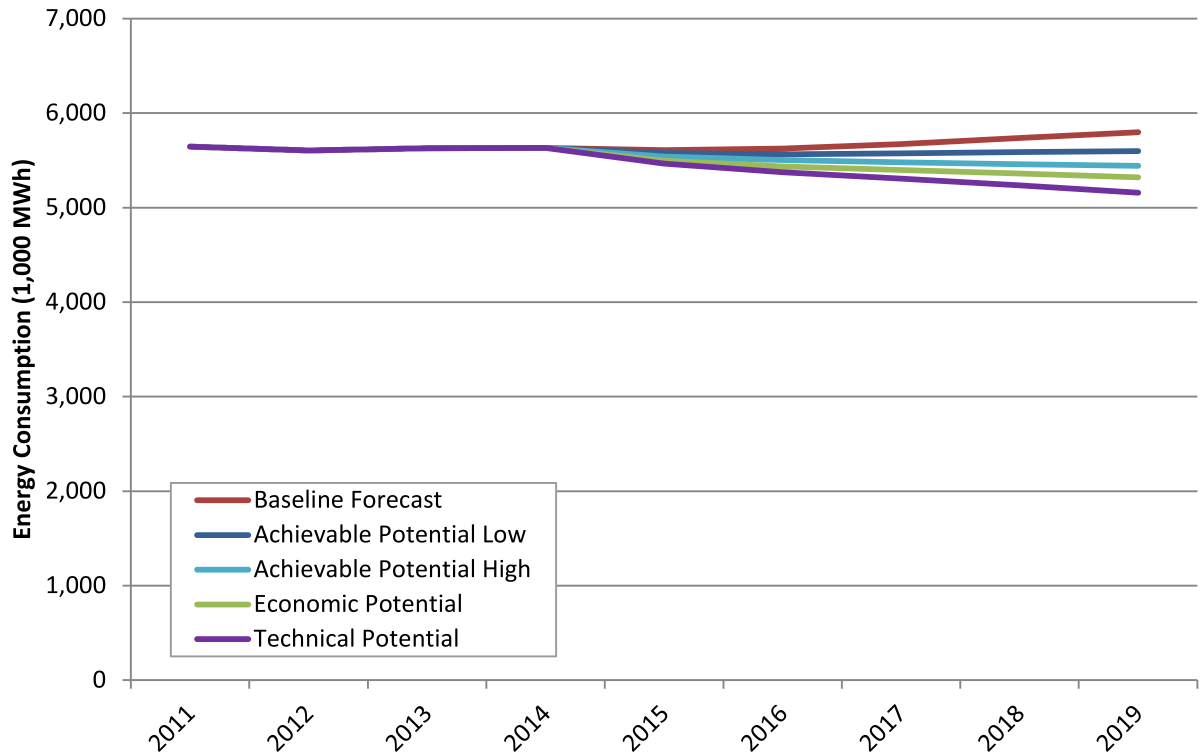
	2015	2016	2017	2018	2019
Baseline Forecast (GWh)	**5,608**	**5,626**	**5,673**	**5,738**	**5,799**
Cumulative Savings (GWh)					
Achievable Low Potential	32	63	100	151	203
Achievable High Potential	67	125	192	277	357
Economic Potential	112	191	274	377	478
Technical Potential	142	251	366	504	640
Energy Savings (% of Baseline)					
Achievable Low Potential	0.6%	1.0%	1.8%	2.6%	3.5%
Achievable High Potential	1.2%	2.2%	3.4%	4.8%	6.2%
Economic Potential	2.0%	3.4%	4.8%	6.6%	8.2%
Technical Potential	2.5%	4.5%	6.5%	8.8%	11.0%

Figure 7-1 Overall Measure-Level Electricity Efficiency Potential



[11] Utilities typically have a small subset of large commercial and industrial customers that comprise a disproportionate share of load and demand. In Vectren's case, there is one particular industrial customer that comprises a full 24% of the C&I load. If this customer were not to participate in EE programs, the savings potential would drop commensurately in the C&I sectors, which would remove approximately 15% from the overall savings potential in all sectors.

Figure 7-2 Overall Measure-Level Electricity Potentials Forecasts (GWh)



Overview of Measure-Level Energy Efficiency Potential by Sector

Table 7-2, Figure 7-3, and Figure 7-4 summarize the range of electric achievable potential by sector. The commercial sector accounts for the largest portion of the savings, followed by residential, and then industrial.

Table 7-2 Electric Achievable Potential by Sector (GWh)

	2015	2016	2017	2018	2019
Achievable Low Cumulative Savings (GWh)					
Residential	9.4	15.7	22.1	32.4	43.4
Commercial	12.1	22.8	36.0	53.0	71.8
Industrial	10.7	24.3	42.2	65.4	87.4
Total	**32.2**	**62.7**	**100.3**	**150.9**	**202.6**
Achievable High Cumulative Savings (GWh)					
Residential	20.4	32.0	43.8	60.9	76.8
Commercial	25.3	45.7	69.2	97.9	127.1
Industrial	21.7	47.2	79.4	118.7	152.7
Total	**67.3**	**124.9**	**192.5**	**277.4**	**356.7**

Figure 7-3 Achievable Low Electric Potential by Sector (GWh)

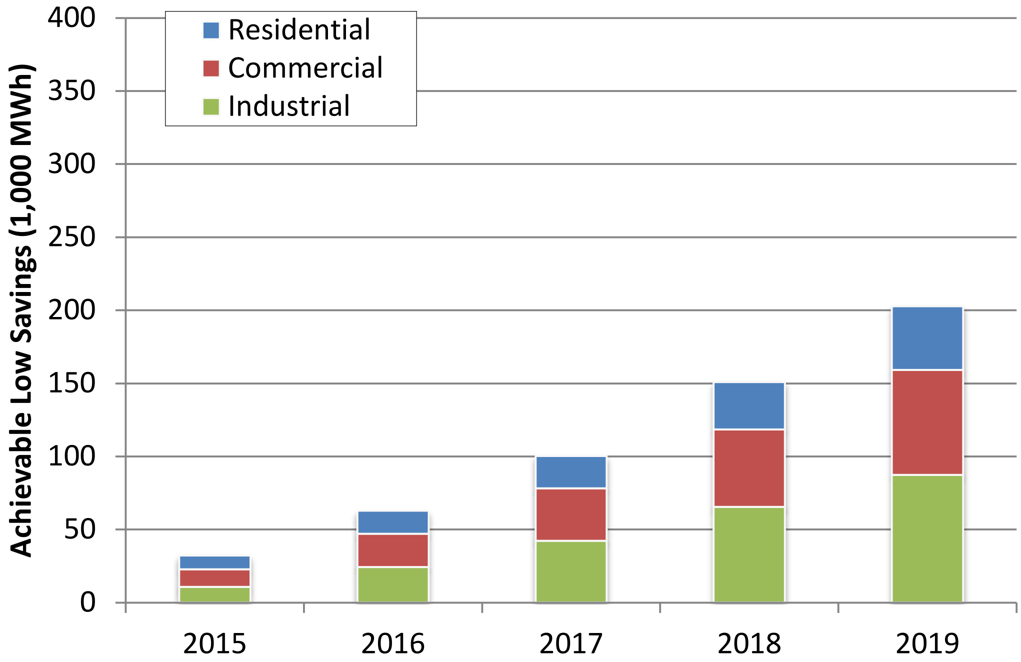
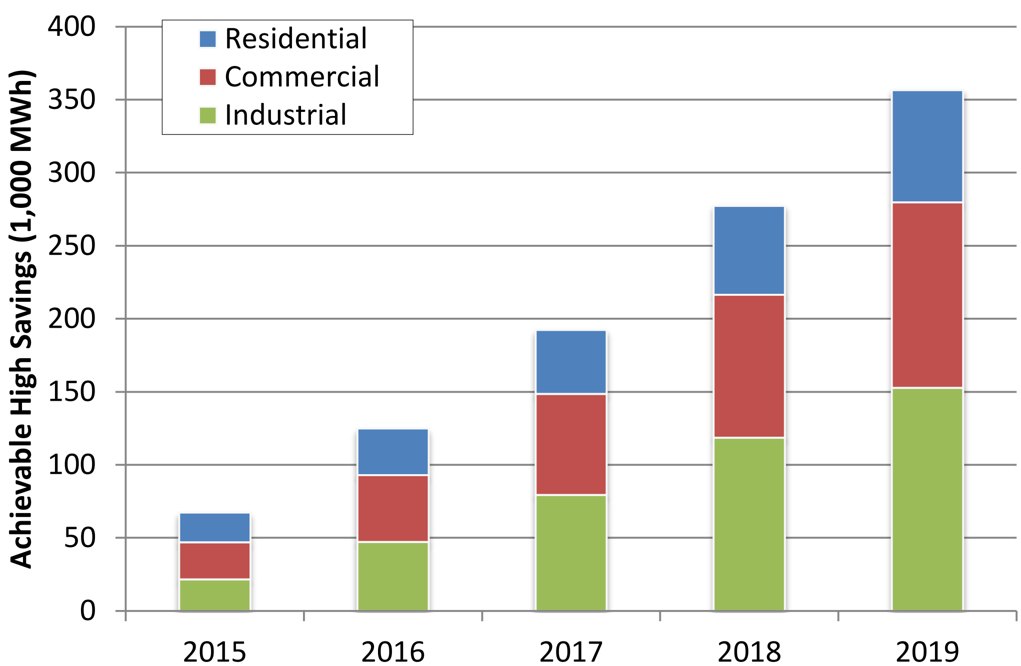


Figure 7-4 Achievable High Electric Potential by Sector (GWh)



Details for each sector are presented in the following chapter.

CHAPTER | 7

MEASURE-LEVEL ENERGY EFFICIENCY POTENTIAL BY SECTOR

This chapter presents the results of the energy efficiency analysis for all measures at the sector level. First, the residential potential is presented, followed by the commercial, and lastly, industrial. Note that the subsequent steps of measure bundling, program design, and program delivery will hone and refine these results later in Chapter 8.

Residential Electricity Potential

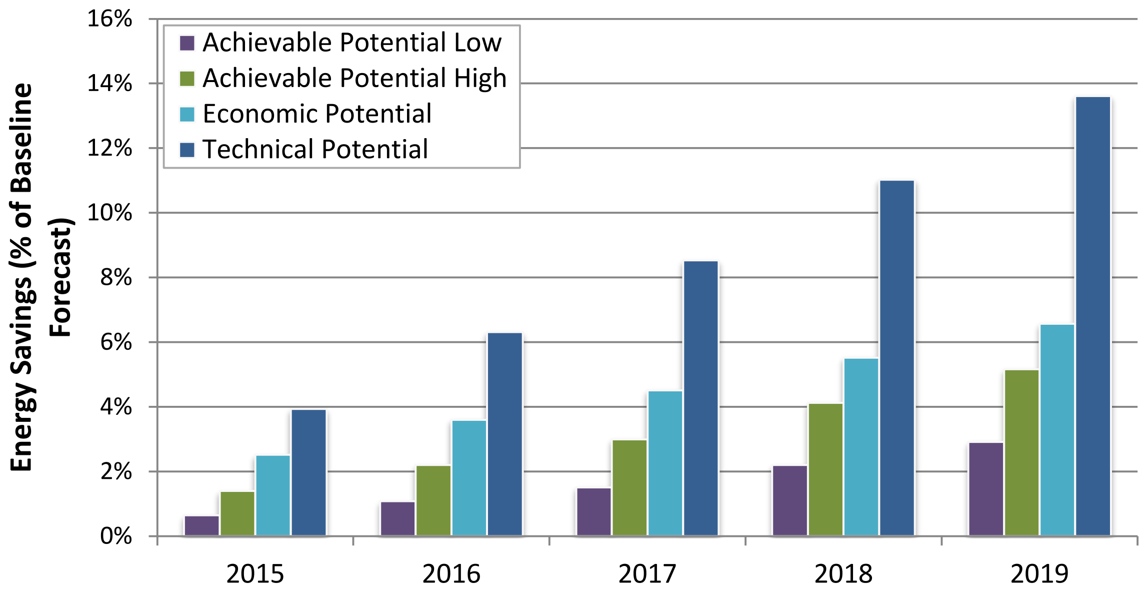
Table 7-1 presents estimates for the four types of potential for the residential electricity sector. Figure 7-1 depicts these potential energy savings estimates graphically.

- **Achievable Low potential** projects 9 GWh of energy savings in 2015, 0.6% of the baseline forecast. This increases to 43 GWh, 2.9% of the baseline forecast, in 2019.
- **Achievable High potential** is 20 GWh in 2015, which represents 1.4% of the baseline forecast. By 2019, the cumulative energy savings are 77 GWh, 5.2% of the baseline forecast.
- **Economic potential,** which reflects a theoretical limit to savings when all cost-effective measures are taken, is 37 GWh in 2015. This represents 2.5% of the baseline energy forecast. By 2019, economic potential reaches 98 GWh, 6.6% of the baseline energy forecast.
- **Technical potential,** which reflects the adoption of all energy efficiency measures regardless of cost, is a theoretical upper bound on savings. In 2015, energy savings are 57 GWh, or 3.9% of the baseline energy forecast. By 2019, technical potential reaches 203 GWh, 13.6% of the baseline energy forecast.

Table 7-1 Electricity Energy Efficiency Potential for the Residential Sector

	2015	2016	2017	2018	2019
Baseline Forecast (GWh)	**1,459**	**1,453**	**1,463**	**1,476**	**1,488**
Cumulative Savings (GWh)					
Achievable Low Potential	9	16	22	32	43
Achievable High Potential	20	32	44	61	77
Economic Potential	37	52	66	81	98
Technical Potential	57	92	125	163	203
Energy Savings (% of Baseline)					
Achievable Low Potential	0.6%	1.1%	1.5%	2.2%	2.9%
Achievable High Potential	1.4%	2.2%	3.0%	4.1%	5.2%
Economic Potential	2.5%	3.6%	4.5%	5.5%	6.6%
Technical Potential	3.9%	6.3%	8.5%	11.0%	13.6%

Figure 7-1 Residential Electric Energy Efficiency Potential Savings



Residential Electric Potential by Market Segment

Single-family homes in Vectren account for the majority of this sector's total sales in the base year and throughout the forecast. Similarly, single-family homes account for the largest share of potential savings by segment, as displayed in Table 7-2, which shows results for 2017.

Table 7-2 Residential Electric Potential by Market Segment, 2017

	Single Family	Multi Family
Baseline Forecast (GWh)	**1,299**	**165**
Energy Savings (GWh)		
Achievable Low Potential	19	3
Achievable High Potential	39	5
Economic Potential	59	7
Technical Potential	111	14
Energy Savings as % of Baseline		
Achievable Low Potential	1.5%	1.6%
Achievable High Potential	3.0%	3.2%
Economic Potential	4.5%	4.3%
Technical Potential	8.6%	8.3%

Table 7-3 shows the Achievable Low savings by end use and market segment in 2017. Single-family homes have more exterior lighting and so have more savings potential for this end use.

Table 7-3 Residential Electric Achievable Low Potential by End Use and Market Segment, 2017 (GWh)

End Use	Single Family	Multi Family
Cooling	1.1	0.0
Heating	0.5	0.0
Water Heating	0.3	0.1
Interior Lighting	11.3	1.5
Exterior Lighting	1.8	0.4
Appliances	0.4	0.0
Electronics	3.9	0.5
Miscellaneous	0.2	-
Total	**19.5**	**2.7**

Residential Electric Potential by End Use

Table 7-4 provides estimates of savings for each end use and type of potential. The most significant savings opportunities come from the lighting end use.

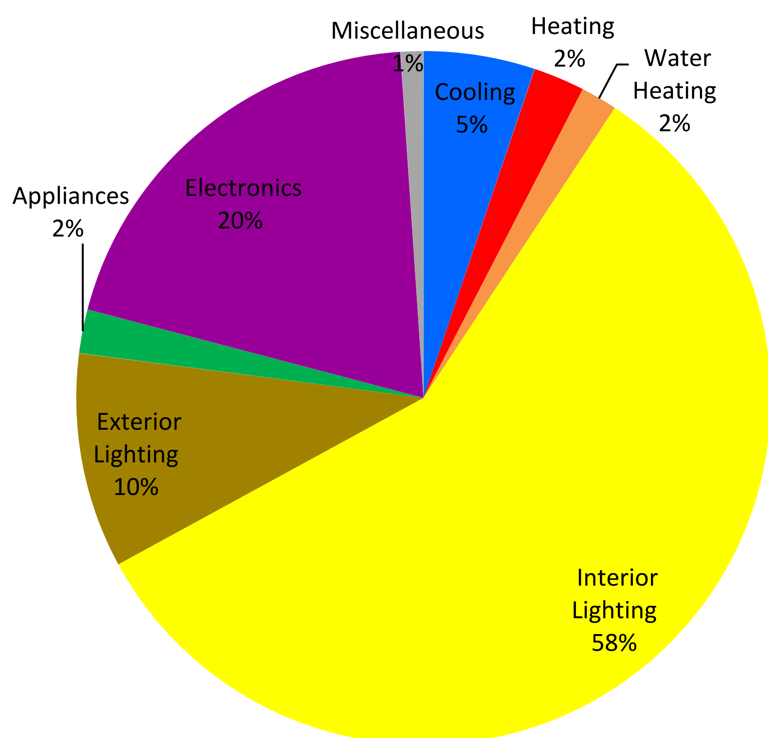
Table 7-4 Residential Electric Savings by End Use and Potential Type (GWh)

End Use	Case	2015	2017	2019
Cooling	Achievable Potential Low	0.23	1.15	3.59
	Achievable Potential High	0.47	2.25	6.67
	Economic Potential	1.13	5.00	12.55
	Technical Potential	8.82	28.79	53.69
Heating	Achievable Potential Low	0.09	0.53	1.72
	Achievable Potential High	0.20	1.08	3.28
	Economic Potential	0.62	2.70	6.69
	Technical Potential	1.20	4.91	11.68
Water Heating	Achievable Potential Low	0.10	0.38	0.95
	Achievable Potential High	0.21	0.76	1.78
	Economic Potential	0.23	0.98	2.39
	Technical Potential	3.97	13.09	24.61
Interior Lighting	Achievable Potential Low	6.34	12.77	21.27
	Achievable Potential High	13.77	25.32	36.26
	Economic Potential	24.05	32.01	31.16
	Technical Potential	27.90	38.81	40.09
Exterior Lighting	Achievable Potential Low	1.44	2.22	3.71
	Achievable Potential High	3.13	4.38	5.97
	Economic Potential	4.33	4.10	4.68
	Technical Potential	5.40	5.42	5.47
Appliances	Achievable Potential Low	0.22	0.45	0.74
	Achievable Potential High	0.34	0.50	0.75
	Economic Potential	0.08	0.36	0.78
	Technical Potential	2.66	8.29	14.26
Electronics	Achievable Potential Low	0.96	4.39	10.97
	Achievable Potential High	2.09	9.05	21.16
	Economic Potential	5.68	19.11	36.86
	Technical Potential	5.81	20.78	45.31
Miscellaneous	Achievable Potential Low	0.07	0.23	0.47
	Achievable Potential High	0.14	0.49	0.93
	Economic Potential	0.59	1.63	2.62
	Technical Potential	1.63	4.66	7.41
Total	**Achievable Potential Low**	**9.44**	**22.11**	**43.42**
	Achievable Potential High	**20.35**	**43.82**	**76.80**
	Economic Potential	**36.72**	**65.90**	**97.74**
	Technical Potential	**57.39**	**124.75**	**202.53**

Figure 7-2 focuses on the residential achievable low potential in 2017. Lighting equipment replacement accounts for the highest portion of the savings in the near term as a result of the efficiency gap between CFL lamps and advanced incandescent lamps, even those that will meet the EISA 2007 standard. Electronics, cooling, and appliances also contribute significantly to the savings. Detailed measure information is available in Volume 3 Appendices. The key measures comprising the potential are listed below:

- Lighting: mostly CFL lamps and specialty bulbs
- Electronics (reduce standby wattage, televisions, set top boxes, PCs)
- Second refrigerator/ freezer removal
- HVAC: Removal of second room AC unit, efficient air conditioners, ducting repair/sealing, insulation, home energy management system and programmable thermostats

Figure 7-2 Residential Electric Achievable Low Potential by End Use in 2017



Commercial Electricity Potential

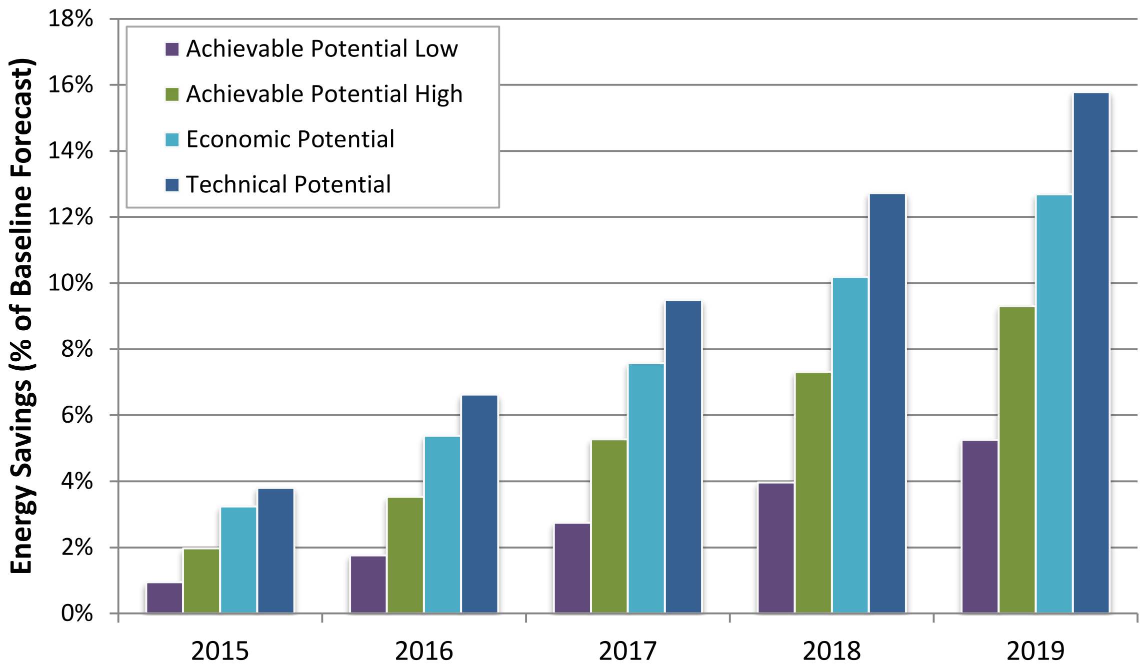
The baseline forecast for the commercial sector only grows slightly, which reflects the sluggish near-term economy and forthcoming codes and standards. Nevertheless, the opportunity for energy-efficiency savings is still significant for the commercial sector. Table 7-5 presents estimates for the four types of potential for the residential electricity sector. Figure 8-3 depicts these potential energy savings estimates graphically.

- **Achievable Low potential** projects 12 GWh of energy savings in 2015, 0.9% of the baseline forecast. The cumulative savings increase to 72 GWh, 5.3% of the baseline forecast, in 2019.
- **Achievable High potential** is 25 GWh in 2015, which represents 2.0% of the baseline forecast. By 2019, the cumulative energy savings are 127 GWh, 9.3% of the baseline forecast.
- **Economic potential,** which reflects a theoretical limit to savings when all cost-effective measures are taken, is 42 GWh in 2015. This represents 3.2% of the baseline energy forecast. By 2019, cumulative economic potential reaches 173 GWh, 12.7% of the baseline energy forecast.
- **Technical potential,** which reflects the adoption of all energy efficiency measures regardless of cost, is a theoretical upper bound on savings. In 2015, energy savings are 49 GWh, or 3.8% of the baseline energy forecast. By 2019, technical potential reaches 216 GWh, 15.8% of the baseline energy forecast.

Table 7-5 Electricity Efficiency Potential for the Commercial Sector

	2015	2016	2017	2018	2019
Baseline Forecast (GWh)	**1,286**	**1,296**	**1,313**	**1,339**	**1,368**
Cumulative Savings (GWh)					
Achievable Low Potential	12	23	36	53	72
Achievable High Potential	25	46	69	98	127
Economic Potential	42	70	99	136	173
Technical Potential	49	86	125	170	216
Savings (% of Baseline)					
Achievable Low Potential	0.9%	1.8%	2.7%	4.0%	5.3%
Achievable High Potential	2.0%	3.5%	5.3%	7.3%	9.3%
Economic Potential	3.2%	5.4%	7.6%	10.2%	12.7%
Technical Potential	3.8%	6.6%	9.5%	12.7%	15.8%

Figure 7-3 Commercial Energy Efficiency Potential Savings



Commercial Electric Potential by Market Segment

Table 7-6 shows potential estimates by building type segment in 2017. Retail has the largest Achievable Low savings potential in 2017, followed by warehouse, grocery, and offices. Table 7-7 summarizes achievable potential for each segment and end use.

Table 7-6 Commercial Electric Potential by Market Segment, 2017

	Small Office	Large Office	Restaurant	Retail	Grocery	College
Baseline Forecast	**145**	**188**	**70**	**254**	**124**	**78**
Energy Savings (GWh)						
Achievable Low Potential	3	4	2	7	4	2
Achievable High Potential	7	8	4	13	8	4
Economic Potential	10	12	5	19	12	6
Technical Potential	14	16	6	25	14	7
Energy Savings (% of Baseline)						
Achievable Low Potential	2.35%	2.25%	2.84%	2.65%	3.63%	2.61%
Achievable High Potential	4.58%	4.40%	5.46%	5.11%	6.87%	5.06%
Economic Potential	7.09%	6.37%	7.71%	7.41%	9.56%	7.33%
Technical Potential	9.39%	8.44%	9.09%	9.70%	11.24%	9.19%
	School	**Health**	**Lodging**	**Warehouse**	**Misc.**	**TOTAL**
Baseline Forecast	**71**	**143**	**29**	**134**	**77**	**1,313**
Energy Savings (GWh)						
Achievable Low Potential	2	3	1	4	3	**36**
Achievable High Potential	4	7	1	8	5	**69**
Economic Potential	5	9	2	13	7	**100**
Technical Potential	7	11	2	15	8	**125**
Energy Savings (% of Baseline)						
Achievable Low Potential	2.79%	2.38%	2.50%	3.31%	3.30%	**2.74%**
Achievable High Potential	5.42%	4.56%	4.77%	6.34%	6.33%	**5.28%**
Economic Potential	7.02%	6.46%	5.68%	9.43%	9.31%	**7.60%**
Technical Potential	9.54%	7.87%	7.34%	11.18%	10.58%	**9.51%**

Table 7-7 Commercial Electric Achievable Low Potential by End Use and Market Segment, 2017 (GWh)

Segment	Cooling	Space Heating	Ventilation	Water Heat	Int. Lighting	Ext. Lighting	Food Prep	Refrigera tion	Office Equip	Misc	Total
Small Office	1.1	0.2	0.2	0.2	0.7	0.5	0.0	0.0	0.6	0.0	3.4
Large Office	0.9	0.2	0.6	0.2	1.1	0.2	0.0	0.0	1.1	0.0	4.2
Restaurant	0.3	0.0	0.2	0.2	0.2	0.2	0.2	0.6	0.0	0.0	2.0
Retail	1.3	0.7	0.5	0.4	2.2	1.0	0.1	0.3	0.3	0.0	6.7
Grocery	0.6	0.4	0.2	0.1	0.6	0.2	0.5	1.9	0.0	0.0	4.5
College	0.4	0.1	0.2	0.2	0.8	0.2	0.0	0.0	0.1	0.0	2.0
School	0.1	0.1	0.2	0.1	1.0	0.2	0.0	0.1	0.1	0.0	2.0
Health	0.1	0.1	0.1	0.1	0.6	0.1	0.0	0.1	0.1	0.0	1.3
Lodging	0.3	0.5	0.2	0.1	1.5	0.1	0.0	0.2	0.0	0.0	3.0
Warehouse	0.5	0.2	0.2	0.1	1.1	0.7	0.1	0.0	0.2	0.0	3.1
Misc.	1.0	0.4	0.7	0.1	0.9	0.4	0.0	0.1	0.1	0.0	3.7
Traffic Signals	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**6.6**	**2.8**	**3.3**	**1.9**	**10.7**	**3.8**	**0.9**	**3.3**	**2.6**	**0.0**	**36.0**

Commercial Electric Potential by End Use

Table 7-8 presents the commercial sector savings by end use and potential type. The end uses with the highest technical and economic potential are lighting, cooling, ventilation, and refrigeration.

Figure 7-4 focuses on achievable potential savings by end use. Not surprisingly, interior lighting delivers the highest achievable savings throughout the study period. In 2017, Cooling is second, and exterior lighting is third. Regarding refrigeration, it is interesting to point out a relatively new control and sensing technology that vendors such as “eCube” are using to regulate the system energy. The technology consists of a solid, waxy food simulant that is fitted around a thermostat sensor that would otherwise measure air temperature. The refrigeration controls therefore attempt to regulate the temperature of food, which changes more slowly and gradually than air, thereby reducing the frequency of refrigeration on/off cycles. Refrigeration energy savings are then followed in descending order by cooling, ventilation, office equipment, and small amounts of the other end uses.

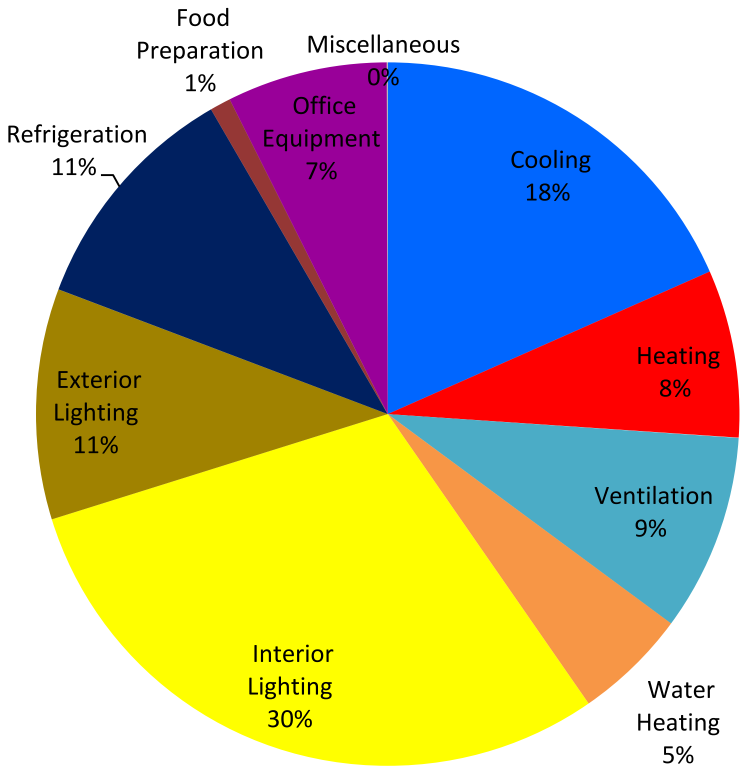
Detailed measure information is available in the Volume 3 Appendices. The key measures comprising the potential are listed below:

- Lighting – CFLs, LED lamps, linear fluorescent, daylighting controls, occupancy sensors, and HID lamps for exterior lighting
- Energy management systems & programmable thermostats
- Ventilation – variable speed control
- Refrigeration – efficient equipment, control systems, decommissioning
- Efficient office equipment – computers, servers

Table 7-8 Commercial Potential by End Use and Potential Type (GWh)

End Use	Case	2015	2017	2019
Cooling	Achievable Potential Low	1	7	13
	Achievable Potential High	3	13	23
	Economic Potential	6	20	36
	Technical Potential	9	32	56
Heating	Achievable Potential Low	0	0	0
	Achievable Potential High	0	0	0
	Economic Potential	1	3	6
	Technical Potential	1	6	11
Ventilation	Achievable Potential Low	3	10	17
	Achievable Potential High	4	13	21
	Economic Potential	1	3	5
	Technical Potential	1	3	5
Water Heating	Achievable Potential Low	1	4	8
	Achievable Potential High	2	8	14
	Economic Potential	4	13	22
	Technical Potential	4	14	24
Interior Lighting	Achievable Potential Low	4	7	15
	Achievable Potential High	10	14	28
	Economic Potential	16	21	36
	Technical Potential	16	21	36
Exterior Lighting	Achievable Potential Low	2	4	7
	Achievable Potential High	4	8	10
	Economic Potential	4	6	6
	Technical Potential	4	6	6
Refrigeration	Achievable Potential Low	1	4	9
	Achievable Potential High	2	8	16
	Economic Potential	3	10	17
	Technical Potential	4	16	29
Food Preparation	Achievable Potential Low	0	0	1
	Achievable Potential High	0	1	1
	Economic Potential	0	1	2
	Technical Potential	0	1	2
Office Equipment	Achievable Potential Low	1	2	2
	Achievable Potential High	2	4	4
	Economic Potential	3	7	8
	Technical Potential	4	8	10
Miscellaneous	Achievable Potential Low	0	1	3
	Achievable Potential High	1	3	5
	Economic Potential	0	0	0
	Technical Potential	0	0	0
Total	**Achievable Potential Low**	**14**	**40**	**75**
	Achievable Potential High	**26**	**71**	**124**
	Economic Potential	**38**	**84**	**139**
	Technical Potential	**44**	**108**	**179**

Figure 7-4 Commercial Achievable Low Potential Electricity Savings by End Use in 2017



Industrial Electricity Potential

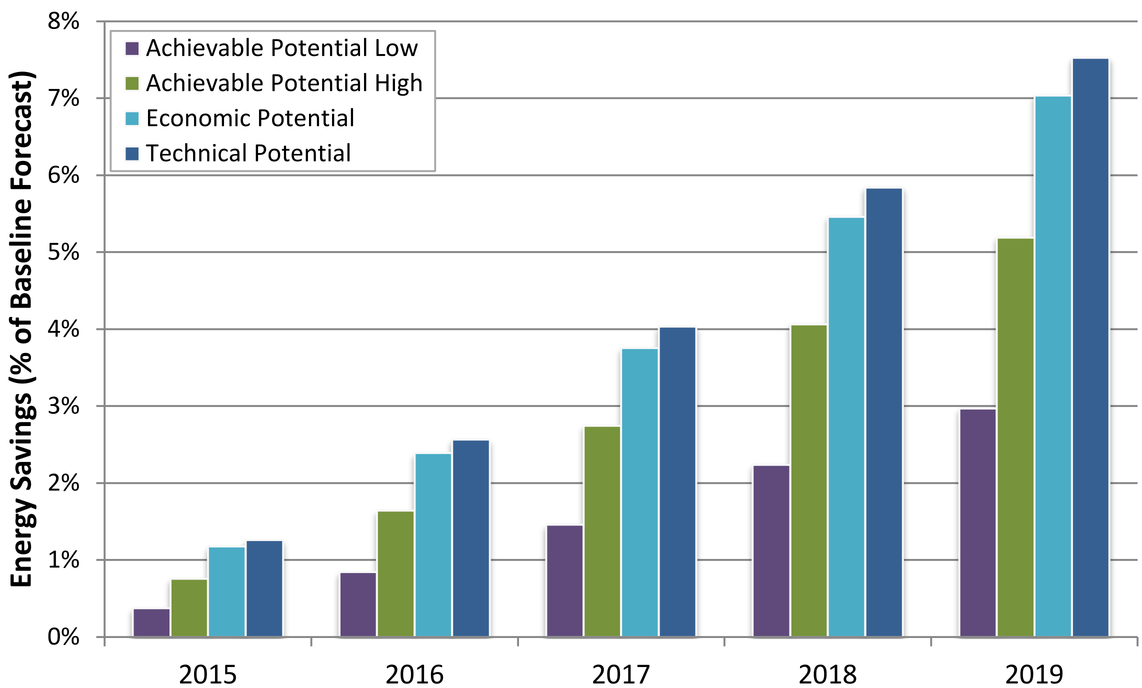
The Vectren industrial sector accounts for 51% of total energy consumption, making for prime efficiency opportunities. Table 7-9 and Figure 7-5 present the savings for the various types of potential considered in this study.

- **Achievable Low potential** projects 11 GWh of energy savings in 2015 and 87 GWh in 2019. This corresponds to 0.4% of the baseline forecast in 2015 and 3.0% in 2019.
- **Achievable High potential** is 22 GWh in 2015, which represents 0.8% of the baseline forecast. By 2019, the cumulative energy savings are 153 GWh, 5.2% of the baseline forecast.
- **Economic potential**, which reflects the savings when all cost-effective measures are taken, is 34 GWh in 2015. This represents 1.2% of the baseline energy forecast. By 2019, economic potential reaches 207 GWh, 7.0% of the baseline energy forecast.
- **Technical potential,** which reflects the adoption of all energy efficiency measures regardless of cost, is a theoretical upper bound on savings. In 2015, energy savings are 36 GWh, or 1.3% of the baseline energy forecast. By 2019, technical potential reaches 221 GWh, 7.5% of the baseline energy forecast.

Table 7-9 Electric Efficiency Potential for the Industrial Sector

	2015	2016	2017	2018	2019
Energy Forecasts (GWh)	**2,863**	**2,877**	**2,896**	**2,922**	**2,943**
Cumulative Energy Savings (GWh)					
Achievable Low Potential	11	24	42	65	87
Achievable High Potential	22	47	79	119	153
Economic Potential	34	69	109	160	207
Technical Potential	36	74	117	171	221
Energy Savings (% of Baseline Forecast)					
Achievable Low Potential	0.4%	0.8%	1.5%	2.2%	3.0%
Achievable High Potential	0.8%	1.6%	2.7%	4.1%	5.2%
Economic Potential	1.2%	2.4%	3.8%	5.5%	7.0%
Technical Potential	1.3%	2.6%	4.0%	5.8%	7.5%

Figure 7-5 Industrial Electric Potential Savings



Industrial Electric Potential by Market Segment

Table 7-10 shows electric energy efficiency potential for the four industrial segments in 2017. Table 7-11 shows the Achievable Low savings by end use and market segment in 2017.

Table 7-10 Industrial Electric Potential by Market Segment, 2017

	Transportation	Other Industrial	Chemicals	Plastics	Total
Baseline Forecast (GWh)	**294**	**822**	**465**	**1,314**	**2,896**
Cumulative Savings (GWh)					
Achievable Low Potential	4	13	7	19	**42**
Achievable High Potential	7	25	13	35	**79**
Economic Potential	10	35	16	48	**109**
Technical Potential	11	38	17	51	**117**
Savings as % of Baseline					
Achievable Low Potential	1.27%	1.60%	1.43%	1.42%	1.46%
Achievable High Potential	2.40%	3.02%	2.69%	2.66%	2.74%
Economic Potential	3.37%	4.22%	3.51%	3.63%	3.75%
Technical Potential	3.69%	4.57%	3.71%	3.89%	4.03%

Table 7-11 Industrial Electric Achievable Potential Low by End Use and Market Segment, 2017

End Use	Transportation	Other Industrial	Chemicals	Plastics	Total
Cooling	0.62	2.18	0.31	1.48	4.58
Heating	0.11	0.40	0.06	0.27	0.84
Ventilation	0.09	0.33	0.05	0.23	0.70
Int. Lighting	1.26	4.04	0.55	3.22	9.08
Ext. Lighting	0.04	0.12	0.02	0.10	0.27
Motors	1.27	5.27	5.06	9.88	21.49
Process	0.35	0.82	0.61	3.48	5.26
Miscellaneous	-	-	-	-	-
Grand Total	**3.74**	**13.17**	**6.66**	**18.66**	**42.23**

Industrial Electric Potential by End Use

Table 7-12 provides estimates of savings for each end use and type of potential. Not surprisingly, the largest savings opportunities are found in motors and drives.

Table 7-12 Industrial Electric Potential by End Use and Potential Type (GWh)

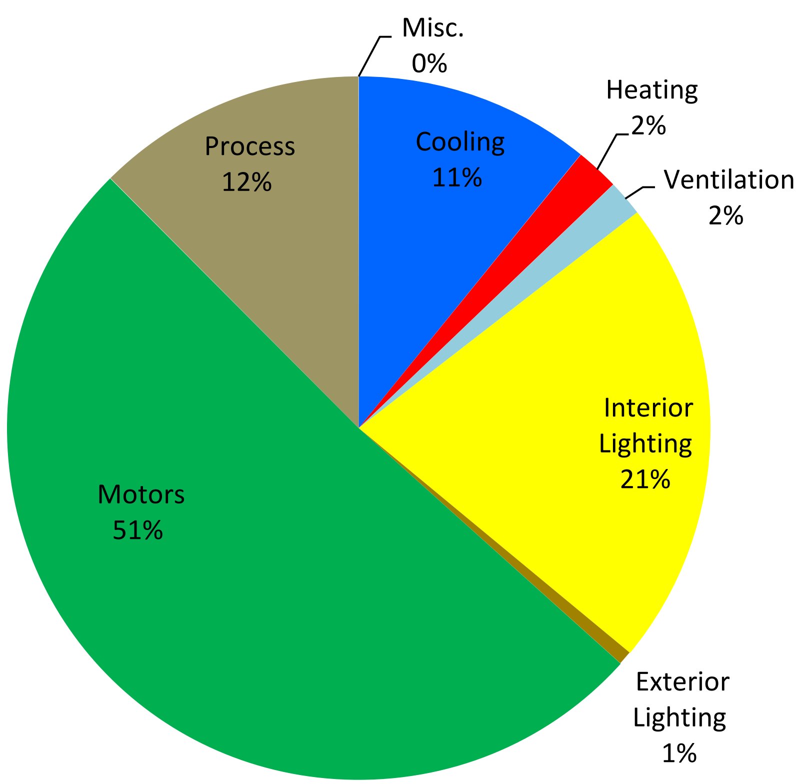
End Use	Potential	2015	2017	2019
Cooling	Achievable Low Potential	1.13	4.58	8.52
	Achievable High Potential	2.28	8.65	14.96
	Economic Potential	3.77	12.04	20.83
	Technical Potential	3.96	12.70	21.87
Heating	Achievable Low Potential	0.20	0.84	1.76
	Achievable High Potential	0.40	1.59	3.09
	Economic Potential	0.53	1.88	3.70
	Technical Potential	0.61	2.16	4.08
Ventilation	Achievable Low Potential	0.19	0.70	1.35
	Achievable High Potential	0.42	1.45	2.67
	Economic Potential	2.31	6.41	10.02
	Technical Potential	2.44	6.89	10.93
Interior Lighting	Achievable Low Potential	2.59	9.08	23.59
	Achievable High Potential	5.32	17.11	41.13
	Economic Potential	8.58	22.04	46.85
	Technical Potential	9.06	24.03	50.62
Exterior Lighting	Achievable Low Potential	0.11	0.27	0.44
	Achievable High Potential	0.22	0.54	0.84
	Economic Potential	0.31	0.71	1.12
	Technical Potential	0.54	1.67	3.22
Motors	Achievable Low Potential	5.09	21.49	42.38
	Achievable High Potential	10.23	40.37	73.95
	Economic Potential	14.69	53.68	103.18
	Technical Potential	14.94	54.07	103.20
Process	Achievable Low Potential	1.41	5.26	9.34
	Achievable High Potential	2.78	9.74	16.08
	Economic Potential	3.52	11.89	21.27
	Technical Potential	4.11	13.83	24.63
Miscellaneous	Achievable Low Potential	-	-	-
	Achievable High Potential	-	-	-
	Economic Potential	-	-	-
	Technical Potential	-	-	-
Total	Achievable Low Potential	**10.72**	**42.23**	**87.38**
	Achievable High Potential	**21.66**	**79.44**	**152.72**
	Economic Potential	**33.71**	**108.65**	**206.97**
	Technical Potential	**35.66**	**115.35**	**218.55**

Figure 7-6 illustrates the achievable potential savings by electric end use in 2017 for the industrial sector. The largest shares of savings opportunities are in the motors and machine drives. Potential savings for straight motor equipment change-outs are being eliminated due to the National Electrical Manufacturer's Association (NEMA) standards, which now make premium efficiency motors the baseline efficiency level. As a result, potential savings are incrementally small to upgrade to even more efficient levels. All the savings opportunities in this end use come from controls, timers, and variable speed drives, which improve system efficiencies where motors are utilized. These system-level measures and upgrades are also applicable to a large swath of applications for heating, cooling, and electrochemical processes. Since the plastics industry is so prominent in the Vectren service territory, measures such as injection molding barrel insulation are very promising sources of potential savings.

Beyond motors and processes, there are large opportunities for savings in lighting and cooling; and smaller opportunities in ventilation and space heating. Detailed measure information is available in the Volume 3 Appendices. The key measures comprising the potential are listed below:

- Motors – drives and controls
- Process – timers and controls
- Application optimization and control – fans, pumps, compressed air
- Efficient high bay lighting
- Efficient ventilation systems
- Energy management systems & programmable thermostats

Figure 7-6 Industrial Achievable Low Electricity Potential Savings by End Use in 2017



PROGRAM POTENTIAL AND ACTION PLAN

The Action Plan is the heart of the study. This is where the multitude of energy efficiency measures covered in previous chapters get bundled into delivery mechanisms to take on the form of specific energy efficiency programs. Several changes and adjustments occur in the translation from the market potential assessment to the program designs in the Action Plan, as the measure mix may change due to program delivery considerations. Table 8-1 below lists the distinct programs that emerge from this exercise to deliver an effective and balanced portfolio of energy savings opportunities across all customer segments.

Table 8-1 Portfolio of Energy Efficiency Programs Included in Action Plan

Residential Programs	Commercial & Industrial Programs
Lighting	Prescriptive
Efficient Products	Custom Incentives
Income Qualified Weatherization (IQW)	Schools Program
IQW Plus	Strategic Energy Management (SEM)
New Construction	Business & Multi Family New Construction
Multi Family Direct Install	Small Business Direct Install
Home Energy Assessment	
School Kit	
Whole House Plus	
Appliance Recycling	
Behavioral Feedback Tools	

Programmatic Framework

Each program contemplates and outlines a programmatic framework for administrators and implementers. The items considered and developed for this framework include those listed below. Detailed write-ups delve into the specific recommendations for each program in Volume 4 of this report.

- Target market
- Implementation strategy, including delivery channels, marketing, education and outreach
- Program issues, risks and risk management strategies
- Eligible measures and incentives
- Evaluation, measurement and verification requirements and guidance
- Administrative requirements
- Estimated participation
- Program budget
- Program energy savings and demand reduction
- Cost effectiveness

The state of Indiana has mandated efficiency targets for regulated electric utilities, specifying that they reach certain levels of savings by implementing a required set of programs, known as Core programs, and that they should make up any shortfall between the targets and the Core program savings with a flexible or optional set of Core Plus programs, which can be designed to suit each utility. The Residential Lighting, Income Qualified Weatherization, Home Energy Assessment, School Kit, and Business Prescriptive programs are Core programs; and the remainder are Core Plus. These distinctions are outlined later in the program highlights and descriptions.

The total amount of energy efficiency savings required by the state targets, in gross incremental savings per year, is shown as a percent of the baseline forecast in Table 8-2 below.

Table 8-2 Indiana State Goals, Gross Incremental Electricity Savings as % of Baseline

2015	2016	2017	2018	2019
1.30%	1.50%	1.70%	1.90%	2.00%

Using Achievable High and Achievable Low as Guidelines

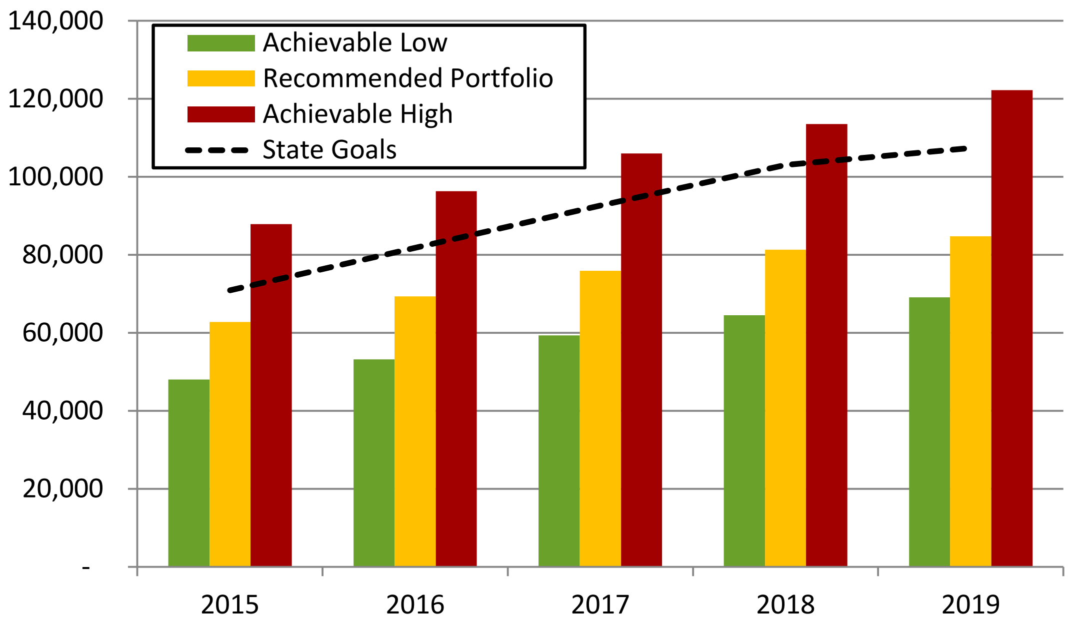
The first step toward creating the recommended Action Plan was to create two separate scenarios that corresponded to the measure-level energy efficiency potentials assessed in the previous chapter: Achievable Low and Achievable High. After applying all the delivery and cost structures, each of the Low and High portfolios resulted in a set of program potential savings and estimated budgets.

These portfolios provided guidelines, allowing us create the Recommended Action Plan by interpolating between Low and High, optimizing to consider the Indiana state goals, past program experience, industry benchmarks, and feedback from Vectren and Stakeholders.

Figure 8-1 below shows the resulting Gross MWh savings per year for the three separate portfolios, along with a black, dotted line indicating the level of the state goals. Note that the recommended portfolio is not able to meet the state goals in any year. Note also that the savings on this chart are in terms of Gross incremental savings since the Indiana goals are expressed as such, and that all other potential savings in this report are given in terms of Net incremental or Net cumulative savings.[12]

[12] Utilities typically have a small subset of large commercial and industrial customers that comprise a disproportionate share of load and demand. In Vectren's case, there is one particular industrial customer that comprises a full 24% of the C&I load. If this customer were not to participate in EE programs, the savings potential would drop commensurately in the C&I sectors, which would remove approximately 15% from the overall savings potential in all sectors.

Figure 8-1 Gross Incremental Electricity Savings (MWh)



To provide an indication of the relative level of program effort between the three portfolios and how the recommended portfolio was reached, key indicators are provided in Table 8-3 below. The remainder of this report focuses on the delivery of the Recommended Portfolio specifically, and further details of the Achievable Low and Achievable High program portfolios are available in the analysis workpapers.

Table 8-3 Recommended Portfolio, Key Indicators Compared to Achievable Low and High

	RECOMMENDED	Achievable Low	Achievable High
Res Lighting	**$7M spend 2015-2019**	$5M spend 2015-2019	$10M spend 2015-2019
Res Efficient Products	**$2M spend 2015-2019**	$1M spend 2015-2019	$2M spend 2015-2019
Res IQW	**5,000 HH, 2015-2019**	4,000 HH, 2015-2019	5,000 HH, 2015-2019
Res IQW Plus	**$1M spend 2015-2019**	$1M spend 2015-2019	$2M spend 2015-2019
Res NC	**$0.5M spend 2015-2019**	$1M spend 2015-2019	$2M spend 2015-2019
Res MF Direct Install	**1,400 HH 2015-2016**	1,250 HH 2015-2016	1,400 HH 2015-2016
Res HEA	**23,000 HH 2015-2019**	20,000 HH 2015-2019	26,000 HH 2015-2019
Res School Kit	**3,000 kits/year**	2,000 kits/year	3,500 kits/year
Res Whole House Plus	**$5M spend 2015-2019**	$3M spend 2015-2019	$6M spend 2015-2019
Res Appliance Recycling	**~1200 units/year (fridges + freezers)**	~1400 units/year	~2800 units/year
Res Behav Feedback	**25,000 All-Electric HH/yr**	25,000 All-Electric HH/yr	75,000 HH/yr
Bus Prescriptive	**$15M spend 2015-2019**	$9M spend 2015-2019	$24M spend 2015-2019
Bus Custom Incentives	**$18M spend 2015-2019**	$18M spend 2015-2019	$43M spend 2015-2019
Bus Schools Program	**$2M spend 2015-2019**	$1M spend 2015-2019	$3M spend 2015-2019
Bus SEM	**$1M spend 2015-2019**	$2M spend 2015-2019	$2M spend 2015-2019
Bus Retrocomissioning	**Removed, not recommended for area**	<$1M spend 2015-2019	$1M spend 2015-2019
Bus & MF NC	**$2M spend 2015-2019**	$1M spend 2015-2019	$3M spend 2015-2019
Bus Direct Install	**Boosted to $5M spend 2015-2019**	$2M spend 2015-2019	$3M spend 2015-2019

Recommended Program Action Plan

While the economic potential shown in the Action Plan meets the aggressive Indiana state goals, the recommended program Action Plan falls short. Figure 8-2 shows the net incremental energy savings in each year of the study by program. Figure 8-3 shows the annual budgets for the portfolio. Note again that the savings presented here are Net, and not Gross.

Figure 8-2 Recommended Action Plan - Net Incremental Energy Savings (MWh)

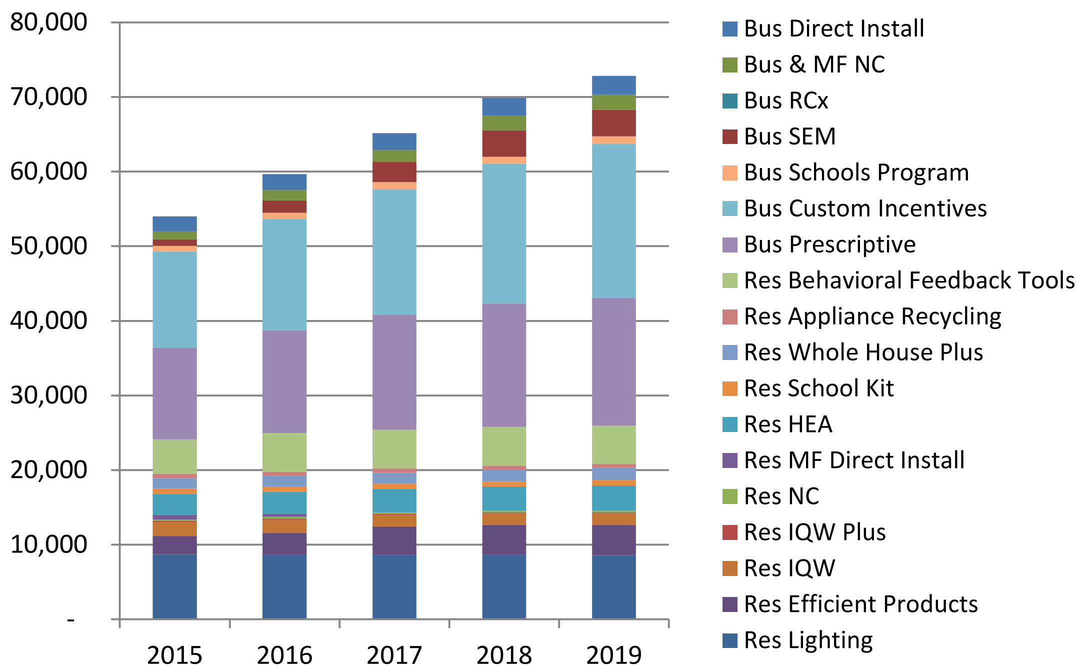


Figure 8-3 Recommended Action Plan - Annual Utility Budgets

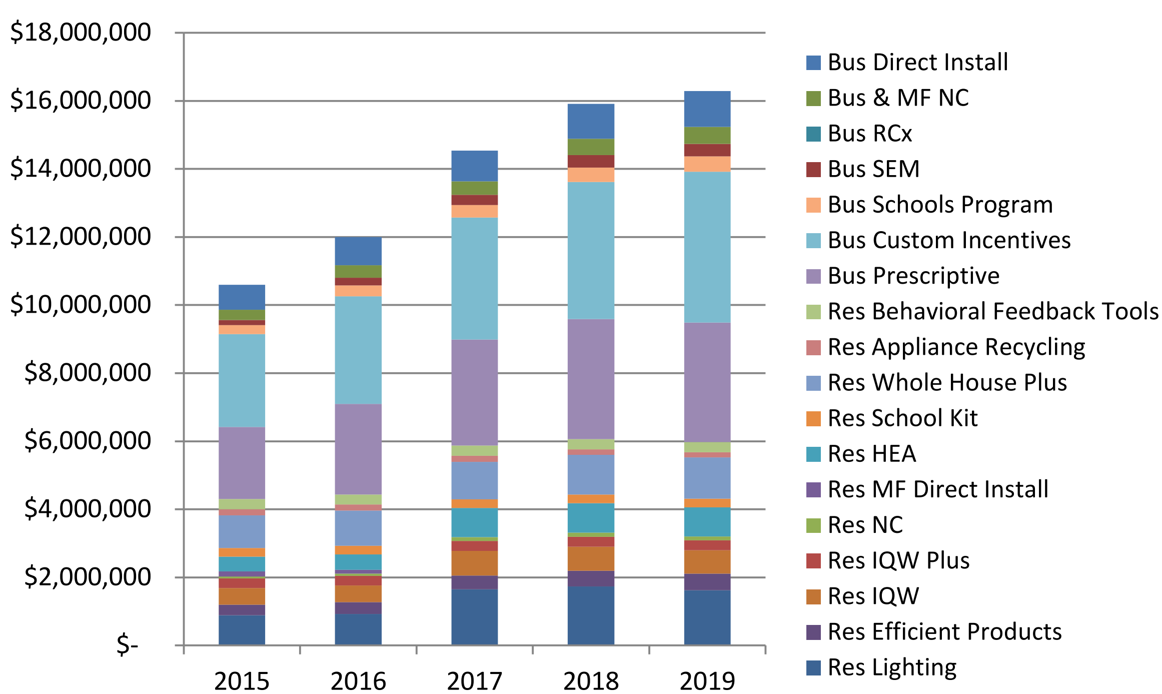


Table 8-4 below shows the detailed annual savings and budgets for the recommended portfolio.

Table 8-4 Vectren Recommended Electric Energy Efficiency Portfolio Summary

Program	Total Utility Costs (000$)					Total Net Incremental Energy Savings (MWh)					Total Net Incremental Demand Savings (kW)				
	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
Res Lighting	891	924	1,648	1,737	1,619	8,738	8,642	8,696	8,621	8,590	525	520	523	518	516
Res Efficient Products	309	349	406	455	496	2,425	2,957	3,773	4,061	4,096	259	310	385	420	438
Res IQW	491	491	728	712	680	1,876	1,799	1,527	1,517	1,518	116	112	95	94	94
Res IQW Plus	282	282	291	291	291	142	141	144	143	142	88	87	87	86	86
Res NC	57	64	107	116	119	193	193	220	236	248	24	26	29	32	35
Res MF Direct Install	146	115	-	-	-	610	448	-	-	-	44	32	-	-	-
Res HEA	434	452	861	872	855	2,846	2,911	3,092	3,218	3,354	138	140	149	155	161
Res School Kit	252	252	252	252	252	741	726	721	715	711	132	131	130	130	130
Res Whole House Plus	966	1,037	1,105	1,163	1,213	1,343	1,426	1,507	1,579	1,646	936	994	1,049	1,100	1,146
Res Appliance Recycling	174	174	174	165	155	561	561	561	528	495	143	143	143	135	126
Res Behavioral Feedback Tools	300	300	300	300	300	4,659	5,177	5,177	5,177	5,177	1,299	1,443	1,443	1,443	1,443
Bus Prescriptive	2,120	2,660	3,119	3,527	3,510	12,310	13,774	15,438	16,535	17,112	8,088	9,683	11,231	14,842	13,627
Bus Custom Incentives	2,725	3,157	3,578	4,025	4,426	12,906	14,891	16,801	18,698	20,595	8,027	9,329	10,587	11,946	13,206
Bus Schools Program	268	324	372	422	454	719	839	919	938	1,027	110	135	155	174	192
Bus SEM	150	225	298	373	373	832	1,663	2,757	3,589	3,589	141	281	495	635	635
Bus & MF NC	298	364	395	479	493	1,109	1,386	1,530	1,902	2,009	587	725	749	960	939
Bus Direct Install	737	826	908	1,025	1,056	1,977	2,134	2,278	2,399	2,526	648	720	797	925	982
Residential Total:	4,301	4,440	5,872	6,062	5,979	24,134	24,981	25,418	25,795	25,977	3,704	3,938	4,034	4,113	4,175
Business Total:	6,298	7,557	8,669	9,851	10,311	29,851	34,686	39,723	44,060	46,857	17,602	20,873	24,013	29,482	29,581
Portfolio Total:	**10,599**	**11,996**	**14,542**	**15,913**	**16,290**	**53,986**	**59,667**	**65,140**	**69,855**	**72,834**	**21,306**	**24,811**	**28,047**	**33,596**	**33,757**

Below are summary highlights of the programs we recommend for delivery. As mentioned above, detailed write-ups are available in Volume 4 of this report.

Residential Programs

- ### Res Lighting

  This program emphasizes standardized rebates, and upstream buydowns, with a market transformation focus. The concentration will mainly be on CFL lighting. It should be noted that the number of general purpose bulbs decreases over the timeframe due to lower savings, the increasing efficiency of the baseline technology due to the EISA 2007 legislation, and increased market transformation. Meanwhile, the number of specialty bulbs delivered by the program increases over the same period, as these are not "general service bulbs" to which the EISA legislation is limited.

  Another highlight is the emergence of LED lighting as a cost-effective measure in certain residential applications, such as outdoor lighting where there are longer hours of operation that allow a more rapid payback. LED technology costs are declining very quickly, and they become cost effective in 2017 for the residential sector in our models.

  The lighting portion of this program is a Core program, required by the Indiana Utility Regulatory Commission (IURC) generic order.

- ### Res Efficient Products

  This program emphasizes standardized rebates, and upstream buydowns, with a market transformation focus. We recommend this as a new, Core Plus program in 2015 to expand the current measure offerings in an attempt to meet aggressive savings targets.

  The measure list includes an electronics program, computers, TV's, set-top boxes, ceiling fans, and Energy Star room air conditioners and dehumidifiers.

  This is a Core Plus program

- ### Income Qualified Weatherization

  This program provides education and a suite of electric efficiency measures to help income qualified customers reduce their energy bills. These customers are defined as those living in geographic census blocks with an average household income at or below 200% of the federal poverty level.

  Full installation of direct-install measures is subsidized and provided to the residents, therefore full measure costs are used in the analysis rather than incremental measure costs. Coverage is targeted at 1,000 households per year.

  Measures in this program are primarily CFLs and low-flow water fixtures.

  This particular program is not highly cost-effective, but consensus agreement around the nation is that this is OK for income-limited populations, as long as the overall portfolio is still cost-effective.

  This is a Core program required by the IURC generic order.

- ### Income Qualified Weatherization Plus

  This program is a set of expanded, highly-subsidized, follow-on measures available to customers qualifying for the IQW Core program that wish to expand their energy savings beyond the set of Core measures. This will capitalize on the customer touches garnered by the Core program and attempt to achieve higher savings.

  Measures in this program are building shell infiltration control, insulation, programmable thermostats, duct repair & sealing, smart power strips, and whole-house fans.

This particular program is not highly cost-effective, but consensus agreement around the nation is that this is OK for income-limited populations, as long as the overall portfolio is still cost-effective.

This is a Core Plus program.

- **Residential New Construction**

  This program, starting in 2015, is designed to accelerate the incorporation of energy efficient design, construction, and operation in new residential buildings. It provides education and incentive payments to upstream designer-builders and owner-builders for installing high efficiency end-use equipment and building envelope measures. Under it, different "tiers" or "packages" of building performance receive tiered incentives.

  This is a Core Plus program.

- **Multi Family Direct Install**

  This program provides targeted, highly cost-effective measures to multifamily households in a quickly deployable program delivery mechanism. These are often rental units with split-landlord-and-renter barrier, i.e., the owner of the equipment does not pay the energy bills. It is therefore typically an underserved market with respect to energy efficiency programs and an important program to include in the portfolio.

  Current measures in this program are primarily CFLs and low-flow water fixtures. Full installation of these direct-install measures is provided, therefore full measure costs are used rather than incremental measure costs. We recommend offering an expanded set of measures in 2015 and beyond include insulation, programmable thermostats, duct repair & sealing, etc. delivered in follow-up touches by a network of qualified trade allies and contractors. These expanded measures would not be fully paid for, like the direct install measures, by the program.

  The target participation in this program will be 800 households in 2015 and decreasing to 600 in 2016. After 2016, it is anticipated that the market for additional multifamily units will be exhausted, and therefore we recommend that this program be shuttered in 2017 and beyond, pending market conditions as that time gets closer.

  This is a Core Plus program.

- **Home Energy Assessment**

  This program provides education and a suite of electric efficiency measures to help single family customers reduce their energy bills.

  Current measures in this program are direct installations of CFLs and low-flow water fixtures. The initial target is 4,200 households in 2015, ramping up gradually to 5,000 households in 2019.

  This program is a prime candidate for cross-selling into other programs and measures, chiefly the Whole House Plus Program.

  This is a Core program required by the IURC generic order.

- **School Kit**

  Under this program, an educational module is provided to 5th graders, along with a take-home kit of energy efficiency measures (CFLs, low-flow water fixtures, an air filter alarm, and an LED nightlight). It is a program goal that education and awareness permeates into the home through the children and effects the behaviors and purchase decisions of their parents, as well as those of the children in the future. 3,000 kits will be distributed each year.

  This is a Core program required by the IURC generic order.

- **Whole House Plus**

  This is a new program we recommend which offers an expanded set of whole house measures delivered primarily by contractors and trade allies in 2015 and beyond. Measures include efficient air conditioning equipment, insulation, programmable thermostats, duct repair & sealing, etc.

  Stringent codes and standards make the cost-effectiveness of this program challenging. It is not cost-effective on a standalone basis, and must be included in the portfolio view to merit its inclusion. Having an expanded program like this is a key strategy to reach deeper savings for the strong subset of customers that would want to pursue additional savings after participating in other Vectren programs such as the Efficient Products or the Home Energy Assessment programs.

  This is a Core Plus program.

- **Appliance Recycling**

  This program pursues energy savings by offering a bounty payment to customers to remove their old, inefficient appliances from the grid and recycle them. It has the potential to deliver large savings available from two cost-effective measures: secondary refrigerators and freezers.

  One concern with this program is the possibility that after program pick-up of their secondary refrigerator, residents might simply buy a new unit and move their former primary unit into the garage or basement to replace it. This is why the program is penalized with a challenging net-to-gross ratio.

  This is a Core Plus program.

- **Behavioral Feedback Tools**

  This program uses energy reports sent periodically to customers to give them self-awareness and a peer comparison of their energy usage. Social competitiveness effects increase efficient behaviors to reduce energy consumption. This produces a statistically measurable energy reduction effect in a treatment group (vs. a control group that does not receive the reports).

  Our modeling assumes 0.9% electric savings for single family households in 2015, rising to 1.0% savings in 2016 through 2019 to account for increased awareness and engagement with the program.

  It is important to note that this initiative was added at the program design stage, and was not included in our bottom-up, measure level potential analysis from Chapters 6 and 7. This is due to the fact that it is not a specific action or piece of equipment, per se, as well as the fact that it does not go through the typical customer-adoption modeling that other measures encounter. The program is simply delivered to as many participants as is deemed feasible by the planners.

  This program should be monitored carefully, as it is a new and emerging opportunity. Relatively little is known about the specific actions that customers perform to reduce their energy usage in this program, and it may undergo meaningful change in customer responsiveness and evaluation paradigms in the coming years.

  Measure life and persistence is also a key issue: behavioral effects only continue while the reports are being provided, and measured effects decay over a period of several months after the reports stop coming. Therefore, savings must be continually renewed each year with additional cost and effort, whereas the savings from a capital equipment measure can last 10 to 20 years once initially installed. This makes for relatively low-cost energy savings when considered on a first-year basis, but relatively high-cost energy savings on a lifetime or levelized cost basis.

The recommended portfolio action plan calls for participation of 25,000 customers encompassing only those households with electric heat and water heat and thereby capturing a larger electricity consumption base and larger energy savings. There are approximately 75,000 customers available for participation, but the relatively low levels of engagement and behavior modifications to-date have made cost-effectiveness challenging. Removal of the program was contemplated, but it provides a relatively large amount of incremental or first-year savings. Given the very aggressive state goals, we recommend that the program continue in one form or another if cost-effectiveness can be achieved. Our analysis shows the TRC ratio for the program in this configuration as 1.18. It is also an excellent platform to educate and engage customers and cross-sell other portfolio offerings.

This is a Core Plus program.

Commercial & Industrial Programs

- **Prescriptive Rebate**

  This program is designed to help non-residential customers save energy through a broad range of EE options that address all major end uses and processes. It offers incentives to customers and engages equipment suppliers and contractors to promote the incentive-eligible equipment, focusing on standardized rebates, upstream buydowns, and market transformation.

  Together with Bus Custom Incentives, this is where a bulk of program savings and dollars are focused. Business energy efficiency efforts are very project-centric, with many large projects participating in a hybrid of standard, prescriptive rebates and custom project incentives. Thus, delivery is integrated in many ways between the two programs.

  It is worth noting that LED lighting is already a cost-effective measure in many non-residential applications due to the typically longer hours of operation that allow a more rapid payback. LED technology costs are declining very quickly, and will become a larger and larger part of the business programs in the coming years.

  This is a Core program required by the IURC generic order.

- **Custom Incentives**

  This program is designed to help non-residential customers save energy through customizable projects that are too complex to fit in standard rebate offering.

  Together with Bus Prescriptive, this is where a bulk of program savings and dollars are focused. Business energy efficiency efforts are very project-centric, with many large projects participating in a hybrid of standard, prescriptive rebates and custom project incentives. Thus, delivery is integrated in many ways between the two programs.

  This is a Core Plus program.

- **Schools Program**

  This program is essentially a combination of the Business Prescriptive and Custom Incentives programs that is targeted toward public schools. It offers an audit and assessment, followed by the opportunity to install efficiency measures for school buildings. It also includes some direct install measures during the audit such as lighting, maintenance, and programmable thermostat.

  This program does not pass the TRC in our analysis, but is a a Core program required by the IURC generic order and has only a minor effect on the overall portfolio TRC, so it is still included in the recommended action plan.

- **Strategic Energy Management**

  Strategic Energy Management (or SEM) involves energy education, advising, and coaching for non-residential customers to drive behavioral change and transformation of company culture toward improved energy efficiency and utilization. This means the appointment of energy liaisons and teams within participating organizations who will regularly correspond with program representatives. Institutionalizing internal policies and practices this way creates longer-lasting behavioral-based savings than residential behavioral programs.

  This program is a new recommendation, and is therefore planned to begin in 2015 to allow time to ramp up and conduct more detailed program planning.

  This is a Core Plus program.

- **Business & Multi Family New Construction**

  This program, starting in 2015, is designed to accelerate the incorporation of energy efficient design, construction, and operation in new business and multi family residential buildings. It provides education and incentive payments to upstream designer-builders and owner-builders for installing high efficiency end-use equipment and building envelope measures. Under it, different "tiers" or "packages" of building performance receive tiered incentives.

  The multifamily component of this program is mean to specifically address the hybrid nature of this market, which contains many aspects of both residential and commercial construction. Such a specialized program would target the particular needs of these customers.

  This is a Core Plus program.

- **Small Business Direct Install**

  This program provides targeted, highly cost-effective measures to small business customers in a quickly deployable program delivery mechanism to help them reduce their energy bills and foster awareness and cross-selling of other efficiency portfolio efforts.

  Measures include lighting replacements, pre-rinse sprayers, programmable thermostats, pipe wrap, vending machine controls, smart power strips, etc. The program goal is to deploy a network of qualified trade allies and contractors that can install these measures quickly and free of charge to participants. The program aims to perform a site assessment and implementation of measures on the same day.

  Special outreach and program focus is given to not-for-profit businesses. They will be provided with enhanced education and training and more attractive rebate rates for follow-on measures.

  This is a Core Plus program.

Omitted Programs

- **Retrocommissioning**

  This program involves the initial, periodic, or continual monitoring and commissioning of building energy systems such as heating, cooling, ventilation, and lighting in order to optimize energy consumption relative to actual building usage.

  This program is not cost-effective in our analysis. The Vectren service territory does not contain a heavy concentration of the customer types that are prime candidates for a program such as this: office buildings, hospitals, universities, etc. It is our recommendation that if singular retrocommissioning projects are attractive with particular customers that they can be run through the Business Custom program.

Cost Effectiveness

With the program savings and budgets, we perform the industry standard cost-effectiveness tests to gauge the economic merits of the portfolio. Each test compares the benefits of the EE programs to their costs – using its own unique perspectives and definitions – all defined in terms of net present value of future cash flows. The definitions for the four standard tests most commonly used in EE program design are described below.

- **Total Resource Cost test (TRC).** The benefits in this test are the lifetime avoided energy costs and avoided capacity costs. The costs in this test are the incremental measure costs plus all administrative costs spent by the program administrator.
- **Utility Cost Test (UCT).** The benefits in this test are the lifetime avoided energy costs and avoided capacity costs, the same as the TRC benefits. The costs in this test are the program administrator's incentive costs and administrative costs.
- **Participant Cost Test (PCT).** The benefits in this test are the lifetime value of retail rate savings (which is another way of saying "lost utility revenues"). The costs in this test are those seen by the participant; in other words: the incremental measure costs minus the value of incentives paid out.
- **Rate Impact Measure test (RIM).** The benefits of the RIM test are the same as the TRC benefits. The RIM costs are the same as the UCT, except for the addition of lost revenue. This test attempts to show the effects that EE programs will have on rates, which is almost always to raise them on a per unit basis. Thus, costs typically outweigh benefits from the point of view of this test, but the assumption is that absolute energy use decreases to a greater extent than per-unit rates are increased — resulting in lower average utility bills.

The cost effectiveness results for the Vectren Recommended Portfolio are shown in Table 8-5, sporting lifetime TRC benefits of $177 million dollars and costs of $92 million dollars for a robust TRC ratio of 1.92.

Table 8-5 Vectren Recommended Action Plan Cost Effectiveness summary

	TRC Ratio	TRC Benefits	TRC Costs	UCT Ratio	PCT Ratio	RIM Ratio
Res Lighting	1.47	$12,729,504	$8,638,583	2.33	7.39	0.44
Res Efficient Products	2.31	$5,767,547	$2,494,058	3.55	11.18	0.51
Res IQW	0.99	$2,475,435	$2,503,149	0.99	-	0.35
Res IQW Plus	0.56	$650,864	$1,166,742	0.56	-	0.35
Res NC	1.02	$453,989	$443,548	1.23	9.82	0.42
Res MF Direct Install	1.47	$383,335	$260,561	1.69	20.72	0.41
Res HEA	1.90	$5,286,017	$2,783,242	1.90	-	0.42
Res School Kit	1.14	$1,165,755	$1,024,230	1.14	-	0.38
Res Whole House Plus	1.07	$8,212,627	$7,653,155	1.85	2.47	0.66
Res Appliance Recycling	1.05	$723,032	$686,727	1.05	-	0.40
Res Behavioral Feedback Tools	1.18	$1,442,788	$1,220,290	1.18	-	0.42
Bus Prescriptive	2.06	$50,575,254	$24,584,518	4.21	3.91	0.83
Bus Custom Incentives	2.52	$70,292,200	$27,918,583	4.87	5.25	0.82
Bus Schools Program	0.69	$2,168,631	$3,155,364	1.46	1.96	0.45
Bus SEM	1.61	$1,821,203	$1,133,881	1.61	-	0.43
Bus & MF NC	2.06	$5,972,921	$2,896,189	3.66	5.04	0.75
Bus Direct Install	1.85	$6,808,569	$3,675,085	1.85	-	0.56
Residential Total:	1.36	$39,290,894	$28,874,285	1.83	8.54	0.47
Business Total:	2.17	$137,638,778	$63,363,620	4.00	4.87	0.78
Portfolio Total:	**1.92**	**$176,929,672**	**$92,237,905**	**3.17**	**5.61**	**0.68**

CONCLUSIONS AND RECOMMENDATIONS

The results of this study reveal that significant energy efficiency opportunities exist for Vectren in Southern Indiana, despite aggressive appliance and efficiency standards and a challenging macroeconomic environment.

Our program analysis shows that Vectren can achieve Net incremental electric energy savings of 53,986 MWh in 2015, increasing to 72,834 MWh in 2019. This equates to Gross incremental savings of 62,818 MWh in 2015 and 84,809 MWh in 2019, all by implementing the programs and measures presented in this report.

Vectren's energy-efficiency programs are relatively young compared to other programs in the nation, but have made significant impacts already and are building appreciable market momentum. Based on our market potential assessment and program design analysis, EnerNOC provides the following high-level recommendations for the portfolio. We fully expect that Vectren, the stakeholders, and the implementers will consider the plans and recommendations in this report now, at the outset of the forthcoming implementation cycle; and that they will adopt the elements that are appropriate, adjust the elements that fit differently when translated into the trenches and front lines of program delivery, and continue to revisit the report as a reference throughout the next years as situations and markets continue to change and evolve.

General Recommendations

- **Increase focus on non-residential programs:** Our study shows that a large portion of the program savings from energy efficiency efforts will come from the commercial and industrial sectors. Vectren has already begun to shift budget and focus toward the C&I sectors, as evidenced by budgeting trends in 2013 and 2014 as well as the primary market research conducted on large C&I customers as part of this study. Increasing program efforts in the C&I sectors will not only lead to harvesting larger EE savings, but to increased business competitiveness and decreased operating costs for customers. Additionally, these sectors offer larger projects, which can be attained and bundled more readily and efficiently.
- **Continued collaboration among stakeholders:** The discourse and information sharing between stakeholders, utilities, and EnerNOC on this study has been effective and transparent. Continuing this trend is of paramount importance to the future success of programs. It is essential to cultivate a mutual understanding of the dynamic nature of the energy efficiency industry due to its intrinsic linkage with human behavior and the customer mind. Ongoing interactions should be marked by an understanding of collaboration, flexibility, and continuous improvement.
- **Deliver electric and natural gas programs jointly when possible:** Vectren also has a broad array of natural gas energy efficiency programs to help its natural gas customers save on their gas bills. Administrative efficiencies and economies of scale can be reached with dual fuel program offerings in applicable programs like HEA and IQW, where both electric and gas savings can be obtained without creating duplicative, administrative cost structures. Further, Indiana's concept of a statewide Therm Bank provides an excellent platform to deliver joint electric and natural gas programs on a straightforward and highly cost-effective basis. In this paradigm, if it proves feasible and appropriate to management and to stakeholders, Vectren could share costs across its electric and gas programs to extend their reach and effectiveness.

Residential Recommendations

- **Focus on lighting:** The largest share of achievable energy efficiency potential in the residential sector continues to come from CFLs. This is in spite of the forthcoming EISA standards that will reduce their per-unit savings compared to the new baseline. Also, Vectren should focus strong attention on specialty lamps, as they are not affected by the EISA standard, and prepare for the entrance of LED lamps into their programs in the later years of the portfolio.
- **Implement and monitor behavioral feedback programs:** The behavioral modification program to be implemented by OPower is shown in the program plans to comprise a significant amount of Vectren's portfolio savings. This initiative was added at the program design stage, and was not included in our bottom-up, measure level potential analysis. This is due to the fact that it is not a specific action or piece of equipment, per se, as well as the fact that it does not go through the typical customer-adoption model that other measures encounter. The program is simply delivered to as many participants as the planners deem appropriate, and produces a statistically measured energy reduction effect in a treatment group (vs. a control group that does not receive the program treatment). It should be monitored carefully, however, as it is a new and emerging opportunity. Relatively little is known about the specific actions that customers perform to reduce their energy usage in this program, and it may undergo meaningful change in customer responsiveness and evaluation paradigms in the coming years. Additionally, savings under this program will not persist after the program is ended, and must be continually renewed each year with additional cost and effort, whereas the savings from a capital equipment measure can last 10 to 20 years.
- **Develop deeper, follow-on measures in existing programs:** Some current Vectren program delivery structures are pursuing low-cost measures through rapid customer touches with direct-install components only. We have recommended the addition of more deep, involved measures to capitalize on customer touches as much as possible. While you are in the home of a customer, it makes better sense to cross-sell these other measures and harvest as many energy savings as you can. This would include major equipment replacements and shell measures such as duct sealing and insulation.
- **Consider social media avenues for targeted program delivery:** As internet social media paradigms become the norm in today's wired society, companies like Groupon, Amazon Local Deals, and Living Social have assembled a nationwide network of businesses into a well-oiled, rebate-issuing machine. Vectren should consider if there are opportunities to link their energy efficiency trade ally network to one of these companies to facilitate the target marketing, processing, and delivery of rebates. These vendors have sophisticated tracking systems and databases that may facilitate EM&V reporting on the back end as well.

Commercial & Industrial Recommendations

- **Aggressively pursue lighting savings:** The commercial sector in particular has significant savings potential in lighting equipment, both interior and exterior. Notably, LED lamps are showing as cost effective in the commercial sector due to aggressive forecasts of cost reductions, as well as higher hours of operation than their non-economic counterparts in residential settings. Savings are also available through occupancy sensors, timers, and energy management systems. Vectren should strongly pursue lighting savings to accelerate the phase out of T12 fluorescent lighting. In particular, program efforts can help intercept building operators before they make purchase and stocking decisions that could lead to the hoarding of T12 lamps.
- **Focus industrial program efforts on motor controls and system optimizations**: The savings for the industrial sector are all about control and optimization of motors and processes. Low-cost retrofits can often have significant energy impacts with minimal disruption of (and often times improvement of) business processes.

- **Target niches with segment specific programs**: There are specific business segments that offer considerable savings potential, but will not typically be reached by standard rebates and generic business programs. Consider initiating specifically targeted sub-programs within business standard and custom for areas such as: hotels and lodging, food preparation equipment in restaurants, and refrigeration equipment in grocery stores.
- **Implement new programs:** We have identified additional programs that show promise to expand Vectren's portfolio of programs to address Indiana's aggressive statewide savings goals. These programs are as follows:
    1. *Strategic Energy Management*. For large customers, SEM initiatives can deliver substantial savings over long time horizons. This means coming alongside the larger customers to create a customized, multi-year plan, identify metrics, set goals, and provide technical assistance and attention from dedicated account executives or energy coaches.
    2. *Business and Multifamily New Construction*. A program to encourage more rapid adoption of efficient building design practices is a very relevant addition to the Vectren portfolio.

About EnerNOC

EnerNOC's Utility Solutions Consulting team is part of EnerNOC's Utility Solutions, which provides a comprehensive suite of demand-side management (DSM) services to utilities and grid operators worldwide. Hundreds of utilities have leveraged our technology, our people, and our proven processes to make their energy efficiency (EE) and demand response (DR) initiatives a success. Utilities trust EnerNOC to work with them at every stage of the DSM program lifecycle – assessing market potential, designing effective programs, implementing those programs, and measuring program results.

EnerNOC's Utility Solutions deliver value to our utility clients through two separate practice areas – Implementation and Consulting.

- Our Implementation team leverages EnerNOC's deep "behind-the-meter expertise" and world-class technology platform to help utilities create and manage DR and EE programs that deliver reliable and cost-effective energy savings. We focus exclusively on the commercial and industrial (C&I) customer segments, with a track record of successful partnerships that spans more than a decade. Through a focus on high quality, measurable savings, EnerNOC has successfully delivered hundreds of thousands of MWh of energy efficiency for our utility clients, and we have thousands of MW of demand response capacity under management.
- The Consulting team provides expertise and analysis to support a broad range of utility DSM activities, including: potential assessments; end-use forecasts; integrated resource planning; EE, DR, and smart grid pilot and program design and administration; load research; technology assessments and demonstrations; evaluation, measurement and verification; and regulatory support.

The team has decades of combined experience in the utility DSM industry. The staff is comprised of professional electrical, mechanical, chemical, civil, industrial, and environmental engineers as well as economists, business planners, project managers, market researchers, load research professionals, and statisticians. Utilities view EnerNOC's experts as trusted advisors, and we work together collaboratively to make any DSM initiative a success.

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ELECTRIC DEMAND SIDE MANAGEMENT: MARKET POTENTIAL STUDY AND ACTION PLAN

Volume 4: Detailed Appendices: Action Plan & Program Write-ups

Report Number 1432

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RESIDENTIAL LIGHTING PROGRAM

Program Description	The Residential Lighting program is a retrofit and renovation program in which Vectren will encourage and assist residential customers in improving the energy efficiency of their homes through high efficiency lighting. The promotion and incentive of high-efficiency lighting measures is a core program required by the state of Indiana. To adapt to the incoming EISA efficiency standards, the program will gradually shift focus from general purpose CFL lighting to specialty CFLs and will begin incorporating LEDs starting in 2017. The program will promote and provide incentives to help defray the cost of high-efficiency lighting by engaging in upstream "buydowns" of lamps so that customers pay a lower price at the point of purchase without needing to apply or mail-in for a rebate. The upstream buydown activity is a component of the program's focus on market transformation that will increase the demand for high efficiency lighting, and eventually decrease the availability of lower-efficiency lighting in the marketplace.
Objectives	The purpose of the Residential Lighting program is to increase the penetration of high-efficiency lighting in the homes of Vectren's residential customers. The program has several objectives: • Increase consumers' awareness of the breadth of energy efficiency lighting opportunities in their homes. • Make significant contribution to Vectren's energy savings goals. • Strengthen customer trust in Vectren as their partner in saving energy. The Residential Lighting program is well-suited for accomplishing these objectives because the incentive-eligible lighting measures are proven technologies about which customers can readily find supporting information; and the program affords Vectren the opportunity to strengthen relationships with upstream suppliers and influence stocking decisions.
Target Market	The target market for the Residential Lighting program is all residential customers in Vectren's service territory. The target market includes customers in existing single-family homes or multifamily dwellings. Both owners and renters are eligible to participate in the program.
Implementation Strategy	<u>Overview of Activities</u> The program will be administered through a third-party implementation contractor. During the implementation of this program, Vectren and the program implementation contractor will be involved in several activity areas: • Development of upstream supplier network to stock and promote program, and to participate in upstream buydown activities • Program marketing and education: including development and distribution of program materials in collaboration with upstream allies; and promotional campaigns in coordination with other Vectren

	programs • Incentive processing: including receipt, review and verification of incentive applications from participating vendors and retailers; and paying of incentives • Program performance tracking and improvement: including tracking availability of qualifying lighting, incentive submittals and payments, opportunities to improve the program • Reporting: including reporting of program activities to meet regulatory and internal requirements, in particular progress toward program goals. The program is designed so that participating retailers can easily submit incentive applications and information to the program administrator. In the next step, the appropriate party submits incentive form(s) to the program administrator with information that documents the qualifying sales. Finally, the program administrator mails incentive checks to retailers. Lighting suppliers and contractors can be very instrumental in achieving program success. Using the incentives and ENERGY STAR quality assurance as selling points, these allies can increase sales of qualifying equipment. All of the rebate processing activities will be done by the retailers and distributors behind the scenes, so that the process is seamless and effortless to the end consumer. Education Overview Under the program, Vectren will educate local dealers and contractors about program procedures and benefits. It may be possible to organize standing annual meetings with local trade ally associations, where Vectren staff describes the program and makes them aware of any changes that may have taken place. To further promote good communication, Vectren may conduct seminars to familiarize participating dealers and contractors with the structure and procedures of the program. Handouts will likely include specific information about incentive schedules. Consumer education will be combined with program awareness activities. Through the use of bill inserts, newsletters, on-line information, and direct mail, customers will receive educational information regarding the benefits of and opportunities to save money on energy efficient lighting. In addition, point of purchase displays may be useful in educating both retail sales associates who may work part time and customers who haven't done a lot of research prior to their visit to the store.
Issues, Risks, and Risk Management Strategies	The use of prescriptive incentives, that is, fixed per-unit incentives for specific types of lighting, is perhaps the approach with the most history among utility-sponsored energy efficiency programs. Because the qualifying lighting is well defined and the per-unit incentives are fixed, it is easily understood by customers and easy to administer. An issue of potential concern is the relatively high cost of processing applications for small incentives. If this is a major concern, minimum purchase conditions for a retailer could be imposed on eligibility. However, this could impose a barrier to participation. All consideration should be given to making the program as accessible and appealing as possible so as to ensure that the potential program savings are achieved..

Marketing and Outreach	The Residential Lighting program will be marketed mainly by working with upstream suppliers, retailers, and trade allies, as well as by direct contact with Vectren customers. • Vectren develops awareness through direct marketing—e.g., bill inserts, newsletters, website, broadcast and print media, point of purchase (POP) displays, and direct mail. • Coordinated advertising with selected retail outlets may be an effective strategy; it will be possible for the program to capitalize on big-box retail store initiatives as additional, collaborative support. Retailers and lighting contractors/installers may be engaged to promote awareness of and use rebate offers to help sell qualifying equipment. Program implementation contractors can also provide assistance with Vectren's direct marketing, and work with upstream suppliers to stock qualifying lighting measures, promote the program, and track and report program activities and achievements toward goals.
Evaluation, Measurement and Verification Requirements	The evaluation methodology and data collection proposed for the Residential Lighting program are guidelines that reflect current measurement and verification (M&V) practices. The ultimate M&V requirements for this program should conform to state protocols. <u>Metrics for Gauging Program Success</u> Primary: • Net number of lighting measures purchased/installed • Energy savings associated with purchased/installed lighting • Customer satisfaction with the program and the products • Program implementation costs incurred Secondary: • Distribution of lighting popularity and cost-effectiveness of the program • Increase in number and variety of suppliers who stock qualified lighting • Market share of high efficiency stock or sales versus standard equipment stock or sales. <u>Data Collection Approaches</u> Program staff will collect data on program marketing, outreach, and service activities. The program will utilize a data tracking system to record and report program activities and achievements. The data required for evaluating the program will depend on the methodology chosen. <u>Impact Evaluation Methodology</u> The program will record energy savings and peak load reductions from the program data tracking systems, using the per-unit savings values. Because lighting is an established technology and data are available demonstrating the reliability of savings, it will not be necessary to conduct customer-level billing analyses or metering studies. However, some projects will be inspected for independent verification of installation and operation as reported. Ex Post Surveys with participating customers will be used to estimate the net-to-gross ratio accounting for free-riders and free-drivers. Customers will be asked to provide information regarding whether they would have purchased the

	incentivized items without the Vectren program, whether they installed the items, and whether they subsequently purchased additional incentive-eligible items at full cost. This outline of the self-report methodology for the assessment of net impacts describes only the basic approach. The selected M&V contractor will develop the complete plan that ensures the appropriate measurement of savings in compliance with industry and state protocols. <u>Process Evaluation Methodology</u> Program process evaluation is important to ensure that the program is operating as intended and to provide information that can enable improvements in both the program design and implementation. Process evaluation will be undertaken and conducted throughout the program. Often issues uncovered by process evaluation early in the program year can be addressed immediately, helping to ensure program success. Process evaluation will assess customer understanding, attitudes about, and satisfaction with the program and with Vectren's other educational activities. The evaluations will make use of survey data collected by Vectren, implementation contractors, and M&V contractors. These surveys will include both customers known to have participated in the program and eligible nonparticipants. Interviews with Vectren program staff and/or implementation contractors will be conducted to assess satisfaction with the program and to identify problems and possible program services/implementation improvements. The M&V contractor will also help Vectren assess the performance of the program design and program delivery, including effectiveness of the marketing and educational materials, effectiveness of advertising and promotional campaigns and messages, effectiveness of the trade ally involvement, and whether implementation milestones are met adequately and on schedule. These evaluations will use sales and promotion data maintained by Vectren, the implementation contractor, and customer survey data.
Program Schedule	The Residential Lighting program is already part of the current Vectren portfolio and will continue to operate through PY 2019. The following table provides a schedule of key milestones:

Key Milestones	Timing
Assign internal program manager and staff	Anticipated in late 2013 or early 2014.
Select and contract with program implementation contractor(s)	2014, in concert with statewide Core program implementation contractor process
Finalize program design	2014, Q2
Pre-rollout program development: Develop upstream network Develop in-store, on-line information Prepare marketing materials and incentive forms Develop activity and incentive processing protocols	2014, Q3 and Q4
Program re-launch: Launch consumer education, marketing,	2015, Q1

	and outreach All program services	
	Prepare reports: Documentation of program activities and progress toward goals Reports to Commission	Monthly throughout program implementation period Quarterly, and annually
	Conclude program operation for this planning cycle	2019

Estimated Participation

Participation and measure adoption estimates were developed based on the number of residential customers in the service territory and an assessment of the attainable market potential in the area, as well as past program performance and the experience of other organizations that have offered this type of program.

Total Estimated Participation (# of Households)

Measure	Option	No. of Gross Installations*	NTG Ratio	No. of Net Installations*
Screw-in	CFL	54,899	0.85	46,664
Specialty	CFL	59,897	0.85	50,912
Screw-in	LED	27,545	0.85	23,413

Projected Energy Savings

The estimated energy savings are given in terms of annual kWh by measure. The savings noted in each year are incremental, that is reflective of new measures installed by customers through the program in that year. This does *not* include the cumulative impact of measures still in operation from previous years.

Total Net Incremental Electricity Savings (kWh)

		Total Net Incremental Energy Savings (kWh)				
Measure	Option	2015	2016	2017	2018	2019
Screw-in	CFL	5,327,261	5,083,005	3,453,261	3,212,983	3,223,886
Specialty	CFL	3,410,785	3,558,788	3,542,170	3,581,672	3,603,519
Screw-in	LED	-	-	1,700,423	1,826,000	1,763,082
TOTAL		**8,738,046**	**8,641,792**	**8,695,854**	**8,620,656**	**8,590,487**

Customer Incentives

Incentives will be paid in the form of cash-back rebates primarily to upstream suppliers and retailers – which in turn result in a buydown of the cost seen by customers. Incentives for the individual measures account for 50% of the incremental measure cost. Incremental cost is the additional cost of a high-efficiency measure beyond a standard-efficiency alternative.

Administrative Requirements

Vectren will administer the Residential Lighting program through an implementation contractor. Vectren's role will be to ensure that:

- the implementation contractor performs all the activities associated with delivery of all components of the program, and
- Vectren's educational and program messages are delivered accurately and clearly to ensure the effectiveness of program delivery and maximize customer satisfaction with the program.

The program is expected to operate according to the following administrative and total utility budget:

Total Program Budget

Total Program Budget					
	2015	2016	2017	2018	2019
Program Staff Labor Cost	$75,000	$75,000	$75,000	$75,000	$75,000
Education & Marketing Cost	$75,096	$78,109	$144,776	$152,966	$142,049
Evaluation Cost	$40,051	$41,658	$77,214	$81,582	$75,760
Implementation Cost	$200,256	$208,291	$386,070	$407,909	$378,798
Incentive Costs	$500,640	$520,728	$965,175	$1,019,772	$946,996
Total Budget	**$891,044**	**$923,787**	**$1,648,235**	**$1,737,228**	**$1,618,603**

Cost-Effectiveness

The cost-effectiveness metrics of the Residential Lighting program are as follows:

Cost Effectiveness Tests						
	TRC Ratio	TRC Benefits	TRC Costs	UCT Ratio	PCT Ratio	RIM Ratio
Res Lighting	**1.47**	**$12,729,504**	**$8,638,583**	**2.33**	**7.39**	**0.44**

CHAPTER 2

RESIDENTIAL EFFICIENT PRODUCTS PROGRAM

Program Description	The Residential Efficient Products program is a retrofit and renovation program in which Vectren will encourage and assist residential customers in improving the energy efficiency of their homes through a broad range of energy efficient products that are commonly purchased in retail settings. The program will begin in 2015 and primarily focus on ENERGY STAR appliances, pool equipment, TVs, computers, set-top boxes, ceiling fans, dehumidifiers, etc. The program will promote and provide cash rebates to help defray the cost of high-efficiency models of common home equipment. In additional to prescriptive rebates for customers, the program will engage in upstream “buydowns” of certain products so that customers pay a lower price at the point of purchase without needing to apply for a rebate. The upstream buydown activity is a component of the program’s focus on market transformation that will increase the demand for high efficiency products, and eventually decrease the availability of lower-efficiency products in the marketplace. Measures will be assigned on a case-by-case basis to an upstream buydown approach or a downstream, direct rebate approach, based on the most suitable approach.
Objectives	The purpose of the Residential Efficient Products program is to increase the penetration of high-efficiency measures in the homes of Vectren’s residential customers. The program has several objectives: • Increase consumers’ awareness of the breadth of energy efficiency opportunities in their homes. • Make significant contribution to Vectren’s energy savings goals. • Strengthen customer trust in Vectren as their partner in saving energy. The Residential Efficient Products program is well-suited for accomplishing these objectives because the rebate-eligible measures are proven technologies about which customers can readily find supporting information; customers are familiar with cash-back rebates from other types of purchases they make, and the list of included measures affords Vectren the opportunity to strengthen relationships with upstream suppliers and influence stocking decisions.
Target Market	The target market for the Residential Efficient Products program is all residential customers in Vectren’s service territory and, in particular, those customers with existing equipment that needs replacing or who can be persuaded to replace early. The target market includes customers in existing single-family homes or multifamily dwellings who are either replacing existing equipment or are purchasing equipment for the first time. Both owners and renters are eligible to participate in the program.
Implementation Strategy	Overview of Activities The program will be administered through a third-party implementation contractor. During the implementation of this program, Vectren and the program implementation contractor will be involved in several activity areas: • Development of upstream supplier network to stock and promote program, and to participate in upstream buydown activities • Program marketing and education: including development and distribution of

	program materials in collaboration with upstream allies; and promotional campaigns in coordination with other Vectren programs • Rebate processing: including receive, review and verify applications; and pay rebates • Program performance tracking and improvement: including tracking availability of qualifying products, rebate submittals and payments, opportunities to improve the program • Reporting: including reporting of program activities to meet regulatory and internal requirements, in particular progress toward program goals. The program is designed so that either customers or participating retailers can easily submit rebate applications and information to the program administrator. In the next step, the appropriate party submits rebate form(s) to the program administrator with information that documents the qualifying sale/installation. The forms allow customers to see the exact rebate they can receive. Finally, the program administrator mails rebate checks to customers or retailers. Retailers can be very instrumental in achieving program success. Using the rebates and ENERGY STAR quality assurance as selling points, these allies can increase sales of qualifying equipment. They can further assist by aiding in the submittal of the rebate application. Across the country, many retailers will print out an extra receipt, suitable for submittal with the application; provide the customer with the appropriate rebate application; some may even help fill out and submit it. For upstream buydowns, all of the above rebate processing activities will be done by the retailers and distributors behind the scenes, so that the process is seamless and effortless to the end consumer. Education Overview Under the program, Vectren will educate retailers about program procedures and benefits. It may be possible to organize standing annual meetings with local retailers, where Vectren staff describes the program and make them aware of any changes that may have taken place. Handouts will likely include specific information about rebate schedules and lists of qualifying high-efficiency models. Consumer education will be combined with program awareness activities. Through the use of bill inserts, newsletters, on-line information, and direct mail, customers will receive educational information regarding the benefits of and opportunities to save money on energy efficiency upgrades. In addition, point of purchase displays may be useful in educating both retail sales associates who may work part time and customers who haven't done a lot of research prior to their visit to the store.
Issues, Risks, and Risk Management Strategies	The use of prescriptive rebates, that is, fixed per-unit incentives for a specific list of measures, is perhaps the approach with the most history among utility-sponsored energy efficiency programs. Because the measures on the list are well defined and the per-unit rebates are fixed, it is easily understood by customers and easy to administer. Targeting of the fixed per-unit incentives at the manufacturer or retailer level to create upstream buydowns should be utilized as frequently as possible, to simplify the process for the end customer.

Marketing and Outreach	The Residential Efficient Products program will be marketed through direct contact between Vectren and its customers, as well as with trade allies and other upstream suppliers. • Vectren develops awareness through direct marketing—e.g., bill inserts, newsletters, website, broadcast and print media, point of purchase (POP) displays, direct mail; and pays the participant rebates. • The Residential Home Energy Assessment program is a natural channel for this program. The walk-through audit recommendations will include resource information for the recommended measures, including rebates available under the Residential Efficient Products program. • The Residential New Construction program is also a natural channel for this program. That program will offer rebates for the installation of packages of measures, rather than individual measures. Owners or builders who participate in the new construction program will be made aware of additional measures that can be installed after construction to further improve the home performance, including installation of ENERGY STAR appliances. • Coordinated advertising with selected retail outlets may be an effective strategy. It will be possible for the program to capitalize on big-box retail store initiatives as additional, collaborative support. Retailers may be engaged to promote awareness of and use rebate offers to help sell qualifying equipment. Program implementation contractors can also provide assistance with Vectren's direct marketing, and work with upstream suppliers to stock qualifying measures, promote the program, assist with rebate applications and rebate fulfillment services, and track and report program activities and achievements toward goals.
Evaluation, Measurement and Verification Requirements	The evaluation methodology and data collection proposed for the Residential Efficient Products program are guidelines that reflect current measurement and verification (M&V) practices. The ultimate M&V requirements for this program should conform to state protocols. <u>Metrics for Gauging Program Success</u> Primary: • Net number of measures purchased/installed • Energy savings associated with purchased/installed measures • Customer satisfaction with the program and the products • Program implementation costs incurred Secondary: • Distribution of measure popularity and cost-effectiveness of the program • Increase in number and variety of suppliers who stock qualified products • Market share of high efficiency stock or sales versus standard equipment stock or sales. <u>Data Collection Approaches</u> Program staff will collect data on program marketing, outreach, and service activities. The program will utilize a data tracking system to record and report program activities and achievements. The data required for evaluating the program will depend on the methodology chosen. <u>Impact Evaluation Methodology</u> The program will record energy savings and peak load reductions from the rebate

	applications processed, using the per-unit deemed savings values. Because measures are established technologies and data are available demonstrating the reliability of savings, it will not be necessary to conduct customer-level billing analyses or metering studies. However, some projects will be inspected for independent verification of installation and operation as reported. Ex Post Surveys with participating customers will be used to estimate the net-to-gross ratio accounting for free-riders and free-drivers. Customers will be asked to provide information regarding whether they would have purchased the rebated items without the Vectren program, whether they installed the items, and whether they subsequently purchased additional rebate-eligible items at full cost. This outline of the self-report methodology for the assessment of net impacts describes only the basic approach. The selected M&V contractor will develop the complete plan that ensures the appropriate measurement of savings in compliance with industry and state protocols. <u>Process Evaluation Methodology</u> Program process evaluation is important to ensure that the program is operating as intended and to provide information that can enable improvements in both the program design and implementation. Process evaluation will be undertaken and conducted throughout the program. Often issues uncovered by process evaluation early in the program year can be addressed immediately, helping to ensure program success. Process evaluation will assess customer understanding, attitudes about, and satisfaction with the program and with Vectren's other educational activities. The evaluations will make use of survey data collected by Vectren, implementation contractors, and M&V contractors. These surveys will include both customers known to have participated in the program and eligible nonparticipants. Interviews with Vectren program staff and/or implementation contractors will be conducted to assess satisfaction with the program and to identify problems and possible program services/implementation improvements. The M&V contractor will also help Vectren assess the performance of the program design and delivery of the products and services featured in the program, including effectiveness of the marketing and educational materials, effectiveness of advertising and promotional campaigns and messages, effectiveness of the trade ally involvement, and whether implementation milestones are met adequately and on schedule. These evaluations will use sales and promotion data maintained by Vectren, the implementation contractor, and customer survey data.
Program Schedule	The Residential Efficient Products program is a newly recommended Core Plus program that would begin in PY 2015 and operate through PY 2019. The following table provides a schedule of key milestones:

Key Milestones	Timing
Assign internal program manager and staff	Anticipated in late 2013 or early 2014.
Select and contract with program implementation contractor(s)	2014, Q2 or immediately upon program approval
Finalize program design	2014, Q2
Pre-rollout program development: Develop upstream network Develop in-store, on-line information Prepare marketing materials and rebate forms	2014, Q3 and Q4

Develop activity and rebate processing protocols	
Program rollout: Launch consumer education, marketing, and outreach All program services	2015, Q1
Prepare reports: Documentation of program activities and progress toward goals Reports to Commission	 Monthly throughout program implementation period Quarterly, and annually
Conclude program operation for this planning cycle	2019

Estimated Participation

Participation and measure adoption estimates were developed based on the number of residential customers in the service territory and an assessment of the attainable market potential in the area, as well as the experience of other organizations that have offered this type of program.

Total Estimated Participation (# of Households)

Measure	Option	No. of Gross Installations*	NTG Ratio	No. of Net Installations*
Room AC	EER 11.5	888	0.80	710
Air-Source Heat Pump	SEER 15, HSPF 8.2	411	0.80	329
Water Heater <= 55 gal	EF 0.95	1,009	0.80	808
Personal Computers	Energy Star	11,797	0.80	9,438
Monitor	Energy Star	9,547	0.80	7,638
Laptops	Energy Star	10,202	0.80	8,162
TVs	Energy Star (5.1)	51,003	0.80	40,802
Printer/Fax/Copier	Energy Star	3,951	0.80	3,161
Set-top Boxes/DVR	Energy Star (2011)	94,891	0.80	75,912
Pool Pump	High Efficiency	1,337	0.80	1,070
Pool Heater	Heat Pump (COP = 5.0)	136	0.80	109
Well Pump	High Efficiency (60% EF)	380	0.80	304
Ceiling Fan - Installation		1,303	0.80	1,042
Electronics - Smart Power Strips		3,492	0.80	2,793
Dehumidifier		1,780	0.80	1,424
PC Power Management Software		68,019	0.80	54,415

Projected Energy Savings

The estimated energy savings are given in terms of annual kWh by measure. The savings noted in each year are incremental, that is reflective of new measures installed by customers through the program in that year. This does *not* include the cumulative impact of measures still in operation from previous years.

Total Net Incremental Electricity Savings (kWh)

Total Net Incremental Energy Savings (kWh)						
Measure	**Option**	**2015**	**2016**	**2017**	**2018**	**2019**
Room AC	EER 11.5	15,673	18,511	24,734	29,000	33,231
Air-Source Heat Pump	SEER 15, HSPF 8.2	14,432	16,469	38,261	50,160	58,786
Water Heater <= 55 gal	EF 0.95	10,020	11,767	17,028	19,667	20,509
Personal Computers	Energy Star	148,082	258,367	180,048	178,365	178,037
Monitor	Energy Star	16,740	20,828	15,295	22,987	19,128
Laptops	Energy Star	80,431	76,768	76,555	71,813	70,411
TVs	Energy Star (5.1)	692,329	873,603	1,055,655	1,314,198	1,355,062
Printer/Fax/Copier	Energy Star	4,874	5,394	13,606	9,216	6,722
Set-top Boxes/DVR	Energy Star (2011)	669,903	793,656	1,350,263	1,237,416	1,115,171
Pool Pump	High Efficiency	22,817	25,952	34,520	38,631	42,718
Pool Heater	Heat Pump (COP = 5.0)	83,173	92,839	91,827	86,041	88,743
Well Pump	High Efficiency (60% EF)	-	-	2,446	28,708	31,499
Ceiling Fan - Installation		41,110	47,465	53,900	60,281	66,642
Electronics - Smart Power Strips		-	-	7,844	8,918	9,997
Dehumidifier		28,403	32,775	37,210	41,605	45,984
PC Power Management Software		597,103	683,006	773,864	863,967	953,686
TOTAL		**2,425,091**	**2,957,401**	**3,773,057**	**4,060,973**	**4,096,327**

Customer Incentives

Incentives will be paid in the form of cash-back rebates to customers or to retailers – which in turn result in a buydown of the cost seen by customers. Incentives for the individual measures account for 50% of the incremental measure cost. Incremental cost is the additional cost of a high-efficiency measure beyond a standard-efficiency alternative. When the program design is finalized, the rebate application form can allow for incentives that vary by measure or even within a measure.

The program upstream buydowns of certain products will enable customers to purchase the products at a lower cost without the need to apply for a rebate.

Administrative Requirements

Vectren will administer the Residential Efficient Products program through an implementation contractor. Vectren's role will be to ensure that

- the implementation contractor performs all the activities associated with delivery of all components of the program, and
- Vectren's educational and program messages are delivered accurately and clearly to ensure the effectiveness of program delivery and maximize customer satisfaction with the program.

The program is expected to operate according to the following administrative and total utility budget:

Total Program Budget

Total Program Budget					
	2015	2016	2017	2018	2019
Program Staff Labor Cost	$50,000	$50,000	$50,000	$50,000	$50,000
Education & Marketing Cost	$23,826	$27,509	$32,748	$37,287	$41,064
Evaluation Cost	$12,707	$14,672	$17,466	$19,887	$21,901
Implementation Cost	$63,535	$73,358	$87,329	$99,433	$109,505
Incentive Costs	$158,837	$183,394	$218,322	$248,582	$273,761
Total Budget	**$308,904**	**$348,932**	**$405,864**	**$455,188**	**$496,231**

Cost-Effectiveness

The cost-effectiveness metrics of the Residential Efficient Products program are as follows:

Cost Effectiveness Tests						
	TRC Ratio	TRC Benefits	TRC Costs	UCT Ratio	PCT Ratio	RIM Ratio
Res Efficient Products	**2.31**	**$5,767,547**	**$2,494,058**	**3.55**	**11.18**	**0.51**

CHAPTER 3

RESIDENTIAL INCOME QUALIFIED WEATHERIZATION PROGRAM

Program Description	The Residential Income Qualified Weatherization program is a Core program that will provide energy efficiency services and energy education to Vectren's low-income customers; helping them to reduce their energy usage and increase the affordability of their energy bills. This program will focus on education and the installation of measures in homes that meet the low income criteria. Participating households will receive the following types of assistance: • In-Home Audits and Education—these are on-site inspections used to identify the applicability of energy-savings measures the program offers and to educate residents about ways to reduce their energy usage. • Direct Installation of Measures—Install measures to reduce energy use in the home at no charge to residents.
Objectives	The purpose of the Residential Income Qualified Weatherization program is to educate and assist eligible residential customers with making their homes more energy efficient. Unlike other programs, a core objective is to provide repairs necessary to install energy savings improvements in a part of the housing stock that is often old and substandard in comparison to middle and upper income housing.
Target Market	The eligible customer population for the Residential Income Qualified Weatherization program is low-income residents in residential units that are provided with electricity by Vectren and who are financially responsible for the utility bill payment. Customers must meet the following usage and income eligibility criteria for program participation: • Income qualified participants are all those with an average household income at or below 200% of the federal poverty level.
Implementation Strategy	During the implementation of this program, the implementation staff will be involved in several activity areas: <u>In-Home Audits and Education</u> • Trained auditors perform on-site audits and assess the energy performance of the house; i.e., identify where energy is used and where there are inefficiencies and determine which measures are appropriate to install. This includes an optional blower door test to check for air infiltration and building envelope tightness. • The auditors discuss the opportunities to reduce energy use and bills with residents. • Follow-up contacts with the participants reinforce the message of the benefits of energy-saving behaviors (e.g., turning off lights in unoccupied rooms) and adoption of energy-savings measures offered by the auditors. <u>Direct Installation Components</u> Applicable measures will be installed, at no cost to residents. Measures for the program include: • Compact fluorescent lamps

	• Low flow showerheads • Low flow faucet aerators Education Overview Customers will be provided with energy education materials to enhance their understanding of energy-saving behaviors and measures and to make them aware of other Vectren energy efficiency and demand response programs, as well as other State and local resources available to assist them. Applicable Collaborative Resources There are several programs in place at the State level that provide qualified residents with loans and/or rebates to enable action on commonly recommended measures. Vectren can leverage these resources to expand or supplement benefits to income qualified customers.
Issues, Risks, and Risk Management Strategies	The Residential Income Qualified Weatherization program focuses on providing energy efficiency services to low-income residents to ensure reduced consumption. There is little risk associated with this program. Attention will be given to ensuring that the implementation contractor supplies the services that funding from this program will enable, as well as the documentation of activities that will meet the tracking and reporting requirements of this program.
Marketing and Outreach	The Residential Income Qualified Weatherization program will reach the target low income households by using the following channels: • Recruitment by the program implementation contractor • Use of utility bill stuffers for customer awareness and education • Weatherization contractors and other appropriate community groups to refer eligible participants • Since this program defines eligibility by income, canvassing neighborhoods with low income census tracking data is a marketing approach that has been used successfully by other low-income program implementers around the nation, such as Focus on Energy. The approach consists of sending a postcard to all households in a specific area, detailing plans to be in the neighborhood during a certain number of days. It then asks the customer to call to set up an appointment for free energy efficiency products. This approach can ensure that contractor teams are efficiently scheduled, decreasing administrative costs and improving cost effectiveness. • In addition, Vectren will encourage in the RFP process that bidding program implementation contractors investigate opportunities to hire low income, unemployed workers through various programs throughout the State.
Evaluation, Measurement and Verification Requirements	The evaluation methodology and data collection proposed for the program are guidelines that reflect current measurement and verification (M&V) practices. The ultimate M&V requirements for this program will conform with the state protocols. Metrics for Gauging Program Success • Number of measures installed in participating households • Customer satisfaction with the program and the products • Energy usage reduction and bill savings among participating households • Program implementation costs incurred • Weatherization program provider satisfaction with partnership Data Collection Approaches

Program staff will collect data on program marketing, outreach, and service activities. The program will utilize a data tracking system to record and report program activities and achievements. The data required for evaluating the program will depend on the methodology chosen.

Impact Evaluation Methodology

The energy savings and demand reduction resulting from measures installed by the program implementation contractor can be evaluated through records of installations performed and follow-up surveys with recipient households to assess retention of the installations. Deemed per-unit savings can be applied to the retained installations to obtain final savings estimates.

It is assumed that participants in this program would not have been able to afford these services without the program, and so there is no free-ridership and a net-to-gross ratio of 100%.

Process Evaluation Methodology

Program process evaluation is important to ensure that the program is operating as intended and to provide information that can enable improvements in both the program design and implementation. Process evaluations will be undertaken and conducted throughout the program by the implementation and M&V contractor selected by Vectren.

Process evaluation will assess eligible customers' understanding, attitudes about, and satisfaction with the program. They will make use of survey data collected by the implementation and M&V contractors. These surveys will include both customers known to have participated in the program and eligible nonparticipants.

Interviews with program service providers will be conducted to assess satisfaction with the program and to identify problems and possible program services/implementation improvements. The data from the interviews will be used to identify problems/concerns with the partnerships and/or procedures. These reviews will be conducted throughout the program operation period so that improvements can be incorporated into the implementation.

Program Schedule

This program is a Core program and is already part of the current Vectren portfolio and will continue to operate through PY 2019. The following table provides a schedule of key milestones:

Key Milestones	Timing
Assign internal program manager and staff	Anticipated in late 2013 or early 2014.
Select and contract with program implementation contractor(s)	2014, in concert with statewide Core program implementation contractor process
Finalize program design	2014, Q2
Pre-rollout program development: Develop procedures and protocols for delivery of services and activity tracking	2014, Q3 and Q4
Program rollout: Re-Launch program services	2015, Q1
Prepare reports: Documentation of program activities	 Monthly throughout program

and progress toward goals Reports to Commission	implementation period Quarterly, and annually
Conclude program operation for this planning cycle	2019

Estimated Participation

Participation and measure adoption estimates were developed based on the number of residential customers in the service territory and an assessment of the attainable market potential in the area, as well as past program performance and the experience of other organizations that have offered this type of program.

Total Estimated Participation (# of Units, Bulbs, or Fixtures)

Measure	Option	No. of Gross Installations*	NTG Ratio	No. of Net Installations*
Screw-in	CFL	34,000	1.00	34,000
Specialty	CFL	10,000	1.00	10,000
Screw-in	LED	6,000	1.00	6,000
Water Heater - Tank Insulation		625	1.00	625
Water Heater - Pipe Wrap		625	1.00	625
Water Heater - Faucet Aerators		5,000	1.00	5,000
Water Heater - Low-Flow Showerheads		2,500	1.00	2,500

Total Estimated Participation (# of Households)

Number of Households Participating					
	2015	2016	2017	2018	2019
Gross HH's	1000	1000	1000	1000	1000
Net HH's	1000	1000	1000	1000	1000

Projected Energy Savings

The estimated energy savings are given in terms of annual kWh by measure. The savings noted in each year are incremental, that is reflective of new measures installed by customers through the program in that year. This does *not* include the cumulative impact of measures still in operation from previous years.

Total Net Incremental Electricity Savings (kWh)

Total Net Incremental Energy Savings (kWh)						
Measure	Option	2015	2016	2017	2018	2019
Screw-in	CFL	1,421,140	1,343,717	908,505	898,576	898,576
Specialty	CFL	139,902	139,906	140,190	140,426	140,703
Screw-in	LED	-	-	162,643	162,871	163,206
Water Heater - Tank Insulation		9,875	9,875	9,875	9,875	9,875
Water Heater - Pipe Wrap		6,375	6,375	6,375	6,375	6,375
Water Heater - Faucet Aerators		158,000	158,000	158,000	158,000	158,000

Water Heater - Low-Flow Showerheads		141,000	141,000	141,000	141,000	141,000
TOTAL		**1,876,292**	**1,798,874**	**1,526,587**	**1,517,123**	**1,517,735**

Customer Incentives

The energy efficiency measures are installed at no charge to low income residents. Since the cost of the measures is fully covered by the program, there are no direct financial incentives provided to the customers.

Administrative Requirements

Vectren will mainly administer the Residential Income Qualified Weatherization program with a program implementation contractor and through partnerships with weatherization program providers. The program is expected to operate according to the following administrative and total utility budget:

Total Program Budget

Total Program Budget					
	2015	2016	2017	2018	2019
Program Staff Labor Cost	$75,000	$75,000	$75,000	$75,000	$75,000
Education & Marketing Cost	$51,318	$51,318	$80,659	$78,678	$74,714
Evaluation Cost	$25,659	$25,659	$40,330	$39,339	$37,357
Implementation Cost	$236,063	$236,063	$371,034	$361,917	$343,683
Incentive Costs	$102,636	$102,636	$161,319	$157,355	$149,427
Total Budget	**$490,676**	**$490,676**	**$728,342**	**$712,288**	**$680,181**

Cost-Effectiveness

The cost-effectiveness metrics of the Residential Income Qualified Weatherization program are as follows:

Cost Effectiveness Tests						
	TRC Ratio	TRC Benefits	TRC Costs	UCT Ratio	PCT Ratio	RIM Ratio
Res IQW	**0.99**	**$2,475,435**	**$2,503,149**	**0.99**	**-**	**0.35**

CHAPTER 4

RESIDENTIAL IQW PLUS PROGRAM

Program Description	The Residential Income Qualified Weatherization (IQW) Plus program will provide additional energy efficiency services and follow-on measures to Vectren's low-income customers; helping them to reduce their energy usage and increase the affordability of their energy bills. This Core Plus program will focus on expanding the types of measures installed in homes that meet the low income criteria beyond what is offered in the Core IQW program in order to pursue deeper savings. The full measure and installation cost will be covered by program rebates so that household income constraints do not preclude the attainment of these savings.
Objectives	The purpose of the Residential IQW Plus program is to educate and assist eligible, income-limited residential customers with making their homes more energy efficient.
Target Market	The eligible customer population for the Residential IQW Core Plus program is all customers that have participated in the IQW Core program.
Implementation Strategy	The implementation of this program will involve careful tracking and follow-up with the participants of the IQW Core program. After they have received a walk-thru audit and direct-install measures, this program will reach out to them and provide the opportunity to follow up on any non-standard measures or recommendations uncovered in the IQW Core activities. Applicable measures would be installed at no cost to residents. These measures include: • Weather stripping and other infiltration reduction • Duct repair and sealing • Ceiling Insulation • Whole-House Fan • Programmable Thermostats • Possible measures from other programs like the Efficient Products program or the Whole House Plus program. Education Overview Customers will be provided with energy education materials to enhance their understanding of energy-saving behaviors and measures and to make them aware of other Vectren energy efficiency and demand response programs, as well as other State and local resources available to assist them. Applicable Collaborative Resources There are several programs in place at the State level that provide qualified residents with loans and/or rebates to enable action on commonly recommended measures. Vectren can leverage these resources to expand or supplement benefits to income qualified customers.
Issues, Risks, and Risk Management	The Residential IQW Plus program focuses on providing energy efficiency services to low-income residents to ensure reduced consumption. There is little risk associated with this program. Attention will be given to ensuring that the implementation contractor and

Strategies	weatherization providers supply the services that funding from this program will enable, as well as the documentation of activities that will meet the tracking and reporting requirements of this program.
Marketing and Outreach	The Residential IQW Core Plus program will primarily target past and current participants in the Residential IQW Core program, reaching out to them via direct mail, email, and phone recruitment.
Evaluation, Measurement and Verification Requirements	The evaluation methodology and data collection proposed for the program are guidelines that reflect current measurement and verification (M&V) practices. The ultimate M&V requirements for this program will conform with the state protocols. Metrics for Gauging Program Success • Number of measures installed in participating households • Customer satisfaction with the program and the products • Energy usage reduction and bill savings among participating households • Program implementation costs incurred • Weatherization program provider satisfaction with partnership Data Collection Approaches Program staff will collect data on program marketing, outreach, and service activities. Customer billing data prior to and following program participation will be required to assess energy use and improvement opportunities, and assess and/or verify savings for the payment of customer incentives. The program will utilize a data tracking system to record and report program activities and achievements. The data required for evaluating the program will depend on the methodology chosen. Impact Evaluation Methodology The first step is to establish a pre-participation energy use "baseline" based on customer bills, followed by post-participation tracking of energy use through bills. This, together with information on exact measures installed during the audit and additional weatherization measures installed as provided by the installation contractors, would allow assessment of customer energy savings. It is assumed that participants in this program would not have been able to afford these services without the program, and so there is no free-ridership and a net-to-gross ratio of 100%. Process Evaluation Methodology Program process evaluation is important to ensure that the program is operating as intended and to provide information that can enable improvements in both the program design and implementation. Process evaluations will be undertaken and conducted throughout the program by the implementation and M&V contractor selected by Vectren. Process evaluation will assess eligible customers' understanding, attitudes about, and satisfaction with the program. They will make use of survey data collected by the implementation and M&V contractors. These surveys will include both customers known to have participated in the program and eligible nonparticipants. Interviews with program service providers will be conducted to assess satisfaction with the program and to identify problems and possible program services/implementation improvements. The data from the interviews will be used to identify problems/concerns with the partnerships and/or procedures. These reviews will be conducted throughout the program operation period so that improvements can be incorporated into the

	implementation.
Program Schedule	This program is a newly recommended Core Plus program that would begin in PY 2015 and operate through PY 2019. The following table provides a schedule of key milestones:

Key Milestones	Timing
Assign internal program manager and staff	Anticipated in late 2013 or early 2014.
Select and contract with program implementation contractor(s)	2014, Q2 or immediately upon program approval
Finalize program design	2014, Q2
Pre-rollout program development: Develop procedures and protocols for delivery of services and activity tracking	2014, Q3 and Q4
Program rollout: Launch program services	2015, Q1
Prepare reports: Documentation of program activities and progress toward goals Reports to Commission	 Monthly throughout program implementation period Quarterly, and annually
Conclude program operation for this planning cycle	2019

Estimated Participation

Participation and measure adoption estimates were developed based on the number of residential customers in the service territory and an assessment of the attainable market potential in the area, as well as the experience of other organizations that have offered this type of program.

Total Estimated Participation (# of Households)

Measure	No. of Gross Installations*	NTG Ratio	No. of Net Installations*
Total Res IQW Plus	354	1	354

Projected Energy Savings

The estimated energy savings are given in terms of annual kWh by measure. The savings noted in each year are incremental, that is reflective of new measures installed by customers through the program in that year. This does *not* include the cumulative impact of measures still in operation from previous years.

Total Net Incremental Electricity Savings (kWh)

Total Net Incremental Energy Savings (kWh)					
Measure	2015	2016	2017	2018	2019
Total Res IQW Plus	141,998	140,662	143,545	142,725	141,991
TOTAL	**141,998**	**140,662**	**143,545**	**142,725**	**141,991**

These savings will be attributable to house-as-a-system type measures such as:

- Insulation - Ceiling
- Insulation - Ducting
- Insulation - Foundation
- Insulation - Infiltration Control
- Insulation - Radiant Barrier
- Ducting - Repair and Sealing
- Windows - Install Reflective Film
- Doors - Storm and Thermal
- Roofs - High Reflectivity
- Whole-House Fan - Installation
- Thermostat - Clock/Programmable
- Electronics - Smart Power Strips

Customer Incentives

The energy efficiency measures are installed at no charge to low income residents. Since the cost of the measures is fully covered by the program, there are no direct financial incentives provided to the customers.

Administrative Requirements

Vectren will mainly administer the Residential IQW Plus program with a program implementation contractor and through partnerships with weatherization program providers. The program is expected to operate according to the following administrative and total utility budget:

Total Program Budget

Total Program Budget					
	2015	2016	2017	2018	2019
Program Staff Labor Cost	$10,000	$10,000	$10,000	$10,000	$10,000
Education & Marketing Cost	$19,687	$19,687	$20,337	$20,337	$20,337
Evaluation Cost	$15,750	$15,750	$16,270	$16,270	$16,270
Implementation Cost	$39,374	$39,374	$40,674	$40,674	$40,674
Incentive Costs	$196,869	$196,869	$203,369	$203,369	$203,369
Total Budget	**$281,679**	**$281,679**	**$290,649**	**$290,649**	**$290,649**

Cost-Effectiveness

The cost-effectiveness metrics of the Residential IQW Plus program are as follows:

Cost Effectiveness Tests						
	TRC Ratio	TRC Benefits	TRC Costs	UCT Ratio	PCT Ratio	RIM Ratio
Res IQW Plus	**0.56**	**$650,864**	**$1,166,742**	**0.56**	**-**	**0.35**

CHAPTER | 5

RESIDENTIAL NEW CONSTRUCTION PROGRAM

Program Description	The Residential New Construction program is designed to accelerate the incorporation of energy efficiency in the design, construction, and operation of single-family homes and renovated or reconstructed homes. The program works with builders and qualified Home Energy Raters to build homes that are, more comfortable, more durable, and more energy efficient than homes built to conventional practices. All home certifications go through a third party verification process, ensuring the construction meets the high standard of the programs. Upstream designers/builders and owner-builders will be offered education on and rebates for the installation of high efficiency end-use equipment and building envelope measures in new residential dwellings. This program takes a “whole home” approach, encouraging designers, builders, and home buyers to think of home performance in total, rather than in terms of the efficiency of individual components. It focuses on raising the standards of all components, from building shell through appliances and fixtures. The program has the following components: • Education – teach the new home market stakeholders, and renovation contractors and developers, about the benefits of energy-efficient home design and inform them of incentives available for the installation of energy-efficiency shell and equipment. • Rebates – offer rebates to builders or homeowners for the incorporation of high efficiency end-use equipment and building envelope measures in new residential dwellings; higher rebates are offered to homes that meet higher efficiency standards. <u>Education</u> • Develop seminars and materials to address the factors that generally prevent homebuilders’ from incorporating energy efficiency into homes; e.g., reliability, cost-effectiveness. • Offer this training to builders, developers, contractors and others, including builders of tract homes, renovation contractors and developers, real estate agents, and lenders. • Set up demonstration homes to familiarize the community, from builders to homeowners, with the high-efficiency measures. <u>Rebates</u> The program will offer rebates that encourage the installation of measures that improve home energy performance as a whole, using ENERGY STAR recommended design practices, materials, and appliances. The packages include progressively more and higher efficiency measures, providing opportunities for builders of homes in many price categories to participate. The packages combine a number of measures offered for retrofits under other residential programs into new housing design; many are more cost-effective to install as part of new construction. The rebate-eligible measure packages are:

	• Bronze Package— high efficiency HVAC equipment, ENERGY STAR lighting fixtures, high-efficiency water heater, programmable thermostat • Silver Package—Bronze Package measures plus: Attic / roof insulation, wall insulation, floor/foundation insulation, ENERGY STAR refrigerator • Gold Package—Silver Package measures plus: ENERGY STAR windows, ENERGY STAR clothes washer, ENERGY STAR dishwasher; one or more of the following measures: exhaust ventilation strategy, drainwater heat recovery, high reflectivity roof. The program will be most effective if the rebates are directed to new home builders rather than to the eventual new homeowners, though owner-builders are eligible to receive them.
Objectives	The purpose of the Residential New Construction program is to greatly improve the energy efficiency of all newly constructed and reconstructed facilities in the Vectren service territory. The goals of the program are to meet the demands of Indiana's climate, push the levels of energy efficiency of Indiana's residential building standards, and facilitate builder participation by adding value to their business. The program provides financial incentives for builders as a means to not only promote energy efficient new construction, but also accelerate the adoption of new technologies. The program has the following objectives: • Make valuable contributions toward achievement of reduction goals. • Produce a permanent improvement in "standard" design practices among building designers and owners that will continue without the need for short-term incentives.
Target Market	The eligible market for this program is all new single-family homes constructed in the applicable service territory, as well as buildings that are completely renovated or reconstructed. The target market for participation in the program is residential designers, builders, developers, and owner-builders. While the energy savings resulting from this program will be accrued by the homeowners of units that include measures installed under the program, and all residential customers who are building new homes are eligible to participate, the key target market of the program are the trades people most responsible for the design and equipment decisions—builders, developers, and contractors. Homes expected to be targeted for participation will include those with water heat and/or space conditioning systems which have the potential to save the most energy.
Implementation Strategy	Overview of Activities The program will be administered through third-party implementation contractors. The implementation contractor will be responsible for providing technical assistance and develop training for builders, building trades, and realtors to raise awareness about the benefits of energy efficient new home construction. During implementation, program staff will be involved in several activity areas: • Identification and recruitment of upstream market stakeholders for program participation and delivery channel activities • Education: including development and operation of training seminars for designers, builders, developers, and homeowners; development and operation of demonstration homes; and development and distribution of educational publications • Marketing: including development and distribution of program materials in

collaboration with upstream trades people who will be both program participants and promoters

- Rebate Processing: including receipt, review and verification of applications; and either pay or submit rebates for payment
- Program Performance Tracking and Improvement: including rebate submittals and payments, opportunities to improve the program
- Reporting: including reporting of program activities to meet regulatory and internal requirements, in particular progress toward program goals

The program will be marketed to builders primarily through the Indiana Builders Association as well as direct business-to-business contacts. The implementation contractor will work with program staff Business Managers to identify key builders and conduct in-person meetings to recruit the builders into the program. The contractor will work on developing opportunities to present the program at builder and other trade association meetings, and to place information in association newsletters. A dedicated program webpage will serve as a source for program information and application forms for rebates. Participating builders will be supplied with collateral materials to aid them in communicating the benefits of energy efficient homes to their customers.

The upstream market stakeholders, including the designers, builders, developers, real estate agents, and mortgage lenders will receive extensive education about energy-efficient home construction and benefits. They will also have the following roles as delivery channels:

- Designers, builders, and developers who participate in training seminars can distinguish themselves to prospective homebuyers as qualified or certified energy-efficient providers. Ones who also receive rebates for installing rebate-eligible measures can pass some or all of these incentives along to buyers.
- Builders and real estate agents educated about the features and advantages of energy-efficient homes will, in-turn, serve as ambassadors for the program and can use the advantages as a selling point.
- Lenders can offer homebuyers larger loan amounts and/or lower interest rates than they would have otherwise qualified for, towards the purchase of certified energy-efficient homes. These are referred to as “energy efficient mortgages.”

<u>Education Overview</u>

Education is a key component of the Residential New Construction program. The market will change through training, education and demonstration. The program will increase confidence in the performance and benefits of increased energy efficiency (better performance, lower fuel bills, reduced maintenance, etc.). Designers and builders will be encouraged to implement more energy-efficient strategies to increase energy efficiency through the program. Emphasis on the additional benefits of comprehensive energy efficiency improvements and continual maintenance to retain savings will demonstrate an overall cost-effectiveness that can be achieved without the need for financial incentives over the longer term. Ongoing deployment of these strategies will become “standard” practice by these same designers and builders in additional projects, affecting long-term market transformation.

To accomplish this, the program will offer several forms of education:

- Training seminars will be taught by experts in specific aspects of high-efficiency home design and construction. Many utilities offer these no-fee sessions on an ongoing basis. In addition to teaching key principles and an understanding of the program, they provide Vectren with an excellent opportunity to develop strong

	relationships and build trust with this influential group. • Publications with technical information, practical advice, and persuasive messages will be developed. These can be included in newsletters directed to the design/build/sales community, published in trade journals, sent in direct mail, distributed at seminars, and made available on a website page designed for this audience. • Demonstration homes are effective in encouraging the community's involvement. Vectren will work with communities to set total savings goals. This demonstration program will work to incorporate the use of the existing Home Energy Rating System (HERS). Program staff will work with HERS raters to establish a workable data tracking system. Vectren may also be able to leverage the support of HERS raters in recruiting and training builders. Demonstration homes will also promote and educate home builders, sellers, and buyers in regards to energy efficiency measures that can be incorporated into their homes, allowing them to see different types of upgrades such as lighting, window and water heaters in operation. One of the goals will be to increase the education of builders of tract homes, real estate agents and lenders about the value of a home rating system. The program will also promote energy efficiency mortgages through the local lending community.
Issues, Risks, and Risk Management Strategies	Currently, several market barriers inhibit the participation in new construction programs. All of the implementation activities—the educational component, together with outreach and marketing of the program, will address the following barriers to achieve the educational and energy savings goals of the program: • Perception of Higher Cost: Many designers and builders feel that increased building performance costs more, and that it is not cost-effective. Higher efficiency measures have higher first cost, but are likely to have a lower cost on a lifecycle basis due to energy savings over the life of the measure. • Risk Aversion: The building industry is particularly slow to adopt new technologies or solutions. Designers prefer to install systems and build buildings using familiar technologies. Liability issues are also a concern. • First Cost vs. Lifecycle Cost Considerations: Building developers are only concerned with first cost considerations as they must build the house within a pre-determined budget. As such, they are reluctant to consider the higher cost high-efficiency equipment that would have to be passed onto the homeowner through a higher cost of the home. • Limited Technical Information: Designers and owners have limited familiarity with new products, technologies and their applications, and their associated benefits that extend beyond energy savings (comfort, durability, health, productivity and maintenance). • Inadequate Operational Procedures: Building systems are usually not tested to ensure that they perform as designed and owners fail to implement an ongoing maintenance and quality assurance procedure to properly operate the equipment. Vectren should take additional steps to encourage participation and satisfaction with the program. Some of these might include: • Recognition of builders who meet or exceed the program requirements through press releases and other advertisements • Offering an annual award for the most energy-efficient residential design

	• Offering information to designers and builders on the cost-effectiveness of higher performance measures • Organizing training sessions and workshops for providing designers and builders with technical information related to the higher efficiency products and their associated benefits. • Providing an incentive bonus for builders to install a "whole home" package of measures • Working with communities to site a demonstration home and set community savings goals
Marketing and Outreach	Because they are the key decision makers in new home design, it will be advantageous for the program to work "upstream"— mainly with designers, builders and developers, but also with real estate agents and mortgage lenders. By doing so, the program can teach these trade allies about the benefits of energy-efficient home design and inform them of the financial incentives for the installation of energy-efficiency equipment. • Vectren develops awareness through direct marketing—e.g., bill inserts, newsletters, website, broadcast and print media, real estate guide ads, and direct mail. A focus of marketing activities should be targeted to homeowners through advertisements in home sales magazines, home shows, parade of homes, and seminars. Informed and educated homeowners are likely to create a market pull and bring up higher efficiency options with their designers/builders. • Designers, Builders, and Developers—Trades people are key decision makers for building shell and systems, and determining the appliances installed in new homes. In order for the program to be effective, the program must educate them on how and why to upgrade their building practices through training sessions and ongoing technical assistance. Once convinced, these construction influencers can promote the program and the efficiency benefits to new homebuyers as well as to their suppliers and subcontractors. Some utility programs are designed to encourage builders to pass the incentives they receive for installing high-efficiency measures on to homebuyers. These trades people are both participants and delivery channels for the program. • Mortgage Lenders—In addition to the participation of local builders, it will be important for the program to enlist the help of mortgage lenders in promoting the sale of energy-efficient homes. Other utilities with similar new construction programs have obtained the cooperation of lenders who have agreed to offer favorable financing terms for energy-efficient homes. • Real Estate Agents—To encourage Realtors to promote energy-efficient homes, it would be extremely beneficial if Vectren were to clearly identify qualifying homes, and perhaps offer cooperative advertising dollars to realtors selling such homes.
Evaluation, Measurement and Verification Requirements	The evaluation methodology and data collection proposed for the Residential New Construction program are guidelines that reflect current measurement and verification (M&V) practices. The ultimate M&V requirements for this program will conform with the state and local protocols. Two key issues for evaluation of new construction programs are: • Determination of whether the program attracts builders who were already building homes that meet the program requirements.

- An assessment of whether promotional and marketing efforts are in fact effective.

Metrics for Gauging Program Success

- Number of projects completed
- Number of participating builders
- Number of in-person visits to key builders
- Energy savings associated with homes built through participation in the program
- Number of seminar attendees and/or trades people certified in energy-efficient building principles
- Increase in receptivity/adoption of energy-efficient building practices by designers, builders, and developers to measure the effectiveness of the marketing and education activities and progress towards market transformation.
- Delivery at or below budgeted costs
- Achieving estimated benefit-cost ratios

Data Collection Approaches

The data required for evaluating the program will depend on the methodology chosen. They will likely include the following sources and information:

- Billing and/or metered use data
- Engineering estimates of measure savings
- Local weather data
- Program tracking system for measures installed, rebates paid, and home characteristics
- Upstream and homeowner surveys regarding program awareness, satisfaction with the program, understanding and perceived savings from measures, program influence on design and construction decisions
- Program staff surveys

Impact Evaluation Methodology

The impact evaluation will conform with the state protocols. Some possible approaches are described below.

The impact evaluation will use a variety of techniques to obtain data on energy consumption in new residential buildings, but will focus on the effect of the program on building practices. The program will compare a sample of homes completed under the program with a control sample of non-program homes, preferably built by the same builders either before they entered the program (a before-after analysis) or at the same time but not as part of the program (a side-by-side analysis). The before-after analysis will be preferable, but it may be difficult to locate the necessary homes. Therefore, a side-by-side analysis will probably be the more viable option

The analysis techniques will include performing engineering analyses on a sample of program and non-program homes "as built", metering these same program and non-program homes to calibrate the engineering estimates, and conducting a billing analysis of weather-adjusted energy consumption for a larger sample of program and a comparable group of non-program homes. To complete the engineering analysis and metering study for the program, detailed data on each home, including occupant characteristics, appliance stock, and structural features, will be required. Similar, but less detailed, information will be gathered using an occupant survey for the homes included in the statistical billing analysis.

A similar approach to sampling program and non-program buildings will be used to evaluate impacts for multifamily units. Metering may be conducted at the whole building level and a sample of units will be carefully selected to provide end-use data on location and structural differences (two-bedroom versus one-bedroom, etc.) for units within a multifamily complex.

<u>Process Evaluation Methodology</u>

Program participants, local inspectors, and program implementation staff will be interviewed for the process evaluation. These interviews will focus on the construction and inspection processes of residences built to new standards. Site visits will be conducted as part of the engineering and metering data collection; additional site visits may be added at a later date if any installation problems are identified. Site visits will be used to determine if measures were installed as expected and to gather data for the engineering analysis of the homes as built. In addition to obtaining information on customer characteristics, the customer survey will ask questions about the effectiveness of program promotional activities, customer satisfaction with their homes, and whether the participants have encountered any problems with their new equipment.

Initially, the process evaluation will focus on program implementation, administration, and delivery. Interviews will be used to determine if the program is encouraging new construction practices and if the upstream market stakeholders and homeowners are finding the program informational and promotional materials useful. If there are difficulties in obtaining participation during the first year, the evaluation may be expanded to include focus group interviews with a larger sample of designers, builders, developers, and new homeowners.

After the first year, the process evaluation will assess how well program changes recommended during the first-year process evaluation are being implemented. The process evaluation will also continue to examine the program implementation and delivery process to determine if additional changes are required.

Program Schedule

This program is a newly recommended Core Plus program that would begin in PY 2015 and operate through PY 2019. The following table provides a schedule of key milestones:

Key Milestones	Timing
Assign internal program manager and staff	Anticipated in late 2013 or early 2014.
Select and contract with program implementation contractor(s)	2014, Q1
Finalize program design	2014, Q2
Pre-rollout program development: Build designer/builder network Develop designer/builder training curriculum and schedule Develop marketing strategies Develop procedures for tracking activities and documenting results	2014, Q3 and Q4
Program rollout:	2015, Q1
Prepare reports: Documentation of program activities and progress toward goals Reports to Commission	Monthly throughout program implementation period Quarterly, and annually
Conclude program operation for this	2019

	planning cycle	

Estimated Participation

Participation and measure adoption estimates were developed based on the number of residential customers in the service territory and an assessment of the attainable market potential in the area, as well as past program performance and the experience of other organizations that have offered this type of program.

The Net to Gross Ratio for this program is modeled as 0.95.

Program NTG Ratio

Measure	NTG Ratio
Total Res NC	0.95

Program Yearly Projections

	2015	2016	2017	2018	2019
Total Number of Homes	74	82	99	109	118
Net kWh Savings/HH	2605	2337	2223	2166	2102
Gross kWh Savings/HH	2742	2460	2340	2280	2213
Program Cost/HH	$ 773	$ 774	$ 1,078	$ 1,062	$ 1,006

Projected Energy Savings

The estimated energy savings are given in terms of annual kWh by measure. The savings noted in each year are incremental, that is reflective of new measures installed by customers through the program in that year. This does *not* include the cumulative impact of measures still in operation from previous years.

Total Net Incremental Electricity Savings (kWh)

Total Net Incremental Energy Savings (kWh)					
Measure	**2015**	**2016**	**2017**	**2018**	**2019**
Total Res NC	192,566	192,552	220,291	236,366	248,191
TOTAL	**192,566**	**192,552**	**220,291**	**236,366**	**248,191**

Customer Incentives

The proposed incentives are designed to cover 50% of the incremental measure costs. Incremental cost is the additional cost of a high-efficiency measure beyond a standard-efficiency alternative. Program administrators can express this as a certain dollar incentive per package or tier level.

Administrative Requirements

The Residential New Construction program will be administered through an implementation contractor. The utility's role will be to ensure that:

- the implementation contractor performs all the activities associated with delivery of all components or the program, and
- Vectren's educational and program messages are delivered accurately and clearly to ensure the effectiveness of program delivery and maximize customer satisfaction with the program.

The program is expected to operate according to the following administrative and total utility budget:

Total Program Budget

Total Program Budget					
	2015	2016	2017	2018	2019
Program Staff Labor Cost	$10,000	$10,000	$10,000	$10,000	$10,000
Education & Marketing Cost	$4,714	$5,381	$9,686	$10,588	$10,883
Evaluation Cost	$1,571	$1,794	$3,229	$3,529	$3,628
Implementation Cost	$9,428	$10,762	$19,372	$21,175	$21,766
Incentive Costs	$31,425	$35,873	$64,573	$70,584	$72,552
Total Budget	**$57,138**	**$63,809**	**$106,859**	**$115,875**	**$118,828**

Cost-Effectiveness

The cost-effectiveness metrics of the Residential New Construction program are as follows:

Cost Effectiveness Tests						
	TRC Ratio	TRC Benefits	TRC Costs	UCT Ratio	PCT Ratio	RIM Ratio
Res NC	**1.02**	**$453,989**	**$443,548**	**1.23**	**9.82**	**0.42**

CHAPTER | 6

RESIDENTIAL MULTI-FAMILY DIRECT INSTALL PROGRAM

Program Description	The Residential Multi-Family Direct Install program provides targeted, highly cost-effective measures to multifamily households in a quickly deployable program delivery mechanism. This will provide energy savings to the multifamily segment, which is typically an underserved market with respect to energy efficiency programs. This is largely because of the preponderance of rental units with the so-called "split owner/renter barrier." In other words, since the landlord or owner does not pay the utility bill, there is very little incentive to purchase and install higher efficiency equipment. The program targets multifamily complexes with units that are both individually metered (residential ratepayers) and master metered (commercial ratepayers). Multi-family is defined as having more than 8 units. The program offers a set of high-impact, direct-install measures, as well as energy savings from additional, follow-on measures recommended by the home auditor and for which customers may obtain additional financial incentives. The Residential Multi-Family Direct Install program has several components: • Walk-Through Audits—These are free on-site inspections and tests used to identify energy efficiency opportunities; audit reports contain specific recommendations, including expected costs, energy savings, and resource referrals. • Direct Installation of Low-Cost Measures—During the audit visit, the auditor will install a package of low-cost energy-saving measures, at no additional charge to the customer, to immediately improve the energy performance of the household. These measures include: efficient light bulbs, low-flow water fixtures, and water heater tank insulation and pipe wrap. • Assistance with Additional Measure Installations—the program will provide cash rebates to audit participants who install follow-on measures recommended from the audit. • Workforce Training and Participation— program staff will provide for the training and utilization of qualified auditors and contractors located within the community to provide program services.
Objectives	The purpose of the Residential Multi-Family Direct Install program is to raise awareness of home energy savings opportunities among residential customers and to help them take action using incentives offered by the utilities and State programs. The program will achieve several objectives: • Improve customer understanding of how their homes use energy and how they can use it more effectively for less money, bridging the gap that often prevents efficiency actions particularly in the multifamily/renter community. • Procure immediate energy savings through installation of low-cost energy-saving measures • Encourage installation of additional energy-saving measures recommendations with additional incentives • Develop a workforce trained in assessing and improving home energy efficiency

	that can, ultimately, transform the market • Aid residential customers' perception of Vectren as their partner in reducing home energy use
Target Market	The target market for the Residential Multi-Family Direct Install program is residential customers that are living in 8+ multi-unit buildings Contractors who can provide quality audits and installation of recommended measures are also targeted for participation to deliver the program services. The program targets multifamily complexes with units that are both individually metered (residential ratepayers) and master metered (commercial ratepayers). Recruitment targets property-management companies as well as property owners to secure agreements to treat multiple properties through a single point of contact.
Implementation Strategy	Overview of Activities During the implementation of this program, program staff will be involved in several activity areas: • Audits and customer reports: ensuring that auditors prepare reports that are comprehensive and comply with guidelines. • Recruitment and training of audit and installation contractors; verifying that all contractors on the qualified list have appropriate testing equipment and data analysis software. • Monitoring of auditors who perform the walk-through audit and contractors who install recommended measures. This includes scheduling of home audit appointments and verification of inspections and measure installations. • Program marketing: including development and distribution of program materials in collaboration with other related marketing efforts within the portfolio and the broader marketplace. • Program education and outreach: including development of promotional campaigns to promote in coordination with other incentive programs. • Incentive processing: this includes payments to contractors for the installation of the low-cost measures during audits and to customers for installation of recommended weatherization measures. • Program activity tracking: including tracking of audit requests, audit activities, customer actions, and incentive tracking. • Reporting: development of documentation to meet reporting requirements for the Commission. Education Overview Education is a prominent element of the Residential Multi-Family Direct Install program. Education will be both publicly distributed and customer-specific. • The customer reports generated following the walk-through audits provide one-on-one educational opportunities. Using data from their own homes, residential customers will learn how they use energy and how they can use it more wisely. Tenants are educated about how low-cost measures and behaviors have a lasting impact on their energy and water consumption. • One of the key success factors of the program may rest upon highlighting of water savings benefits. Property managers and owners are typically responsible for water costs even if they are not liable for energy bills. Therefore, promoting water savings benefits is likely to drive program success. • The program will distribute educational materials to renters directly and through

property management companies in an effort to educate them about energy, money, and environmental benefits of using less water.

- ENERGY STAR provides a website that educates customers and contractors about what the program does, and legitimizes the program to customers; and provides cases studies that present results from customers and contractors who have participated in the program.
- The workforce training provides an opportunity to educate equipment and construction contractors about the benefits of energy efficiency and about the program.

Walk-Through Audits

- Trained auditors perform the inspection and, along with review of billing history, assess the energy performance of the house (where energy is used, where inefficiencies are); provide customers with itemized lists of energy efficiency improvements, their anticipated costs and savings, along with information on financial resources available to help defray first-costs.
- The assessments cover the entire home, including insulation, windows, heating and cooling systems, lighting and major appliances.

Direct Installation of Measures

- The auditor will install a package of low-cost measures, simple installations known to improve the energy efficiency of homes, during the walk-through audit.
- These measures will be installed at no additional charge to the audit participants.
- These installations will provide immediate benefit to participants and savings attributable to the program.

Assistance with Additional Measure Installations

Providing customers with help in implementing the audit recommendations is key to the success of the program. These services will be delivered beginning in 2015 through follow up touches by the network of qualified contractors and trade allies. This includes offering resources that include both financial incentives and installation assistance. Since the program was started in 2011, recruiting from the pool of previous participants and steering them toward follow-on measures and opportunities in the broader portfolio can also increase the program's success.

- Cash-back incentives to install weatherization measures, programmable thermostats, and common area lighting upgrades recommended during the audit.
- Access to incentives available from other Vectren programs to reduce the cost of installing remaining recommendations.
- Vectren will contract with an implementation contractor who will manage and oversee that contractors are qualified/certified to install other measures recommended in the walk-through audit.

If landlords and property owners wish to install other measures that may be beyond the scope of this program, such as HVAC systems, exterior lighting, efficient pool pumps, etc; the program implementers will be able to connect them with the appropriate rebate opportunities in the Residential Efficient Products or Business Custom programs.

Workforce Training and Participation

Vectren will make use of auditors qualified to perform the walk-through audits and contractors knowledgeable about energy-efficient products and other measures likely to

	be recommended in the audit report. This can be achieved through development of relationships with electrical and general contracting trade allies, and as well as community groups. The implementers will: • Provide training to ensure the walk-through auditors demonstrate an understanding of building science principles and understanding of the other EE programs in the portfolio. • Ensure that the walk-through auditors are familiar with all the incentives programs available to customers as well as provide education to customers to enhance their understanding of the whole home approach.
Issues, Risks, and Risk Management Strategies	All of the implementation activities—the educational component, together with outreach and marketing of the program, will address the following barriers to achieve the educational and energy savings goals of the program: • Contractor Participation—A limited supply of qualified contractors with the skills to diagnose and market whole-house energy efficiency improvements can limit program potential. A solution is the development of a local network of qualified professionals to provide audit and installation services and to promote the program to residential energy customers. The implementers will: o Offer technical training to participating home improvement trade contractors, including classroom and field sessions and cover building science principles, diagnostic testing and installation best practices. Consider including certification to ensure the training is effective and valuable as a selling point for the contractors. o Offer sales and business process training to help contractors succeed in selling and delivering home performance services, including procedures for quality assurance, employee training, and understanding program incentives or financing. • Marketing and Consumer Education—Consumers may not be familiar with energy efficiency and the benefits it can provide for improving comfort, as well as saving money. Marketing activities can educate them about the benefits. o Vectren will communicate known partner offers and make customers aware through bill inserts, web site or some targeted direct mail. These tactics can help educate homeowners about the benefits of the whole-house approach to energy improvements and how they can take advantage of the program. o The program implementation contractor will work to develop and enlist the help of participating contractors to promote and educate customers about the program. • Quality Assurance—Consumers should be assured that the program offers reliable, high quality services. o The program should have a quality assurance plan to aid delivery of the program services, provide protocols for contractor reporting, and support program evaluation. o Participating auditors and contractors have sufficient training to perform program audits and installations and sets standards for the number of work inspections completed by participation contractors.
Marketing and Outreach	Marketing and outreach in the Residential Multi-Family Direct Install program will employ the following strategies: • Vectren will develop awareness through direct marketing—e.g., bill inserts, newsletters, website, broadcast and print media, direct mail, advertising in

	Apartment Guides, and cold calling of apartment management companies. • The program will be marketed via apartment associations and face-to-face meetings with property-management firms and owners. As needed, apartment associations will be identified and targeted for presentations. • It is particularly important to deliver marketing messages to landlords and owners stressing the increased tenant retention and satisfaction that comes with program participation and lower utility bills. • Walk-Through auditors—part of auditors' services can and should include making customers aware of this program and the incentives available for installation of high-efficiency measures. • Coordination of marketing efforts with other related Vectren programs.
Evaluation, Measurement and Verification Requirements	The evaluation methodology and data collection proposed for the Residential Multi-Family Direct Install program are guidelines that reflect current measurement and verification (M&V) practices. The ultimate M&V requirements for this program will conform with the State protocols. <u>Metrics for Gauging Program Success</u> Primary: • Number of participating multifamily units • Improvement in customer understanding of the whole-house approach to improving energy efficiency • Number of walk-through audits completed • Number of audits that result in documented energy efficiency improvements • Number of participating audit and energy efficiency improvement contractors • Customer satisfaction with the program and the products • Participation in other Vectren programs Secondary: • Energy usage reduction in homes that have had home performance audits • Program implementation costs incurred <u>Data Collection Approaches</u> Vectren will collect and submit data that meet the reporting requirements. The participating contractors who conduct the audits and/or perform the energy improvements will provide much of the data. The contractors should provide at least the following: • Name, address, and contact information (including email address if possible) of owner and renter • Home assessment summary report • Recommended improvements • Estimated cost of improvement • Estimated energy savings • Summary of completed improvements Data will also be collected through surveys of Vectren residential customers and participating contractors to aid the process and impact evaluation, assess participant satisfaction, and identify opportunities for program improvement. The surveys may be conducted by the implementation and M&V contractors. Customer billing data prior to and following program participation will be required to

assess energy use and improvement opportunities, and assess and/or verify savings for the payment of customer incentives.

The program will have a tracking system to house the program activity information and enable regulatory reporting.

Impact Evaluation Methodology

The first step is to establish a pre-participation energy use "baseline" based on customer bills, followed by post-participation tracking of energy use through bills. This, together with information on exact measures installed during the audit and additional weatherization measures installed as provided by the installation contractors, would allow assessment of customer energy savings.

The M&V contractor will determine the appropriate means of estimating savings attributable to the program; that is, net savings, including both free-ridership and spillover. Spillover may be particularly relevant to this program. Because the major thrust of the program is to encourage customers to think about the home as an entire system and consider how the structure, and all their energy-using equipment, affects the energy performance of the home, it would not be surprising to find that customers continue to make additional energy-related improvements on their own (i.e., without incentives) after participation in the program.

Process Evaluation Methodology

The Residential Multi-Family Direct Install program is a relatively complex program, involving home visits, direct installation of measures, delivery of an audit report with additional recommendations, and even subsequent installations with either the implementation contractor or other contractors. Process evaluations throughout the program will be critical to ensure that the program is operating as intended and to provide information that can enable improvements in both the program design and delivery of services.

Process evaluations will assess customer understanding, attitude about, and satisfaction with the program and with Vectren's other educational activities and materials. They will obtain feedback from the contractors who perform installations and audits. The evaluations will make use of survey data collected by the implementation and M&V contractors. Process evaluation will be conducted throughout the program by the implementation and M&V contractors selected by Vectren.

Program Schedule

The Residential Multi-Family Direct Install program is currently a part of the Vectren portfolio, and will continue to operate during PY 2015 and 2016. Due to the expectation of market saturation, i.e. – exhausting the available supply of participants, the program is scheduled to sunset in 2017. The following table provides a schedule of key milestones:

Key Milestones	Timing
Assign internal program manager and staff	Anticipated in late 2013 or early 2014.
Select and contract with program implementation contractor(s)	2014, Q2 or immediately upon program approval
Finalize program design	2014, Q2
Pre-rollout program development: Auditor/contractor training and recruitment	2014, Q3 and Q4
Program rollout: Re-launch consumer marketing and outreach	2015, Q1

Perform audits and improvements	
Prepare reports: Documentation of program activities and progress toward goals Reports to Commission	Monthly throughout program implementation period Quarterly, and annually
Conduct assessment of market saturation. If untapped customers are in short supply, conclude program operation for this planning cycle.	2016, Q4

Estimated Participation

Participation and measure adoption estimates were developed based on the number of residential customers in the service territory and an assessment of the attainable market potential in the area, as well as past program performance and the experience of other organizations that have offered this type of program.

Total Estimated Participation (# of Units, Bulbs, or Fixtures)

Measure	Option	No. of Gross Installations*	NTG Ratio	No. of Net Installations*
Water Heater <= 55 gal	EF 0.95	105	1.00	105
Screw-in	CFL	7,000	1.00	7,000
Specialty	CFL	1,400	1.00	1,400
Water Heater - Tank Insulation		263	1.00	263
Water Heater - Pipe Wrap		263	1.00	263
Insulation - Infiltration Control		263	1.00	263
Thermostat - Clock/Programmable		263	1.00	263
Water Heater - Faucet Aerators		2,100	1.00	2,100
Water Heater - Low-Flow Showerheads		2,100	1.00	2,100
Dehumidifier		105	1.00	105

Total Estimated Participation (# of Households)

	Number of Households Participating				
	2015	2016	2017	2018	2019
Gross HH's	800	600	0	0	0
Net HH's	800	600	0	0	0

Projected Energy Savings

The estimated energy savings are given in terms of annual kWh by measure. The savings noted in each year are incremental, that is reflective of new measures installed by customers through the program in that year. This does *not* include the cumulative impact of measures still in operation from previous years.

Total Net Incremental Electricity Savings (kWh)

Total Net Incremental Energy Savings (kWh)						
Measure	**Option**	**2015**	**2016**	**2017**	**2018**	**2019**
Water Heater <= 55 gal	EF 0.95	5,882	4,401	-	-	-
Screw-in	CFL	209,974	151,105	-	-	-
Specialty	CFL	44,885	33,629	-	-	-
Water Heater - Tank Insulation		11,850	8,888	-	-	-
Water Heater - Pipe Wrap		7,650	5,738	-	-	-
Insulation - Infiltration Control		26,546	19,785	-	-	-
Thermostat - Clock/Programmable		6,234	4,642	-	-	-
Water Heater - Faucet Aerators		52,826	39,153	-	-	-
Water Heater - Low-Flow Showerheads		241,028	178,644	-	-	-
Dehumidifier		2,750	2,040	-	-	-
TOTAL		**609,625**	**448,023**	-	-	-

Customer Incentives

Under this program, incentives are provided in several forms and to both customers and contractors who provide the audit and direct installation services. Incentives go to customers in the form of direct installation of measures during the audit visit and in the form of rebates for installation of recommended measures.

Audit contractors are also eligible to receive incentives under this program. Vectren will pay for the cost of materials for the measures that auditors install during the audits. This means that the auditor receives payment from the customer for the cost of the audit and from Vectren for the cost of materials in the package of measures installed during the audit. Customers are also free to contract with the same contractor to install additional measures, for additional cost, if the contractor offers this service.

Administrative Requirements

Vectren will administer the Residential Multi-Family Direct Install program through an implementation contractor. Vectren's role will be to ensure that:

- the implementation contractor performs all the activities associated with delivery of all components or the program, and
- educational and program messages are delivered accurately and clearly to ensure the effectiveness of program delivery and maximize customer satisfaction with the program.

The program is expected to operate according to the following administrative and total utility budget:

Total Program Budget

Total Program Budget					
	2015	2016	2017	2018	2019
Program Staff Labor Cost	$25,000	$25,000	$ -	$ -	$ -
Education & Marketing Cost	$10,333	$7,750	$ -	$ -	$ -
Evaluation Cost	$6,889	$5,166	$ -	$ -	$ -
Implementation Cost	$34,443	$25,832	$ -	$ -	$ -
Incentive Costs	$68,885	$51,664	$ -	$ -	$ -
Total Budget	**$145,549**	**$115,412**	**$ -**	**$ -**	**$ -**

Cost-Effectiveness

The cost-effectiveness metrics of the Residential Multi-Family Direct Install program are as follows:

Cost Effectiveness Tests						
	TRC Ratio	TRC Benefits	TRC Costs	UCT Ratio	PCT Ratio	RIM Ratio
Res MF Direct Install	**1.47**	**$383,335**	**$260,561**	**1.69**	**20.72**	**0.41**

CHAPTER 7

RESIDENTIAL HOME ENERGY ASSESSMENT PROGRAM

Program Description	The Residential Home Energy Assessment program is a Core program that provides education, an on-site audit, and direct install measures to help single family customers reduce their energy bills. The program is designed to go beyond providing financial incentives to residential customers and aims to make them well-educated energy consumers. The services the program will provide, including in-home audits and referrals to contractors and financial resources, aim to help them gain a better understanding of their home energy use and achieve savings while also improving the comfort of their homes. The program offers a set of high-impact, direct-install measures, as well as energy savings from additional, follow-on measures recommended by the home auditor and for which customers may obtain additional financial incentives. The Residential Home Energy Assessment program has several components: • Walk-Through Audits—These are on-site inspections used to identify energy efficiency opportunities; audit reports contain specific recommendations, including expected costs, energy savings, and resource referrals. • Direct Installation of Low-Cost Measures—During the audit visit, the auditor will install a package of low-cost energy-saving measures, at no additional charge to the customer, to immediately improve the energy performance of the household. These measures include: efficient light bulbs, low-flow water fixtures, and water heater tank insulation and pipe wrap. • Referral to Other Programs for Additional Measure Installations—Vectren will provide information to customers on how to access rebates offered under other programs for measures recommended in the audit. • Workforce Training and Participation—The program will provide for the training and utilization of qualified auditors and contractors located within the community to provide program services.
Objectives	The purpose of the Residential Home Energy Assessment program is to help residential customers view the energy performance of their homes as more than the sum of independent decisions about individual components. It reflects the view that reducing residential energy use is more than a series of actions; it is an attitude and plan borne of knowledge. This is a “big picture” approach. The services are designed to bring customers to a more holistic view of home energy performance. The program is part of a long-term strategy to raise awareness of home energy savings opportunities among residential customers and to help them take action using incentives offered by the utilities and State programs. The program will achieve several objectives: • Improve customer understanding of how their homes use energy and how they can use it more effectively for less money • Procure immediate energy savings through installation of low-cost energy-saving measures • Encourage installation of additional energy-saving measures available through other programs

	• Develop a workforce trained in assessing and improving home energy efficiency that can, ultimately, transform the market • Aid residential customers' perception of Vectren as their partner in reducing home energy use
Target Market	The target market for the Residential Home Energy Assessment program is residential customers. While the primary market is single-family homeowners, multi-family homes up to 8 units are eligible to participate. Contractors who can provide quality audits and installation of recommended measures are also targeted for participation to deliver the program services.
Implementation Strategy	The implementation strategy will incorporate the following components: Walk-Through Audits • Trained auditors provide households with a walk-through examination of their home using standard audit software for identifying existing conditions related to electric energy usage. The auditor will identify specific energy saving opportunities that could be installed by the contractor upon approval of a job scope by the customer. The auditor will review the billing history of the customer, anticipated costs and savings of the measures, along with information on financial resources available to help defray first-costs. • The assessments cover the entire home, including insulation, windows, heating and cooling systems, lighting and major appliances. Direct Installation of Measures • The auditor will install a package of low-cost measures, simple installations known to improve the energy efficiency of homes, during the walk-through audit. • These measures will be installed at no additional charge to the audit participants. • These installations will provide immediate benefit to participants and savings attributable to the program. • At the conclusion of the site visit, customers will be provided with a check list of preliminary recommendations from the audit, to be followed within one week by a full report generated by the audit software. The program will take credit for only the installed measures at the time of the audit. Workforce Training and Participation Vectren will make use of auditors qualified to perform the walk-through audits and contractors knowledgeable about measures likely to be recommended in the audit report. This can be achieved through development of relationships with electrical and general contracting trade allies, as well as community groups. Under the program, The implementers will: • Provide training to ensure the walk-through auditors demonstrate an understanding of building science principles and understanding of the Vectren programs. • Ensure that the walk-through auditors are familiar with all the incentives programs available to customers as well as provide education to customers. Overview of Implementation Activities During implementation, program staff will be involved in several activity areas: • Audits and customer reports: ensuring that auditors prepare reports that are

	comprehensive and comply with guidelines. • Recruitment and training of audit and installation contractors; verifying that all contractors on the qualified list have appropriate testing equipment and data analysis software. • Monitoring of auditors who perform the walk-through audit and contractors who install recommended measures. This includes scheduling of home audit appointments and verification of inspections and measure installations. • Program marketing: including development and distribution of program materials in collaboration with Vectren, and promotional campaigns in collaboration with upstream participants. • Program education and outreach: including development of promotional campaigns to promote in coordination with other incentive programs. • Incentive processing: payments to contractors for the installation of the low-cost measures during audits . • Program activity tracking: including tracking of audit requests, audit activities, customer actions, and incentive tracking. • Reporting: development of documentation to meet reporting requirements for the Commission. <u>Education Overview</u> Education is most of what the Residential Home Energy Assessment program is about. Education will be both publicly distributed and customer-specific. • The customer reports generated following the walk-through audits provide one-on-one educational opportunities. Using data from their own homes, residential customers will learn how they use energy and how they can use it more wisely. • ENERGY STAR provides a website that educates customers and contractors about what the program does, and legitimizes the program to customers; and provides cases studies that present results from customers and contractors who have participated in the program. • The workforce training provides an opportunity to educate equipment and construction contractors about the benefits of energy efficiency and about the program.
Issues, Risks, and Risk Management Strategies	All of the implementation activities—the educational component, together with outreach and marketing of the program, will address the following barriers to achieve the educational and energy savings goals of the program: • Contractor Participation—A limited supply of qualified contractors with the skills to diagnose and market whole-house energy efficiency improvements can limit program potential. A solution is the development of a local network of qualified professionals to provide audit and installation services and to promote the program to residential energy customers. The implementers will: o Offer technical training to participating home improvement trade contractors, including classroom and field sessions and cover building science principles, diagnostic testing and installation best practices. Consider including certification to ensure the training is effective and valuable as a selling point for the contractors. o Offer sales and business process training to help contractors succeed in selling and delivering home performance services, including

	procedures for quality assurance, employee training, and understanding program incentives or financing. • Marketing and Consumer Education—Consumers may not be familiar with the whole-house approach and the benefits it can provide for improving comfort, as well as saving energy. Marketing activities can educate them about the benefits. o Vectren will communicate known partner offers and make customers aware through bill inserts, web site or some targeted direct mail. These tactics can help educate homeowners about the benefits of the whole-house approach to energy improvements and how they can take advantage of the program. o The program implementation contractor will work to develop and enlist the help of participating contractors to promote and educate customers about the program. • Quality Assurance—Consumers should be assured that the program offers reliable, high quality services. o The program should have a quality assurance plan to aid delivery of the program services, provide protocols for contractor reporting, and support program evaluation. o Participating auditors and contractors have sufficient training to perform program audits and installations and sets standards for the number of work inspections completed by participation contractors. • Challenges with Customer Engagement – If participants begin to demonstrate that they are not engaging with follow-on measures or further audit recommendations, or that they are not fully invested in the program, the implementer may consider adding a nominal audit fee of $50, simply to discourage participation by households that have no intention of fully utilizing the program. The audit fee may be credited back to the customer if they proceed with further installation of the measures.
Marketing and Outreach	Marketing and outreach in the Residential Home Energy Assessment program will employ the following strategies: • Vectren will develop awareness through direct marketing—e.g., bill inserts, newsletters, website, broadcast and print media, and direct mail. The program information may need to be mailed frequently to customers. • Walk-Through auditors—part of auditors' services can and should include making customers aware of this program and the incentives available for installation of high-efficiency measures. • Coordination of marketing efforts with the Residential Efficient Products, Whole House Plus and other Vectren programs.
Evaluation, Measurement and Verification Requirements	The evaluation methodology and data collection proposed for the Residential Home Energy Assessment program are guidelines that reflect current measurement and verification (M&V) practices. The ultimate M&V requirements for this program will conform with the State protocols. <u>Metrics for Gauging Program Success</u> Primary: • Improvement in customer understanding of the whole-house approach to improving energy efficiency • Number of walk-through audits completed

- Number of direct installation packages delivered
- Number of audits that result in documented energy efficiency improvements in other Vectren programs
- Number of participating audit and energy efficiency improvement contractors
- Periodic summary of 'before' and 'after' audit data from the implementation contractor
- Projected energy savings from the audit
- Number of customer audit fees received and reimbursed
- Customer satisfaction with the program and the products
- Participation in other Vectren programs

Secondary:

- Information related to which of the recommended measures were installed
- Energy usage reduction in homes that have had home performance audits
- Program implementation costs incurred

Data Collection Approaches

Vectren will collect and submit data that meet the reporting requirements. The participating contractors who conduct the audits and/or perform the energy improvements will provide much of the data. The contractors should provide at least the following:

- Name, address, and contact information (including email address if possible) of homeowner
- Home assessment summary report
- Recommended improvements
- Estimated cost of improvement
- Estimated energy savings
- Summary of completed improvements and test-out results

Data will also be collected through surveys of Vectren residential customers and participating contractors to aid the process and impact evaluation, assess participant satisfaction, and identify opportunities for program improvement. The surveys may be conducted by the implementation and M&V contractors.

The program will have a tracking system to house the program activity information and enable regulatory reporting.

Impact Evaluation Methodology

The energy savings and demand reduction resulting from measures installed by the program implementation contractor can be evaluated through records of installations performed and follow-up surveys with recipient households to assess retention of the installations. Deemed per-unit savings can be applied to the retained installations to obtain final savings estimates.

The M&V contractor will determine the appropriate means of estimating savings attributable to the program; that is, net savings, including both free-ridership and spillover. Spillover may be particularly relevant to this program. Because the major thrust of the program is to encourage customers to think about the home as an entire system and consider how the structure, from roof to basement and all their energy-using equipment, affects the energy performance of the home, it would not be surprising to

	find that customers continue to make additional energy-related improvements on their own (i.e., without incentives) after participation in the program. <u>Process Evaluation Methodology</u> The Residential Home Energy Assessment program is a relatively complex program, involving home visits, direct installation of measures, and delivery of an audit report with additional recommendations. Process evaluations throughout the program will be critical to ensure that the program is operating as intended and to provide information that can enable improvements in both the program design and delivery of services. Process evaluations will assess customer understanding, attitude about, and satisfaction with the program and with Vectren's other educational activities and materials. They will obtain feedback from the contractors who perform installations and audits. The evaluations will make use of survey data collected by the implementation and M&V contractors. Process evaluation will be conducted throughout the program by the implementation and M&V contractors selected by Vectren.
Program Schedule	This program is a Core program and is already part of the current Vectren portfolio and will continue to operate through PY 2019. The following table provides a schedule of key milestones:

Key Milestones	Timing
Assign internal program manager and staff	Anticipated in late 2013 or early 2014.
Select and contract with program implementation contractor(s)	2014, Q2 or immediately upon program approval
Finalize program design	2014, Q2
Pre-rollout program development: Auditor/contractor training and recruitment	2014, Q3 and Q4
Program rollout: Re-launch consumer marketing and outreach Perform audits and improvements	2015, Q1
Prepare reports: Documentation of program activities and progress toward goals Reports to Commission	Monthly throughout program implementation period Quarterly, and annually
Conclude program operation for this planning cycle	2019

Estimated Participation

Participation and measure adoption estimates were developed based on the number of residential customers in the service territory and an assessment of the attainable market potential in the area, as well as past program performance and the experience of other organizations that have offered this type of program.

Total Estimated Participation (# of Units, Bulbs, or Fixtures)

Measure	Option	No. of Gross Installations*	NTG Ratio	No. of Net Installations*
Screw-in	CFL	132,200	1.00	132,200
Specialty	CFL	46,000	1.00	46,000
Screw-in	LED	28,800	1.00	28,800
Water Heater - Tank Insulation		2,875	1.00	2,875
Water Heater - Pipe Wrap		2,875	1.00	2,875
Water Heater - Faucet Aerators		23,000	1.00	23,000
Water Heater - Low-Flow Showerheads		11,500	1.00	11,500

Total Estimated Participation (# of Households)

Number of Households Participating					
	2015	2016	2017	2018	2019
Gross HH's	4200	4400	4600	4800	5000
Net HH's	4200	4400	4600	4800	5000

Projected Energy Savings

The estimated energy savings are given in terms of annual kWh by measure. The savings noted in each year are incremental, that is reflective of new measures installed by customers through the program in that year. This does *not* include the cumulative impact of measures still in operation from previous years.

Total Net Incremental Electricity Savings (kWh)

Total Net Incremental Energy Savings (kWh)						
Measure	Option	2015	2016	2017	2018	2019
Screw-in	CFL	1,228,004	1,216,060	870,651	898,576	936,016
Specialty	CFL	293,794	307,794	322,436	337,024	351,758
Screw-in	LED	-	-	448,893	469,067	489,618
Water Heater - Tank Insulation		41,475	43,450	45,425	47,400	49,375
Water Heater - Pipe Wrap		26,775	28,050	29,325	30,600	31,875
Water Heater - Faucet Aerators		663,600	695,200	726,800	758,400	790,000
Water Heater - Low-Flow Showerheads		592,200	620,400	648,600	676,800	705,000
TOTAL		**2,845,848**	**2,910,954**	**3,092,130**	**3,217,866**	**3,353,643**

Customer Incentives

Under this program, incentives are provided in several forms and to both customers and contractors who provide the audit and direct installation services. Incentives go to customers in the form of direct installation of measures during the audit visit.

Audit contractors are also eligible to receive incentives under this program. Vectren will pay for the cost of materials for the measures that auditors install during the audits. This means that the auditor receives payment from the customer for the cost of the audit and from Vectren for the cost of materials in the package of measures installed during the audit. Customers are also free to contract with the same contractor to install additional measures, for additional cost, if the contractor offers this service.

Administrative Requirements

Vectren will administer the Residential Home Energy Assessment program through an implementation contractor. Vectren's role will be to ensure that

- the implementation contractor performs all the activities associated with delivery of all components or the program, and
- educational and program messages are delivered accurately and clearly to ensure the effectiveness of program delivery and maximize customer satisfaction with the program.

The program is expected to operate according to the following administrative and total utility budget:

Total Program Budget

Total Program Budget					
	2015	2016	2017	2018	2019
Program Staff Labor Cost	$50,000	$50,000	$50,000	$50,000	$50,000
Education & Marketing Cost	$26,788	$28,064	$56,588	$57,336	$56,158
Evaluation Cost	$17,859	$18,709	$37,726	$38,224	$37,439
Implementation Cost	$160,730	$168,384	$339,531	$344,019	$336,948
Incentive Costs	$178,589	$187,093	$377,256	$382,243	$374,387
Total Budget	**$433,966**	**$452,250**	**$861,101**	**$871,822**	**$854,931**

Cost-Effectiveness

The cost-effectiveness metrics of the Residential Home Energy Assessment program are as follows:

Cost Effectiveness Tests						
	TRC Ratio	TRC Benefits	TRC Costs	UCT Ratio	PCT Ratio	RIM Ratio
Res HEA	**1.90**	**$5,286,017**	**$2,783,242**	**1.90**	**-**	**0.42**

CHAPTER 8

RESIDENTIAL SCHOOL KIT

Program Description	The Residential School Kit program is a Core program that incorporates an educational module provided to 5th graders, along with a take-home kit of energy efficiency measures. Measures include CFLs, low-flow water fixtures, an air filter alarm, and an LED nightlight. It targets students to help them learn about energy efficiency and how they can apply it at school and at home. Participating schools will receive education in the classroom and take-home kits filled with energy efficiency saving devices. The program is designed to educate both the students and their parents about simple energy efficiency and conservation practices, driving grassroots market transformation throughout the service territory.
Objectives	The program has several objectives: • Increase consumers' awareness of the breadth of energy efficiency opportunities in their homes. • Lay the foundation for future energy stewardship by educating young students. • Make significant contribution to portfolio energy savings goals. • Strengthen customer trust in Vectren as their partner in saving energy.
Target Market	The target market for the Residential School Kit program is students in the Fifth Grade, and therefore all residential households in Vectren's service territory with Fifth Graders.
Implementation Strategy	<u>Overview of Activities</u> An educational module is provided to 5th graders, along with a take-home kit of energy efficiency measures. These measures will include: • CFL light bulbs • Low-flow showerheads and faucet aerators • A thermometer to measure water and refrigerator temperature, to help customers set their thermostats in line with recommended best practices. 3,000 kits are planned for delivery in each year. The educational module will consist of an interactive presentation with visual aids, demonstrations of how to use and install the measures, background material on energy and conservation, and dialogue with the students. <u>Education Overview</u> Children will be provided with energy education materials to enhance their understanding of energy-saving behaviors and measures in hopes that they will carry that information forward themselves into their adulthood, as well as pass on the information directly and immediately to their parents, who are the primary energy decision-makers. Efforts will also be made to increase awareness of other EE programs in the portfolio, as well as other State and local resources available to assist them.
Issues, Risks, and Risk Management Strategies	The primary risk in the program is that of the measures in the kit are not installed at home correctly or at all.

Marketing and Outreach	The Residential Schools Kit program will be marketed to schools and teachers of 5th grade students. This will entail a simple compilation of eligible schools within the service territory and the accompanying outreach and scheduling activities. The Schools program in the business portfolio is a natural partner for this program's delivery. That program provides financial and technical assistance to achieve significant electricity savings in public schools. The program offers the same financial incentives to reduce energy use as in other nonresidential facilities, along with providing assistance in identifying key improvement opportunities and addressing the special planning and purchasing protocols of public schools.

Evaluation, Measurement and Verification Requirements	The evaluation methodology and data collection proposed for the Residential School Kit program are guidelines that reflect current measurement and verification (M&V) practices. The ultimate M&V requirements for this program will conform with the state protocols.
	
	<u>Metrics for Gauging Program Success</u>
	
	Primary:
	• Number of kits distributed
	• Number of measures installed
	• Energy savings associated with installed measures
	• Customer satisfaction with the program and the products
	• Program implementation costs incurred
	
	Secondary:
	• Increase in the knowledge of the benefits of energy efficiency.
	• Participation in other Vectren programs by the homeowner.
	
	<u>Data Collection Approaches</u>
	• Impact Evaluation
	  o Tracking system data for all projects
	  o On-site inspection of a sample of projects to verify installation as reported
	  o Customer surveys to verify installation of measures in the kit and identify post-participation purchases outside the program (free-rider and free-driver impacts)
	• Process Evaluation—Evaluation of program design and implementation will be conducted by gathering and analyzing data through a variety of surveys and interviews, including:
	  o Surveys of target market customers (participants and nonparticipants)
	  o Surveys of teachers
	  o Interviews with program staff and implementation contractor
	  o Review of program documents and tracking system data
	
	<u>Impact Evaluation Methodology</u>
	
	The program will record energy savings and peak load reductions from the rebate applications processed, using the per-unit deemed savings values. Because measures are established technologies and data are available demonstrating the reliability of savings, it will not be necessary to conduct customer-level billing analyses or metering studies. However, some projects will be inspected for independent verification of installation and operation as reported.

	Post-Surveys with participating customers will be used to estimate the net-to-gross ratio accounting for free-riders and free-drivers. Customers will be asked to provide information regarding whether they would have purchased the rebated items without the promotion, whether they installed the items, and whether they subsequently purchased additional rebate-eligible items at full cost. This outline of the self-report methodology for the assessment of net impacts describes only the basic approach. The selected M&V contractor will develop the complete plan that ensures the appropriate measurement of savings in compliance with industry and state protocols. Process Evaluation Methodology Program process evaluation is important to ensure that the program is operating as intended and to provide information that can enable improvements in both the program design and implementation. Process evaluation will be undertaken and conducted throughout the program. Process evaluation will assess customer understanding, attitudes about, and satisfaction with the program and with Vectren's other educational activities. The evaluations will make use of survey data collected by program and M&V staff.. Interviews with Vectren program staff and/or implementation contractors will be conducted to assess satisfaction with the program and to identify problems and possible program services/implementation improvements. The M&V contractor will also help Vectren assess the performance of the program design and delivery of the products and services featured in the program, including effectiveness of the marketing and educational materials, effectiveness of advertising and promotional campaigns and messages, and whether implementation milestones are met adequately and on schedule.
Program Schedule	This program is a Core program and is already part of the current Vectren portfolio and will continue to operate through PY 2019. The following table provides a schedule of key milestones:

Key Milestones	Timing
Assign internal program manager and staff	Anticipated in late 2013 or early 2014.
Select and contract with program implementation contractor(s)	2014, Q2 or immediately upon program approval
Finalize program design	2014, Q2
Pre-rollout program development: Prepare list of school contacts, marketing materials, and kit supply	2014, Q3 and Q4
Program rollout: Re-launch education modules and kit distribution	2015, Q1
Prepare reports: Documentation of program activities and progress toward goals Reports to Commission	Monthly throughout program implementation period Quarterly, and annually
Conclude program operation for this planning cycle	2019

Estimated Participation

Participation and measure adoption estimates were developed based on the number of residential customers in the service territory and an assessment of the attainable market potential in the area, as well as past program performance and the experience of other organizations that have offered this type of program.

Total Estimated Participation (# of Units, Bulbs, or Fixtures)

Measure	Option	No. of Gross Installations*	NTG Ratio	No. of Net Installations*
Air Filter Alarm		15,000	0.70	10,500
Screw-in	LED Nightlight	15,000	0.70	10,500
Screw-in	CFL	30,000	0.70	21,000
Water Heater - Faucet Aerators		15,000	0.70	10,500
Water Heater - Low-Flow Showerheads		7,500	0.70	5,250

Total Estimated Participation (# of Kits or Households)

Number of Kits					
	2015	2016	2017	2018	2019
Gross Kits (Distributed)	3000	3000	3000	3000	3000
Net Kits (Correctly Installed)	2100	2100	2100	2100	2100

Projected Energy Savings

The estimated energy savings are given in terms of annual kWh by measure. The savings noted in each year are incremental, that is reflective of new measures installed by customers through the program in that year. This does *not* include the cumulative impact of measures still in operation from previous years.

Total Net Incremental Electricity Savings (kWh)

Total Net Incremental Energy Savings (kWh)						
Measure	**Option**	**2015**	**2016**	**2017**	**2018**	**2019**
Air Filter Alarm		86,100	86,100	86,100	86,100	86,100
Screw-in	LED Nightlight	65,100	65,100	65,100	65,100	65,100
Screw-in	CFL	171,231	160,310	158,988	157,251	157,251
Water Heater - Faucet Aerators		103,828	102,748	101,772	100,676	99,629
Water Heater - Low-Flow Showerheads		315,178	311,900	308,936	305,609	302,432
TOTAL		**741,437**	**726,158**	**720,896**	**714,735**	**710,512**

Customer Incentives

The customer incentive for this program will be the take-home kit of efficiency measures that the children receive after their educational module. The program will cover the entire cost of the kits.

Administrative Requirements

The program administration role will be to ensure that:

- the implementation contractor performs all the activities associated with delivery of all components or the program, and
- Vectren's educational and program messages are delivered accurately and clearly to ensure the effectiveness of program delivery and maximize customer satisfaction with the program.

The program is expected to operate according to the following administrative and total utility budget:

Total Program Budget

Total Program Budget					
	2015	2016	2017	2018	2019
Program Staff Labor Cost	$25,000	$25,000	$25,000	$25,000	$25,000
Education & Marketing Cost	$67,200	$67,200	$67,200	$67,200	$67,200
Evaluation Cost	$8,400	$8,400	$8,400	$8,400	$8,400
Implementation Cost	$67,200	$67,200	$67,200	$67,200	$67,200
Incentive Costs	$84,000	$84,000	$84,000	$84,000	$84,000
Total Budget	**$251,800**	**$251,800**	**$251,800**	**$251,800**	**$251,800**

Cost-Effectiveness

The cost-effectiveness metrics of the Residential Schools program are as follows:

Cost Effectiveness Tests						
	TRC Ratio	TRC Benefits	TRC Costs	UCT Ratio	PCT Ratio	RIM Ratio
Res School Kit	**1.14**	**$1,165,755**	**$1,024,230**	**1.14**	**-**	**0.38**

CHAPTER 9

RESIDENTIAL WHOLE HOUSE PLUS PROGRAM

Program Description	The Residential Whole House Plus program is designed to provide energy savings through household products and services that are typically associated with onsite installation or implementation by contractors and vendors. This includes such energy efficiency measures as weatherization, increased insulation, or installing efficient heating, ventilation, and air conditioning equipment. The program offers cash rebates to residential customers who install these measures, while simultaneously engaging equipment suppliers, contractors, and trade allies to promote the rebate-eligible equipment.
Objectives	The purpose of the Residential Whole House Plus program is to increase the penetration of high-efficiency measures in the homes of residential customers. The program enables the adoption of these energy efficiency measures by offering cash rebates for the purchase and installation of qualifying measures affecting cooling and heating. Other core objectives are: • Provide a robust set of follow-on or expansion options for participants in other Vectren programs that wish to "dig deeper" into energy efficiency savings. • Increase consumers' awareness of the breadth of energy efficiency opportunities in their homes. • Make significant contribution to portfolio energy savings goals. • Strengthen customer trust in Vectren as their partner in saving energy. The Residential Whole House Plus program is well-suited for accomplishing these objectives because the rebate-eligible measures are proven technologies about which customers can readily find supporting information; customers are familiar with cash-back rebates from other types of purchases they make, and the list of included measures affords Vectren the opportunity to strengthen relationships with upstream suppliers and influence stocking decisions.
Target Market	The target market for the Residential Whole House Plus program is all residential customers in Vectren' service territory and, in particular, those customers who have participated in other Vectren programs such as the Home Energy Assessment program. This would include customers with existing equipment that needs replacing or those who can be persuaded to replace early. The target market also includes customers in existing single-family homes or multifamily dwellings, both owners and renters.
Implementation Strategy	<u>Overview of Activities</u> During the implementation of this program, the implementers will be involved in several activity areas: • Development of upstream supplier network to stock and promote program • Program marketing and education: including development and distribution of program materials in collaboration upstream allies; and promotional campaigns in coordination with other Vectren programs • Rebate processing: including receive, review and verify applications; and pay

	rebates • Program performance tracking and improvement: including tracking availability of qualifying products, rebate submittals and payments, opportunities to improve the program • Reporting: including reporting of program activities to meet regulatory and internal requirements, in particular progress toward program goals. The program is designed so that customers can easily submit rebate applications on their own. However, equipment suppliers and contractors can be very instrumental in achieving program success. Using the rebates and ENERGY STAR quality assurance as selling points, these allies can increase sales of qualifying equipment. They can further assist by aiding in the submittal of the rebate application. <u>Education Overview</u> Under the program, Vectren will educate local contractors about program procedures and benefits. To further promote good communication, the utilities may conduct seminars to familiarize participating contractors with the structure and procedures of the program. Handouts will likely include specific information about rebate schedules and lists of qualifying measures. Consumer education will be combined with program awareness activities. Through the use of bill inserts, newsletters, on-line information, and direct mail, customers will receive educational information regarding the benefits of and opportunities to save money on energy efficiency upgrades.
Issues, Risks, and Risk Management Strategies	Contractor Participation—A limited supply of qualified weatherization and HVAC contractors with the skills to market whole-house energy efficiency improvements can limit program potential. A solution is the development of a local network of qualified professionals to provide installation services and to promote the program to residential energy customers. The implementers will: o Offer technical training to participating home improvement trade contractors, including classroom and field sessions and cover building science principles, diagnostic testing and installation best practices. Consider including certification to ensure the training is effective and valuable as a selling point for the contractors. o Offer sales and business process training to help contractors succeed in selling and delivering home performance services, including procedures for quality assurance, employee training, and understanding program incentives or financing. Consumer Financing and Incentives—The up-front costs of making the recommended improvements may limit customer participation in the program or delay projects unless customers have a way to get them done and to pay for them. o Some program sponsors partner with financial institutions to provide low-interest loans. o Some program sponsors offer cash rebates directly through the program or in collaboration with other program. o Additionally, having easy access to contractors who can complete the work provides incentive to act. Offering referrals or a list of qualified/participating contractors can be a help. Marketing and Consumer Education—Consumers may not be familiar with energy efficiency and the benefits it can provide for improving comfort, as well as saving money. Marketing activities can educate them about the benefits.

	o Vectren will communicate known partner offers and make customers aware through bill inserts, web site or some targeted direct mail. These tactics can help educate homeowners about the benefits of the whole-house approach to energy improvements and how they can take advantage of the program. o The program implementation contractor will work to develop and enlist the help of participating contractors to promote and educate customers about the program. Quality Assurance—Consumers should be assured that the program offers reliable, high quality services. o The program should have a quality assurance plan to aid delivery of the program services, provide protocols for contractor reporting, and support program evaluation. o Participating contractors have sufficient training to perform program installations and sets standards for the number of work inspections completed by participation contractors.
Marketing and Outreach	The Residential Whole House Plus program will be marketed mainly through direct contact between Vectren and its customers as well as trade allies and other upstream suppliers. • Vectren develop awareness through direct marketing—e.g., bill inserts, newsletters, website, broadcast and print media, direct mail; and pays the participant rebates. • The Residential Home Energy Assessment program is a natural channel for this program. The walk-through audit recommendations will include resource information for the recommended measures, including rebates available under this and the Residential Efficient Products program. • The Residential New Construction program is also a natural channel for this program. That program will offer rebates for the installation of packages of measures, rather than individual measures. Owners or builders who participate in the new construction program will be made aware of additional measures that can be installed after construction to further improve the home performance. • Equipment contractors/installers may be engaged to promote awareness of and use rebate offers to help sell qualifying equipment; they may also provide or pre-fill rebate forms to help customers obtain rebates. These allies are most likely to include: o Weatherization contractors o Residential air conditioning and heating equipment dealers and installers o Small electrical equipment dealers o Implementation contractors that will implement the program on Vectren's behalf, providing assistance with their direct marketing; working with upstream suppliers to stock qualifying measures, promote the program, and assist with rebate applications; providing rebate fulfillment services; and tracking and reporting program activities and achievements toward goals.
Evaluation, Measurement	The evaluation methodology and data collection proposed for the Residential Whole House Plus program are guidelines that reflect current measurement and verification

and Verification Requirements	(M&V) practices. The ultimate M&V requirements for this program will conform with the state protocols. <u>Metrics for Gauging Program Success</u> Primary: • Net number of measures purchased/installed • Energy savings associated with purchased/installed measures • Customer satisfaction with the program and the products • Program implementation costs incurred Secondary: • Distribution of measure popularity and cost-effectiveness of the program • Increase in number and variety of suppliers who stock qualified products <u>Data Collection Approaches</u> • Impact Evaluation o Tracking system data for all projects o On-site inspection of a sample of projects to verify operation as reported o Customer billing data prior to and following program to assess energy use and improvement opportunities, and assess and/or verify savings for the payment of customer incentives. o Customer surveys to assess likelihood of purchase without availability of program services and incentives and identify post-participation purchases outside the program (free-rider and free-driver impacts) • Process Evaluation—Evaluation of program design and implementation will be conducted by gathering and analyzing data through a variety of surveys and interviews, including: o Surveys of target market customers (participants and nonparticipants) o Surveys of contractors who participate and/or promote the program o Interviews with Vectren program staff and implementation contractor o Review of program documents and tracking system data <u>Impact Evaluation Methodology</u> The first step is to establish a pre-participation energy use “baseline” based on customer bills, followed by post-participation tracking of energy use through bills. This, together with information on exact measures installed during the audit and additional weatherization measures installed as provided by the installation contractors, would allow assessment of customer energy savings. Ex Post Surveys with participating customers will be used to estimate the net-to-gross ratio accounting for free-riders and free-drivers. Customers will be asked to provide information regarding whether they would have purchased the rebated items without the Vectren promotion, whether they installed the items, and whether they subsequently purchased additional rebate-eligible items at full cost. This outline of the self-report methodology for the assessment of net impacts describes only the basic approach. The selected M&V contractor will develop the complete plan that ensures the appropriate measurement of savings in compliance with industry and state protocols. <u>Process Evaluation Methodology</u> Program process evaluation is important to ensure that the program is operating as

	intended and to provide information that can enable improvements in both the program design and implementation. Process evaluation will be undertaken and conducted throughout the program. Often issues uncovered by process evaluation early in the program year can be addressed immediately, helping to ensure program success. Process evaluation will assess customer understanding, attitudes about, and satisfaction with the program and with Vectren's other educational activities. The evaluations will make use of survey data collected by Vectren and/or implementation contractors, and M&V contractors. These surveys will include both customers known to have participated in the program and eligible nonparticipants. Interviews with Vectren program staff and/or implementation contractors will be conducted to assess satisfaction with the program and to identify problems and possible program services/implementation improvements. The M&V contractor will also help Vectren assess the performance of the program design and delivery of the products and services featured in the program, including effectiveness of the marketing and educational materials, effectiveness of advertising and promotional campaigns and messages, effectiveness of the trade ally involvement, and whether implementation milestones are met adequately and on schedule. These evaluations will use sales and promotion data maintained by Vectren and/or the implementation contractor and customer survey data.
Program Schedule	This program is a newly recommended Core Plus program that would begin in PY 2015 and operate through PY 2019. The following table provides a schedule of key milestones:

Key Milestones	Timing
Assign internal program manager and staff	Anticipated in late 2013 or early 2014.
Select and contract with program implementation contractor(s)	2014, Q2 or immediately upon program approval
Finalize program design	2014, Q2
Pre-rollout program development: Develop contractor network Prepare marketing materials and rebate forms Develop activity and rebate processing protocols	2014, Q3 and Q4
Program rollout: Launch all program services	2015, Q1
Prepare reports: Documentation of program activities and progress toward goals Reports to Commission	 Monthly throughout program implementation period Quarterly, and annually
Conclude program operation for this planning cycle	2019

Estimated Participation

Participation and measure adoption estimates were developed based on the number of residential customers in the service territory and an assessment of the attainable market potential in the area, as well as the experience of other organizations that have offered this type of program.

Total Estimated Participation (# of Households)

Measure	Option	No. of Gross Installations*	NTG Ratio	No. of Net Installations*
Room AC	EER 11.5	2,300	0.70	1,610
Air-Source Heat Pump	SEER 15, HSPF 8.2	4,600	0.70	3,220
Central AC		6,900	0.70	4,830
ECM		2,300	0.70	1,610
Insulation - Ceiling		85	0.70	60
Insulation - Ducting		411	0.70	287
Insulation - Foundation		612	0.70	429
Insulation - Infiltration Control		934	0.70	654
Insulation - Radiant Barrier		309	0.70	216
Ducting - Repair and Sealing		3,537	0.70	2,476
Windows - Install Reflective Film		739	0.70	517
Doors - Storm and Thermal		2,406	0.70	1,684
Roofs - High Reflectivity		35	0.70	24
Whole-House Fan - Installation		200	0.70	140
Ceiling Fan - Installation		446	0.70	312
Thermostat - Clock/Programmable		1,916	0.70	1,341
Electronics - Smart Power Strips		1,106	0.70	774

Projected Energy Savings

The estimated energy savings are given in terms of annual kWh by measure. The savings noted in each year are incremental, that is reflective of new measures installed by customers through the program in that year. This does *not* include the cumulative impact of measures still in operation from previous years.

Total Net Incremental Electricity Savings (kWh)

Total Net Incremental Energy Savings (kWh)						
Measure	Option	2015	2016	2017	2018	2019
Room AC	EER 11.5	49,953	52,334	54,861	57,384	59,911
Air-Source Heat Pump	SEER 15, HSPF 8.2	341,628	357,896	374,164	390,432	406,700
Central AC		463,050	485,100	507,150	529,200	551,250
ECM		111,720	117,040	122,360	127,680	133,000
Insulation - Ceiling		768	845	912	965	1,007
Insulation - Ducting		3,151	3,460	3,729	3,946	4,114
Insulation - Foundation		43,394	47,764	51,566	54,618	56,976
Insulation - Infiltration Control		15,152	16,687	18,021	19,093	19,922

Insulation - Radiant Barrier		2,107	2,320	2,504	2,653	2,769
Ducting - Repair and Sealing		164,677	180,979	195,142	206,489	215,239
Windows - Install Reflective Film		79,048	86,782	93,505	98,935	103,148
Doors - Storm and Thermal		10,832	11,918	12,863	13,622	14,209
Roofs - High Reflectivity		627	688	741	784	818
Whole-House Fan - Installation		6,602	7,253	7,818	8,275	8,630
Ceiling Fan - Installation		13,797	15,161	16,342	17,299	18,043
Thermostat - Clock/Programmable		36,214	39,873	43,049	45,609	47,595
Electronics - Smart Power Strips		-	-	2,288	2,412	2,507
TOTAL		**1,342,719**	**1,426,100**	**1,507,015**	**1,579,398**	**1,645,837**

Customer Incentives

Incentives will be paid in the form of cash-back rebates. Incentives for the individual measures account for 50% of the incremental measure cost. Incremental cost is the additional cost of a high-efficiency measure beyond a standard-efficiency alternative. When the program design is finalized, the rebate application form can allow for incentives that vary by measure or even within a measure. For example, for room air conditioning, higher incentives can be offered for higher EER levels.

Administrative Requirements

The program administrative staff's role will be to ensure that

- the implementation contractor performs all the activities associated with delivery of all components or the program, and
- Vectren educational and program messages are delivered accurately and clearly to ensure the effectiveness of program delivery and maximize customer satisfaction with the program.

The program is expected to operate according to the following administrative and total utility budget:

Total Program Budget

Total Program Budget					
	2015	**2016**	**2017**	**2018**	**2019**
Program Staff Labor Cost	$25,000	$25,000	$25,000	$25,000	$25,000
Education & Marketing Cost	$34,841	$37,482	$40,007	$42,132	$43,992
Evaluation Cost	$34,841	$37,482	$40,007	$42,132	$43,992
Implementation Cost	$174,205	$187,412	$200,033	$210,658	$219,959
Incentive Costs	$696,822	$749,649	$800,133	$842,633	$879,837
Total Budget	**$965,710**	**$1,037,026**	**$1,105,180**	**$1,162,555**	**$1,212,780**

Cost-Effectiveness

The cost-effectiveness metrics of the Residential Whole House Plus program are as follows:

Cost Effectiveness Tests						
	TRC Ratio	TRC Benefits	TRC Costs	UCT Ratio	PCT Ratio	RIM Ratio
Res Whole House Plus	**1.07**	**$8,212,627**	**$7,653,155**	**1.85**	**2.47**	**0.66**

CHAPTER 10

RESIDENTIAL APPLIANCE RECYCLING PROGRAM

Program Description	The Residential Appliance Recycling program pursues energy savings by offering a bounty payment to customers to remove their old, inefficient appliances and recycle them. This includes aging refrigerator and freezer units. The program offers free pickup of units from residences plus customer incentives and education about the benefits of secondary unit disposal, to encourage their participation. There are no costs to participating customers. The contractor will pick-up, disable, and recycle the units. Once Vectren receives verification that a unit has been recycled, the customer will receive a $30 incentive payment. In addition to educating residential customers about the benefits of secondary unit disposal, the program provides services to enable disposal of the units. The major program components are: <u>Customer Incentives</u> • Complimentary removal of existing or potential secondary units from customer's home. Pickup will be by scheduling appointments directly with the program implementation contractor. • The program implementation contractor mails incentive checks to customers after units have been removed. • To qualify, refrigerator or freezer units must be in working condition, meet minimum size requirements, and be readily accessible for removal. <u>Environmental Disposal of Units</u> • Units will be removed to a collection facility and disassembled for environmentally responsible disposal of CFCs in the refrigerant and recycling of other materials such as metal and plastic components.
Objectives	The purpose of the Residential Appliance Recycling program is to eliminate a very inefficient usage of electricity in homes: the retention of refrigerators and freezers for use as secondary units. This is a two-pronged goal: to remove existing secondary units from operation and to prevent existing primary refrigerators and freezers from being retained and used as secondary units when customers purchase new units. The program has several objectives: • Transform attitudes about retaining older, less efficient refrigerators and freezers as secondary units. • Accrue electricity consumption and demand savings toward Vectren's savings goals. • Demonstrate Vectren's commitment to good stewardship of the environment by sponsoring proper disposal of units. Appliance Recycling is well-suited for accomplishing these objectives because: consumers are more willing than ever to help safeguard the environment and adopt behaviors that save energy without compromising their lifestyles. The program makes it convenient and cost-effective for customers to dispose of these older units, overcoming a past barrier to getting rid of them.
Target Market	The eligible population for the Residential Appliance Recycling program is all residential

	customers in Vectren's service territory. The target markets are residential customers who currently own and operate secondary refrigerator or freezer units and customers who are purchasing new replacement units.
Implementation Strategy	<u>Overview of Activities</u> During the implementation of this program, Vectren and the implementation contractor will be involved in several activity areas: • Development of facilities and protocols for removal and disposal of qualifying units • Program marketing and education: including development and distribution of program materials in collaboration with Vectren; education and engagement of appliance dealers; and program promotion • Scheduling of pickups from customer homes, verification of unit qualification for complimentary removal and incentive payment, pickup and proper disposal of units • Rebate Processing: fulfillment house to receive, review and verify documentation; and either pay incentives or submit incentives to Vectren for payment • Program performance tracking and improvement: including tracking of unit qualification, removal and disposal; rebate submittals and payments; and opportunities to improve the program • Reporting: including reporting of program activities to meet regulatory and internal requirements, in particular progress toward program goals
Issues, Risks, and Risk Management Strategies	The Residential Appliance Recycling program is perhaps the simplest program to operate from the portfolio administrator's perspective. Vectren will select an implementation contractor with a demonstrated record of providing the services to be offered in this program and responsibly disposing of the units. It is likely that a single provider can be engaged to perform or subcontract for performance of all the necessary services. Experience at other utilities and discussions with contractors, however, suggest that the cost effectiveness of this program hinges on volume. Unit disposal costs can be reduced by ensuring higher volumes. The implementation contractor will need to use extensive and effective marketing to obtain the volumes. Removal of old units requires site-to-site pickups. If the distances involved in more remote pickups will significantly increase unit costs, the program can target particular urban regions and be marketed community by community with mailings and local newspaper and radio advertisements. Customer demographic data can be used to determine if some areas have greater-than-average saturations of secondary refrigerators and freezers. If so, these areas would be effective places to initiate this component of the program. The net-to-gross ratio is key issue for this program, which affects program cost-effectiveness. After program pick-up of secondary refrigerator, it seems probable that residents will simply buy a new unit and move their former primary unit into the garage or basement to replace the one being disposed. This will lead to a lowering of the planned savings amount.
Marketing and Outreach	The Residential Appliance Recycling program will be marketed through the following strategies: • Vectren develops awareness through direct marketing—e.g., bill inserts, newsletters, website, broadcast and print media, direct mail; and pays the

	participant incentives. • Appliance dealers/distributors are excellent channels to provide information about this program because they interact with the target market at the time of replacement purchase decisions. Since many dealers offer free removal of existing units to close a sale, utilizing the services of the program contractor to remove the old units can save them money. • The program implementation contractor will provide assistance with Vectren's direct marketing and advertising, providing consumer education, recruiting participants, providing rebate fulfillment services, tracking program activities, and reporting activities and achievements toward goals. • The program will be also be promoted to participants of the other Vectren energy efficiency programs.
Evaluation, Measurement and Verification Requirements	The evaluation methodology and data collection proposed for the Appliance Pickup program are guidelines that reflect current measurement and verification (M&V) practices. The ultimate M&V requirements for this program will conform with the state protocols. Metrics for Gauging Program Success • Number of existing secondary units removed • Number of primary units replaced and prevented from operation as secondary units • Energy savings associated with removed units • Customer satisfaction with the program • Program implementation costs incurred • Increase in awareness and receptivity to secondary appliance turn-in Data Collection Approaches Data for evaluating the program will come from the following sources: • Engineering estimates of measure savings • Local weather data • Follow-up surveys of residential customers contacted from customer information provided on the rebate applications and from Vectren customer information system (for nonparticipants) • Tracking of dealers engaged in promoting the program and assisting customers with rebate application submittal • Program implementer/Vectren staff surveys Impact Evaluation Methodology The program will use deemed per-unit savings estimates to determine savings. The impact evaluation can either accept these values or use engineering estimates to calculate the savings associated with the reduction in refrigerator, freezer load, and air conditioner loads that result from the program. Additional data will be obtained from program records and a survey of program participants. The additional data will include information on customer operating conditions before the units are recycled as part of the program. Post-participation surveys with participating customers will be used to review and revise as necessary the net-to-gross ratio accounting for free-riders and free-drivers. Customers will be asked to provide information regarding whether they would have disposed of the qualifying units without the Vectren incentives, and whether they subsequently disposed

	of additional units on their own. The critical issue in the impact evaluation will be the acquisition of valid and reliable survey data. The process evaluation will be used to monitor the data-tracking system that the recycling contractor uses to ensure the validity of the impact evaluation calculations. This outline of the self-report methodology for the assessment of net impacts describes only the basic approach. The selected M&V contractor will develop the complete plan that ensures defensible measurement of savings in compliance with industry and state protocols. <u>Process Evaluation Methodology</u> The process evaluation will focus on program delivery, administration, implementation and customer response. Key issues will include assessment of the marketing and promotional efforts, monitoring of the contractor data-tracking system, and implementation procedures to ensure that the program is being implemented as designed. The data collection techniques for the process evaluation will include in-person interviews with utility staff and the recycling contractors, on-site inspection of a sample of participant homes, and a survey of sample of participant homes. The interviews will focus on program implementation and administrative procedures. Site visits will be used to review contractor implementation procedures. The participant survey will include questions on customer characteristics, equipment operating conditions, reasons for participation, program satisfaction, and response to promotional efforts. In the first year of the program, the focus of the process evaluation will be to assess if the program is operating as planned and if the contractor is carefully maintaining records on program-related equipment. In the second year, the process evaluation will assess how well any program recommendations from the first-year process evaluation are being implemented. In subsequent years, the evaluation will continue to monitor program implementation.
Program Schedule	The Residential Appliance Recycling program is already part of the current Vectren portfolio and will continue to operate through PY 2019. The following table provides a schedule of key milestones:

Key Milestones	Timing
Assign internal program manager and staff	Anticipated in late 2013 or early 2014.
Select and contract with program implementation contractor(s)	2014, Q2 or immediately upon program approval
Finalize program design	2014, Q2
Pre-rollout program development: Establish disposal site(s) and procedures Develop relationships with appliance retailers Develop procedures for tracking activities and documenting results	2014, Q3 and Q4
Program re-launch: Re-launch consumer marketing and outreach	2015, Q1

Pick up and dispose of units	
Prepare reports: Documentation of program activities and progress toward goals Reports to Commission	Monthly throughout program implementation period Quarterly, and annually
Conclude program operation for this planning cycle	2019

Estimated Participation

Participation and measure adoption estimates were developed based on the number of residential customers in the service territory and an assessment of the attainable market potential in the area, as well as the experience of other organizations that have offered this type of program.

Total Estimated Participation (# of Units Decommissioned)

Measure	No. of Gross Installations*	NTG Ratio	No. of Net Installations*
Refrigerator - Remove Second Unit	4,683	0.70	3,278
Freezer - Remove Second Unit	1,264	0.70	885

Total Estimated Participation per year (# of Units Decommissioned)

	2015	2016	2017	2018	2019
Refrigerator - Remove Second Unit	971	971	971	914	857
Freezer - Remove Second Unit	262	262	262	247	231

Projected Energy Savings

The estimated energy savings are given in terms of annual kWh by measure. The savings noted in each year are incremental, that is reflective of new measures installed by customers through the program in that year. This does *not* include the cumulative impact of measures still in operation from previous years.

Total Net Incremental Electricity Savings (kWh)

Total Net Incremental Energy Savings (kWh)					
Measure	**2015**	**2016**	**2017**	**2018**	**2019**
Refrigerator - Remove Second Unit	446,477	446,477	446,477	420,214	393,950
Freezer - Remove Second Unit	114,861	114,861	114,861	108,104	101,348
TOTAL	**561,338**	**561,338**	**561,338**	**528,318**	**495,298**

Customer Incentives

In addition to cash incentives, customers receive the added benefit of no-cost removal of units from their homes. The following table shows the incentives for each measure.

Measure	Incentive
Refrigerator – Removal of Second Unit	$30 per unit plus free removal of old unit
Freezer – Removal of Second Unit	$30 per unit plus free removal of old unit

Administrative Requirements

Vectren will administer the Residential Appliance Recycling program through an implementation contractor. Vectren's role will be to ensure that

- the implementation contractor performs all the activities associated with delivery of all components or the program, and
- Vectren's educational and program messages are delivered accurately and clearly to ensure the effectiveness of program delivery and maximize customer satisfaction with the program.

The program is expected to operate according to the following administrative and total utility budget:

Total Program Budget

Total Program Budget					
	2015	2016	2017	2018	2019
Program Staff Labor Cost	$10,000	$10,000	$10,000	$10,000	$10,000
Education & Marketing Cost	$10,357	$10,357	$10,357	$9,747	$9,138
Evaluation Cost	$5,918	$5,918	$5,918	$5,570	$5,222
Implementation Cost	$-	$-	$-	$-	$-
Incentive Costs	$147,952	$147,952	$147,952	$139,249	$130,546
Total Budget	**$174,227**	**$174,227**	**$174,227**	**$164,566**	**$154,906**

Cost-Effectiveness

The cost-effectiveness metrics of the Residential Appliance Recycling program are as follows:

Cost Effectiveness Tests						
	TRC Ratio	TRC Benefits	TRC Costs	UCT Ratio	PCT Ratio	RIM Ratio
Res Appliance Recycling	**1.05**	**$723,032**	**$686,727**	**1.05**	**-**	**0.40**

CHAPTER 11

RESIDENTIAL BEHAVIORAL FEEDBACK TOOLS PROGRAM

Program Description	The Residential Behavioral Feedback Tools program provides individualized energy use information to customers, simultaneously offering recommendations on how to save energy and money by making small changes to energy consumption. The information is updated and provided regularly throughout the year. A key component is a peer comparison, where they are shown their own energy usage relative to similar, nearby households. Peoples' intrinsic social competitiveness enhances the energy reductions and effectiveness of this program.
Objectives	The purpose of the Residential Behavioral Feedback Tools program is to reduce energy consumption through socially-driven and information-driven behavioral change. Another very important objective of the program is to raise general awareness regarding energy efficiency and to cross-sell and market other programs within the portfolio.
Target Market	The target market for the Residential Behavioral Feedback Tools program is residential single family homes in the service territory that have electric space heating and electric water heating systems. This will target the program on customers with relatively large electric baseline loads from which larger savings can be subtracted. Both owners and renters are eligible to participate in the program.
Implementation Strategy	<u>Overview of Activities</u> • Customer usage data is collected by the Utility and a data transfer protocol is developed. • An experimental or treatment group of customers is selected from the target market to receive the energy usage information. These homes are then matched with an appropriately-sized control group, also from the target market, that will not receive the information. Savings will be measured by comparing the changes in energy consumption between these two groups. • The energy information is given along with strategically-chosen program marketing, messaging, and education, with the goal of increasing awareness of the portfolio and cross-selling services within the other programs. <u>Education Overview</u> This program should be used as a key touch point to cross-sell and market other programs within the portfolio. This is a prime avenue to feature promotions, contests, and special announcements that can spur enhancements in overall portfolio performance.
Issues, Risks, and Risk Management Strategies	This program should be monitored carefully, as it is difficult to achieve and sustain savings. Relatively little is known about the specific actions that customers perform to reduce their energy usage in this program, and it may undergo meaningful change in customer responsiveness and evaluation paradigms in the coming years. Savings under this program will not persist after the program is ended and the information is no longer available. The savings must be continually renewed each year with additional cost and effort, whereas the savings from a capital equipment measure can last 10 to 20 years. This makes for relatively low-cost energy savings when

considered on a first-year basis, but relatively high-cost energy savings on a lifetime or levelized cost basis.

Marketing and Outreach

The program in and of itself is a marketing and outreach endeavor, so the energy information provided to the customer will comprise the marketing and outreach strategy.

Evaluation, Measurement and Verification Requirements

The program structure has a built-in scientific design due to its utilization of an experimental and a control group. Net program effects will be measured by comparing the energy consumption of these two groups side by side. Great care should be taken to ensure the experimental and control groups are randomly selected and have comparable demographics and characteristics, and that the data transfer and energy analysis processes have been rigorously tested and verified. The ultimate M&V requirements for this program will conform with the state protocols.

<u>Metrics for Gauging Program Success</u>

- Energy savings associated with the energy information
- Customer satisfaction with the program and the products
- Program implementation costs incurred
- Participation in other Vectren programs.

<u>Data Collection Approaches</u>

- Impact Evaluation
  - Tracking system data for all projects
  - Billing analysis
  - Because the experimental design, in theory, isolates the program effect, the net-to-gross ratio is assumed to be 1.00
- Process Evaluation—Evaluation of program design and implementation will be conducted by gathering and analyzing data through a variety of surveys and interviews, including:
  - Surveys of target market customers (participants and nonparticipants)
  - Interviews with Vectren program staff and implementation contractor
  - Review of program documents and tracking system data

Program Schedule

The Residential Behavioral Feedback Tools program is already part of the current Vectren portfolio and, pending the cost effectiveness evaluations, will continue to operate through PY 2019. The following table provides a schedule of key milestones:

Key Milestones	**Timing**
Assign internal program manager and staff	Anticipated in late 2013 or early 2014.
Select and contract with program implementation contractor(s)	2014, Q2 or immediately upon program approval
Finalize program design	2014, Q2
Pre-rollout program development: Develop data transfer requirements and protocols for customer consumption and usage Prepare marketing materials and messaging	2014, Q3 and Q4
Program re-launch:	2015, Q1

All program services	
Prepare reports: Documentation of program activities and progress toward goals Reports to Commission Cost-effectiveness assessment and "go or no go" decision on whether to continue program	 Monthly throughout program implementation period Quarterly, and annually Annually
Conclude program operation for this planning cycle	2019

Estimated Participation

Participation and measure adoption estimates were developed based on the number of residential customers in the service territory and an assessment of the attainable market potential in the area, as well as the experience of other organizations that have offered this type of program.

Estimated NTG Ratio

Measure	NTG Ratio
Res Behavioral Feedback Tools	1.00

Total Estimated Participation (# of Households)

	2015	2016	2017	2018	2019
Res Behavioral Feedback Tools	25000	25000	25000	25000	25000

Projected Energy Savings

The estimated energy savings are given in terms of annual kWh by measure. The savings noted in each year are incremental, that is reflective of new measures installed by customers through the program in that year. This does *not* include the cumulative impact of measures still in operation from previous years.

Total Net Incremental Electricity Savings (kWh)

Total Net Incremental Energy Savings (kWh)					
Measure	**2015**	**2016**	**2017**	**2018**	**2019**
Res Behavioral Feedback Tools	4,659,300	5,177,000	5,177,000	5,177,000	5,177,000
TOTAL	**4,659,300**	**5,177,000**	**5,177,000**	**5,177,000**	**5,177,000**

Customer Incentives

The program subsidizes the cost of acquiring customer data, processing and analyzing it, and using it to create and send customer reports. There is no monetary incentive directly given to the customer.

Administrative Requirements

Vectren will administer the Residential Behavioral Feedback Tools program through an implementation contractor. Vectren's role will be to ensure that

- the implementation contractor performs all the activities associated with delivery of all components or the program, and
- Vectren's educational and program messages are delivered accurately and clearly to ensure the effectiveness of program delivery and maximize customer satisfaction with the program.

The program is expected to operate according to the following administrative and total utility budget:

Total Program Budget

Total Program Budget					
	2015	2016	2017	2018	2019
Program Staff Labor Cost	$25,000	$25,000	$25,000	$25,000	$25,000
Education & Marketing Cost	$-	$-	$-	$-	$-
Evaluation Cost	$25,000	$25,000	$25,000	$25,000	$25,000
Implementation Cost	$-	$-	$-	$-	$-
Incentive Costs	$250,000	$250,000	$250,000	$250,000	$250,000
Total Budget	**$300,000**	**$300,000**	**$300,000**	**$300,000**	**$300,000**

Cost-Effectiveness

The cost-effectiveness metrics of the Residential Behavioral Feedback Tools program are as follows:

Cost Effectiveness Tests						
	TRC Ratio	TRC Benefits	TRC Costs	UCT Ratio	PCT Ratio	RIM Ratio
Res Behavioral Feedback Tools	**1.18**	**$1,442,788**	**$1,220,290**	**1.18**	**-**	**0.42**

CHAPTER | 12

BUSINESS PRESCRIPTIVE PROGRAM

Program Description	The Business Prescriptive Rebate program is a core program designed to encourage and assist non-residential customers in improving the energy efficiency of their existing facilities through a broad range of energy efficiency options that address all major end uses and processes. This program offers incentives to customers who install high-efficiency electric equipment and engages equipment suppliers and contractors to promote the incentive-eligible equipment. The program has the following components, to accommodate the variety of customer needs and facilities in this sector: • Prescriptive Incentives—deemed per-unit savings for itemized measures; easy and appropriate for relatively low-cost or simple measures. • Specialized outreach to promote and enable prescriptive measures best suited to smaller facilities. • Customer referrals to qualified energy audit providers who can help customers identify appropriate and cost-effective retrofit opportunities. <u>Prescriptive Measure Incentives</u> • Quick and easy incentive application for measures with known and reliable energy savings. No pre-approval required. • Customers purchase and install qualified products from retailers and/or contractors. • Customers or their contractors submit incentive form to Vectren with information that documents the qualifying sale/installation. The form allows customers to see the exact incentive they can receive. Vectren mails rebate checks to customers or their contractors. • The prescriptive incentives are cash-back rebates that generally cover a portion of the incremental cost of the qualifying models; that is, the cost premium of qualifying models over less-efficient models available. In additional to prescriptive rebates for customers, the program will engage in upstream “buydowns” of certain products such as compact fluorescent lamps so that customers pay a lower price at the point of purchase without needing to apply for a rebate. The upstream buydown activity is a component of the program’s focus on market transformation that will increase the demand for high efficiency products, and eventually decrease the availability of lower-efficiency products in the marketplace. This program, along with the Business Custom program, is likely to provide the bulk of the energy savings from business customers. It should be noted that since business energy efficiency efforts are very project-centric, there are many projects that may fit partially under both the Prescriptive and Custom programs. Therefore, a flexible delivery approach should be employed, with a method to share or allocate projects between the two programs.
Objectives	The purpose of the Business Prescriptive Rebate program is to increase awareness of energy savings opportunities and assist customers in acting on those opportunities to decrease energy usage in commercial and industrial facilities. This program is designed

	for retrofit and replacement projects. The program has several objectives: • Increase consumers' awareness and understanding of the breadth of energy efficiency opportunities in their facilities. • Make it easier for customers to adopt more energy-efficient equipment and behaviors. • Make a significant contribution to attainment of Vectren's energy savings goals. • Strengthen customer trust in Vectren as their partners in saving energy.
Target Market	The eligible customer population for the Business Prescriptive Rebate program is all existing commercial and industrial accounts, including master-metered multifamily housing facilities, provided with electricity by Vectren.[1] Within the target market, the focus for this program is the equipment retrofit or change-out market; that is, customers with existing equipment that needs replacing or who can be persuaded to replace their equipment early.
Implementation Strategy	Overview of Activities The implementers will be involved in several activity areas: • Development of relationships with equipment and maintenance suppliers to make eligible equipment and services available, to implement upstream buy down of high efficiency products, and to promote their participation in the program • Program marketing: including development and distribution of program materials and assistance with direct mail or other promotion in collaboration with other contractors • Participant recruitment and assistance: including assisting customers and contractors with selection of measures and incentive application submittal • Rebate processing: including a fulfillment house to receive, review and verify applications; and either pay or submit the financial incentives to Vectren for payment • Program performance tracking and improvement: including tracking availability of qualifying products, rebate submittals and payments, and opportunities to improve the program • Reporting: including reporting of program activities to meet regulatory and internal requirements, including progress toward program goals • Integration with Business Custom Incentives Program: Business energy efficiency efforts are very project-centric, with many large projects participating in a hybrid of standard/prescriptive rebates and custom project incentives. Thus, it may be useful to follow an integrated delivery approach for the Business Prescriptive and the Business Custom Incentives program. Vectren will not provide direct technical services, but will maintain a list of qualified Energy Service Contractors (ESCOs) that can provide those services. The list will be provided to interested customers. ESCOs will provide customers with technical expertise to determine what equipment is most appropriate for them. Education Overview The program will provide and leverage education provided by other groups to ensure

[1] Public Schools will be covered in the separately organized Schools Program as part of the State of Indiana Core Program delivery.

	that participants have the understanding and tools to make the program successful. These are mainly focused on educating equipment suppliers and contractors, and include: • Training sessions for trade allies and other providers of products and services — these are to provide technical information regarding the applicability and benefits of the measures, information about how the program works, and their role in and incentives for having their customers participate in the program. • Since referrals to auditors who can help identify energy efficiency opportunities is part of the program, having trained and qualified auditors available is important. Many utility-sponsored programs rely upon outside training organizations to ensure that auditors are well-versed in building science principles and whole-building concepts for energy performance. For example, the Building Performance Institute (BPI) and Residential Energy Services Network (RESNET) have set widely-used standards for auditor training.
Issues, Risks, and Risk Management Strategies	There are several issues associated with providing an energy efficiency program to commercial and industrial customers. Key ones are identified below, along with how the Business Prescriptive Rebate program can address them. • This is a very diverse market sector, both in size and makeup. The final program design should include multiple tracks, for smaller businesses and for larger commercial and industrial customers, in order to provide the structure to develop specific outreach activities and educational/promotional messages that resonate with each group. • The energy uses of industrial customers are also diverse and often site-specific. The implementation contractor must have expertise to understand or engage the services of process experts to assist industrial customers in particular with project development as well as to perform pre- and post-installation inspections. • Equipment vendors and installation contractors have considerable influence in equipment purchase decisions. This effectively makes these trade allies part of the participant target market. To engage them in promoting and having their clients' projects participate in the program, it may be necessary and appropriate to structure the incentive payments so that part or all the incentive is directed to them or split with the customer.
Marketing and Outreach	Effective implementation of the program depends on marketing and outreach activities working effectively. This includes making qualifying products available, distributing information about the products and the program, promoting the program adequately, and educating those influential in making product selection and purchasing decisions. Also, as noted earlier, an integrated marketing approach needs to be followed for this program and other relevant programs in the portfolio like the Business Custom Incentives program. • Product Supply o Equipment suppliers—Vendors are influential in equipment selection in commercial and industrial facilities. They can be and should be engaged to recommend rebate-eligible models of equipment for retrofit and replacement projects. As appropriate, the incentives for equipment purchased under the program can be split or directed to these vendors. o Other trade allies—Installation and maintenance contractors can

provide services associated with some of the qualifying measures, such as HVAC diagnostic tune-ups, identifying and sealing air and duct leaks, and refrigeration system maintenance. Again, as appropriate, incentives offered on qualifying measures can be directed to or split with these providers to encourage them to promote program participation.

- Program and Product Information Distribution
  - Trade allies—As both deliverers of program products and potential participants in the program, all vendors of the qualifying equipment and service measures should be engaged to receive and also provide to their public sector clients information about the program measure benefits, how the program works, and assistance with the incentive process.
  - Utility staff—While Vectren will engage a contractor to implement the program, the staff has ongoing contact with all key account customers. The staff will provide information about the program benefits, measures, and process.
  - Business associations- Advertising in business association publications will provide information and awareness to prospective customers.
  - The implementation contractor will develop and distribute information about the qualifying products and participation assistance by establishing and leveraging existing relationships with the product and service suppliers.
- Program Promotion
  - Trade allies—All vendors of the qualifying equipment and service measures should be engaged to make their clients aware of the program and encourage their participation by recommending high-efficiency equipment models and diagnostic services.
  - Facility auditors—Part of auditors' services can and should include making customers aware of this program and the incentives available for installation of high-efficiency measures.
  - Bill inserts to all and direct mail to sub-segments within this target market; e.g., small businesses.
  - A key responsibility of the implementation contractor is outreach and effective promotion of the program to the target market.
- Education: Opportunities to educate both the trade allies, who themselves are potential participants and delivery channels, and facility managers include:
  - Bill inserts and/or direct mail
  - Trade publication articles on the benefits of specific measures, technologies, and diagnostic tune-ups, as well as whole facility assessments
  - Trade industry meetings leveraged to include product and program education as part of them
  - Workshops provided by government agencies for commercial and industrial businesses to understand how to improve energy use in their facilities
  - Facility audit reports

	o Industry and technology experts who meet individually with facility decision makers during outreach and project development Specialized outreach activities will be undertaken for specific customer segments to promote and enable prescriptive measures best suited for high-impact/high-need customers such as municipal buildings, hospitals, food service, and hospitality industry to influence implementation of high efficiency equipment that would not have taken place without the program. For example, for the small hospitality sector, the program could be delivered through a specialized vendor. The specialized program vendors will be primarily responsible for marketing activities, and for contacting and recruiting participants. Direct mail and company website information are effective channels for outreach activities.
Evaluation, Measurement and Verification Requirements	The evaluation methodology and data collection proposed for the program are guidelines that reflect current measurement and verification (M&V) practices. The ultimate M&V requirements for this program will conform with the state protocols. Metrics for Gauging Program Success Primary: • Number of program measures installed • Energy savings associated with installed measures • Customer satisfaction with the program and the products • Program implementation costs incurred Secondary: • Distribution of measure popularity and cost-effectiveness of program, to enable program improvement • Number and variety of suppliers/contractors who stock qualified products Data Collection Approaches Data for evaluating the program will come from the following sources: • Impact Evaluation o Tracking system data for all projects o Data on customer electrical equipment, hours of operation, life of the equipment, etc. o On-site inspection and metering of a sample of projects to verify operation as reported o Vectren customer energy consumption data for engineering or statistical analyses of impacts • Process Evaluation Evaluation of program design and implementation process will be conducted by gathering and analyzing data through a variety of surveys and interviews, including: o Follow-up surveys of C&I customers contacted from customer information provided on the incentive applications and from Vectren customer information system (for nonparticipants) o Surveys of upstream suppliers engaged in promoting the program and assisting customers with project development and incentive application submittal o Interviews with the implementation contractor and program staff o Review of program documents and tracking system data

	<u>Impact Evaluation Methodology</u> The program will record energy savings and peak load reductions from the rebate applications processed. For prescriptive measures, recorded savings will use the per-unit deemed savings values. Because prescriptive measures are established technologies and data are available demonstrating the reliability of savings, it will not be necessary to conduct customer-level billing analyses or metering studies on these projects. However, some number of projects will be inspected for independent verification of installation and operation as reported. Assessment of free-rider and free-driver effects, if deemed appropriate, may be conducted using customer billing and survey data in conjunction with established M&V methodologies and procedures. <u>Process Evaluation Methodology</u> Evaluation of the program implementation is important to ensure that the program is operating as intended and to provide information that can enable improvements in both the program design and implementation. Process evaluation will be undertaken and conducted throughout the program by the implementation and the M&V contractor(s) selected by Vectren. Process evaluation will assess customer understanding of, attitudes about, and satisfaction with both the program and with Vectren's broader educational activities. The evaluations will make use of survey data collected by the implementation and M&V contractors. These surveys will include both customers known to have participated in the program and eligible nonparticipants. The diversity of customers in this target market, including small businesses, master-metered multifamily housing facilities, general office as well as specialty facilities, and factories, means that survey content and fielding will need to accommodate a wide variety of participation experiences. Interviews with program service providers will be conducted to assess satisfaction with the program and to identify problems and possible program services/implementation improvements. The M&V contractor will also help Vectren assess the performance of the program design and delivery of the products and services featured in the program, including effectiveness of the educational materials, effectiveness of promotional campaigns and messages, effectiveness of the trade ally involvement, and whether implementation milestones are met adequately and on schedule. These evaluations will use sales and promotion data maintained by the implementation contractor, information provided by Vectren, and customer survey data.
Program Schedule	The Business Prescriptive Rebate program is a Core program and is already part of the current Vectren portfolio and will continue to operate through PY 2019. The following table provides a schedule of key milestones:

Key Milestones	Timing
Assign internal program manager and staff	Anticipated in late 2013 or early 2014.
Select and contract with program implementation contractor(s)	2014, Q2 or immediately upon program approval
Finalize program design	2014, Q2
Pre-rollout program development: Prepare marketing materials and incentive applications Develop activity and incentive	2014, Q3 and Q4

processing protocols Identify qualified auditors, contractors, and trade allies	
Program re-launch: Launch consumer education, marketing, and outreach All program services	2015, Q1
Prepare reports: Documentation of program activities and progress toward goals Reports to Commission	Monthly throughout program implementation period Quarterly, and annually
Conclude program operation for this planning cycle	2019

Estimated Participation

Participation and measure adoption estimates were developed based on the number of commercial and industrial customers in the service territory and an assessment of the attainable market potential in the area, as well as past program experience and the experience of other organizations that have offered this type of program.

Total Estimated Participation (# of SqFt or Employees)

Measure	Option	No. of Gross Installations*	NTG Ratio	No. of Net Installations*
Air-Cooled Chiller	0.97 kw/ton, COP 3.6	1,239,100	0.80	991,280
Geothermal Heat Pump	EER 30, COP 5.0	446,233	0.80	356,986
Other Cooling	EER 11.5	657,493	0.80	525,994
Geothermal Heat Pump	EER 16, COP 3.5	35,484	0.80	28,387
Water Heating	EF 2.4	7,054,478	0.80	5,643,583
Screw-in	Mix of LEDs/CFLs	79,107,356	0.80	63,285,884
High-Bay Fixtures	T5	8,878,099	0.80	7,102,479
Linear Fluorescent	T5	38,971,985	0.80	31,177,588
HID	T5	21,870,608	0.80	17,496,486
Oven	Energy Star	4,691,465	0.80	3,753,172
Dishwasher	Energy Star	1,074,848	0.80	859,878
Desktop Computer	Energy Star	12,666,803	0.80	10,133,443
Laptop	Energy Star	14,133,986	0.80	11,307,189
Server	Energy Star	30,118,938	0.80	24,095,151
Monitor	Energy Star	3,843,697	0.80	3,074,957
Printer/Copier/Fax	Energy Star	4,162,765	0.80	3,330,212
Non-HVAC Motors	Premium (NEMA)	-	0.80	-
Non-HVAC Motors	Premium (NEMA 2015)	7,202,779	0.80	5,762,223
Air Source Heat Pump	EER 11.0, COP 3.3	5,706	0.80	4,565

Other Cooling	EER 10.2	615,891	0.80	492,713
Fryer	Energy Star	3,880,818	0.80	3,104,655
Hot Food Container	Energy Star	3,403,939	0.80	2,723,152
Roof top AC	EER 12.0	1,567,638	0.80	1,254,110
Pool Pump	High Efficiency, Multi-Speed	185,686	0.80	148,549
Pool Heater	Heat Pump	45,585	0.80	36,468
Geothermal Heat Pump	EER 18, COP 3.8	23,317	0.80	18,654
Air Source Heat Pump	EER 12.0, COP 3.4	217,592	0.80	174,074
Air Source Heat Pump	EER 11.7, COP 3.4	74,297	0.80	59,438
Traffic Lights	LED	140	0.80	112
Crosswalk Lights	LED	25	0.80	20
Roof top AC	Ductless Minisplit	462	0.80	370
Air-Source Heat Pump	Ductless Minisplit	9	0.80	7
Compressed Air	High Efficiency	7,057	0.80	5,645
Air-Cooled Chiller - Maintenance		89,736	0.80	71,789
Water-Cooled Chiller - Maintenance		67,126	0.80	53,701
RTU - Maintenance		3,154,423	0.80	2,523,539
Heat Pump - Maintenance		2,330,283	0.80	1,864,226
Water Heater - Faucet Aerators/Low Flow Nozzles		8,456,777	0.80	6,765,422
Exterior Lighting - Daylighting Controls		18,565,236	0.80	14,852,189
Office Equipment - ENERGY STAR Power Supplies		104,648,914	0.80	83,719,131
Thermostat - Clock/Programmable		5,773,848	0.80	4,619,078
HVAC - Occupancy Sensors		975,423	0.80	780,338
PC Power Management Software		64,122,133	0.80	51,297,706
Pre-rinse Sprayer		506,627	0.80	405,301
Interior Lighting - LED Exit Lighting		20,984,567	0.80	16,787,653
Interior Lighting - Occupancy Sensors		32,107,043	0.80	25,685,634
Interior Lighting - Timeclocks and Timers		22,991,753	0.80	18,393,402
Water Heater - Install Timer		122,902	0.80	98,322
Water Heater - Tank Blanket/Insulation		1,131,697	0.80	905,357
Refrigerator - Anti-Sweat Heater		288,379	0.80	230,703
Interior Lighting - Daylighting Controls		1,970,634	0.80	1,576,507
Refrigerator - Strip Curtain		274,017	0.80	219,214
Interior Lighting - Skylights		2,252	0.80	1,802
Compressed Air - Compressor		1,226	0.80	981

Replacement				
Compressed Air - System Maintenance		4,178	0.80	3,343
Pumping System - Maintenance		2,904	0.80	2,323
Fan System - Maintenance		3,622	0.80	2,897
Motors - Efficient Rewind		6,043	0.80	4,834

Projected Energy Savings

The estimated energy savings are given in terms of annual kWh by measure. The savings noted in each year are incremental, that is reflective of new measures installed by customers through the program in that year. This does *not* include the cumulative impact of measures still in operation from previous years.

Total Net Incremental Electricity Savings (kWh)

Total Net Incremental Energy Savings (kWh)						
Measure	**Option**	**2015**	**2016**	**2017**	**2018**	**2019**
Air-Cooled Chiller	0.97 kw/ton, COP 3.6	165,676	203,238	239,694	259,406	236,138
Geothermal Heat Pump	EER 30, COP 5.0	49,552	68,140	86,461	136,405	148,811
Other Cooling	EER 11.5	16,104	21,416	27,159	33,247	36,321
Geothermal Heat Pump	EER 16, COP 3.5	2,314	-	-	4,297	5,408
Water Heating	EF 2.4	486,120	589,800	708,140	792,953	842,442
Screw-in	Mix of LEDs/CFLs	2,011,212	2,096,414	2,156,219	2,464,153	2,770,309
High-Bay Fixtures	T5	292,179	287,182	309,397	77,816	34,238
Linear Fluorescent	T5	1,299,506	1,703,232	2,109,387	2,561,684	2,757,385
HID	T5	844,161	819,854	774,384	221,530	104,914
Oven	Energy Star	37,433	49,908	62,291	71,563	66,919
Dishwasher	Energy Star	29,849	39,843	49,760	61,687	66,017
Desktop Computer	Energy Star	503,615	533,970	574,553	325,389	130,892
Laptop	Energy Star	80,981	150,251	62,531	29,283	17,746
Server	Energy Star	856,004	327,703	121,229	73,264	62,669
Monitor	Energy Star	17,634	32,430	12,599	5,148	2,880
Printer/Copier/Fax	Energy Star	22,154	23,348	24,231	44,102	15,382
Non-HVAC Motors	Premium (NEMA)	-	-	-	-	-
Non-HVAC Motors	Premium (NEMA 2015)	7,206	9,112	11,109	13,404	14,239

Air Source Heat Pump	EER 11.0, COP 3.3	299	542	840	1,282	1,578
Other Cooling	EER 10.2	5,303	7,134	9,044	11,084	12,114
Fryer	Energy Star	20,472	27,300	34,048	39,125	36,544
Hot Food Container	Energy Star	98,518	104,559	108,316	114,404	106,736
Roof top AC	EER 12.0	17,302	58,637	77,529	91,922	89,257
Pool Pump	High Efficiency, Multi-Speed	49	65	81	100	205
Pool Heater	Heat Pump	46	62	77	95	196
Geothermal Heat Pump	EER 18, COP 3.8	498	6,480	8,186	677	737
Air Source Heat Pump	EER 12.0, COP 3.4	5,802	7,761	9,790	11,906	19,031
Air Source Heat Pump	EER 11.7, COP 3.4	-	2,466	3,201	3,947	-
Traffic Lights	LED	3,078	2,078	1,216	26,065	8,790
Crosswalk Lights	LED	1,679	1,134	663	300	209
Roof top AC	Ductless Minisplit	182,980	249,125	295,429	325,685	299,115
Air-Source Heat Pump	Ductless Minisplit	2,252	5,138	6,876	8,815	9,925
Compressed Air	High Efficiency	18,206	21,906	25,437	29,490	30,512
Air-Cooled Chiller - Maintenance		46,220	56,475	67,688	78,899	83,765
Water-Cooled Chiller - Maintenance		44,972	54,956	65,926	77,011	81,814
RTU - Maintenance		524,563	635,944	756,261	874,712	921,113
Heat Pump - Maintenance		125,641	152,162	181,118	209,822	221,432
Water Heater - Faucet Aerators/Low Flow Nozzles		34,666	41,796	49,325	56,549	58,856
Exterior Lighting - Daylighting Controls		249,493	291,081	337,204	392,439	410,975
Office Equipment - ENERGY STAR Power Supplies		17,657	21,316	25,399	29,612	31,503
Thermostat - Clock/Programmable		102,378	125,490	150,872	176,339	189,143
HVAC - Occupancy Sensors		13,224	16,353	19,820	23,343	25,004
PC Power Management Software		779,370	938,820	1,114,267	1,296,709	1,377,505

Pre-rinse Sprayer		7,349	8,837	10,404	11,902	12,393
Interior Lighting - LED Exit Lighting		5,254	6,298	7,439	8,508	21,488
Interior Lighting - Occupancy Sensors		2,100,450	2,537,907	3,023,613	3,468,701	3,645,655
Interior Lighting - Timeclocks and Timers		270,951	326,498	387,866	444,509	466,292
Water Heater - Install Timer		8,639	10,421	12,300	14,100	14,687
Water Heater - Tank Blanket/Insulation		7,950	9,598	11,339	13,009	13,559
Refrigerator - Anti-Sweat Heater		14,645	17,496	20,478	23,313	24,149
Interior Lighting - Daylighting Controls		244,392	295,325	352,059	404,172	425,185
Refrigerator - Strip Curtain		804	934	1,068	1,193	1,219
Interior Lighting - Skylights		126,543	153,297	183,213	210,408	221,683
Compressed Air - Compressor Replacement		236,240	290,445	350,089	410,154	437,071
Compressed Air - System Maintenance		91,998	113,109	136,340	159,734	170,219
Pumping System - Maintenance		98,985	121,713	146,727	171,925	183,236
Fan System - Maintenance		50,794	62,457	75,292	88,223	94,027
Motors - Efficient Rewind		28,208	34,684	41,810	48,989	52,210
TOTAL		**12,309,568**	**13,773,638**	**15,437,791**	**16,534,502**	**17,111,839**

Customer Incentives

Incentives will be paid in the form of rebates. Incentives for the individual measures account for 40% of the incremental measure cost. Incremental cost is the additional cost of a high-efficiency measure beyond a standard-efficiency alternative.

Administrative Requirements

Program administrative staff's role will be to ensure that:

- the implementation contractor performs all the activities associated with delivery of all components or the program, and
- educational and program messages are delivered accurately and clearly to ensure the effectiveness of program delivery and maximize customer satisfaction with the program.

The program is expected to operate according to the following administrative and total utility budget:

Total Program Budget

Total Program Budget					
	2015	2016	2017	2018	2019
Program Staff Labor Cost	$75,000	$75,000	$75,000	$75,000	$75,000
Education & Marketing Cost	$146,050	$184,664	$217,423	$246,570	$245,323
Evaluation Cost	$73,025	$92,332	$108,712	$123,285	$122,662
Implementation Cost	$365,125	$461,660	$543,558	$616,425	$613,309
Incentive Costs	$1,460,502	$1,846,642	$2,174,233	$2,465,700	$2,453,234
Total Budget	**$2,119,703**	**$2,660,299**	**$3,118,927**	**$3,526,980**	**$3,509,528**

Cost-Effectiveness

The cost-effectiveness metrics of the Business Prescriptive Rebate program are as follows:

Cost Effectiveness Tests						
	TRC Ratio	TRC Benefits	TRC Costs	UCT Ratio	PCT Ratio	RIM Ratio
Bus Prescriptive	**2.06**	**$50,575,254**	**$24,584,518**	**4.21**	**3.91**	**0.83**

CHAPTER 13

BUSINESS CUSTOM INCENTIVES PROGRAM

<table>
<tr><td>Program Description</td><td>
The Business Custom Incentives program is designed to encourage and assist nonresidential customers to save energy through customizable projects that are too complex to fit in the standard rebate offering. The program will affect the purchase and installation of efficient technologies and/or implementation of process improvements by working directly with key end-use customers and market providers.
The program has the following components, to accommodate the variety of customer needs and facilities in this sector:

Custom Incentives—paid on fixed dollar per first-year-kWh-saved basis; appropriate for large and complex projects, often with multiple measures.
Emphasis on flexibility of custom projects to address variety of business and industrial process energy improvements.
Customer referrals to qualified energy audit providers who can help customers identify appropriate and cost-effective retrofit opportunities.

<u>Custom Project Incentives</u>

Provides financial incentives on projects not suitable for prescriptive incentives because of size or multiple types of equipment involved.
More complex offering, with the following services and requirements:

Review design/specification and savings estimates for completeness and applicability of incentives
Pre- and post-project inspections to estimate and verify savings
Incentives paid on a fixed $/kWh basis

Examples of custom projects include energy management systems, air compressor system optimization, building envelope improvements, and experimental technologies.

This program, along with the Business Prescriptive program, is likely to provide the bulk of the energy savings from business customers. It should be noted that since business energy efficiency efforts are very project-centric, there are many projects that may fit partially under both the Prescriptive and Custom programs. Therefore, an flexible delivery approach should be employed, with a method to share or allocate projects between the two programs.
</td></tr>
<tr><td>Objectives</td><td>
The purpose of the Business Custom Incentives program is to increase awareness of energy savings opportunities and assist customers in acting on those opportunities to decrease energy usage in commercial and industrial facilities. This program is designed for retrofit and replacement projects.
The program has several objectives:

Increase consumers' awareness and understanding of the breadth of energy efficiency opportunities in their facilities.
Make it easier for customers to adopt more energy-efficient equipment and equipment maintenance.
Make a significant contribution to attainment of Vectren's energy savings goals.

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	• Strengthen customer trust in Vectren as their partner in saving energy.
Target Market	The eligible customer population for the Business Custom Incentives program is all existing commercial and industrial accounts, including master-metered multifamily housing facilities, provided with electricity by Vectren.[2] Within the target market, the focus for this program is the equipment retrofit or change-out market; that is, customers with existing equipment that needs replacing or who can be persuaded to replace their equipment early.
Implementation Strategy	Overview of Activities The implementers will be involved in several activity areas: • Development of relationships with equipment and maintenance suppliers to make incentive-eligible equipment and services available and to promote their participation in the program • Program marketing: including development and distribution of program materials and assistance with direct mail or other promotion in collaboration with other Vectren contractors • Participant recruitment and assistance: including assisting customers and contractors with selection of measures and incentive application submittal, assisting customers and contractors with custom engineering calculations for development of savings estimates, payback, and documentation for approval of custom measure projects • The implementation contractor will work with Vectren to identify the top energy consumers and continue outreach with EE service providers that are familiar with the program. The established EE service providers include mechanical contractors, commercial equipment distributors, energy service companies, architects, and engineers. • Rebate processing: including a fulfillment house to receive, review and verify applications; and either pay or submit the financial incentives to Vectren for payment • Program performance tracking and improvement: including tracking availability of qualifying products, rebate submittals and payments, and opportunities to improve the program • Reporting: including reporting of program activities to meet regulatory and internal requirements, including progress toward program goals Specialized outreach activities will be undertaken for specific customer segments to promote and enable prescriptive measures best suited for high-impact/high-need customers such as municipal buildings, hospitals, food service, and the hospitality industry to influence implementation of high efficiency equipment that would not have taken place without the program. For example, for the small hospitality sector, the program could be delivered through a specialized vendor. The specialized program vendors will be primarily responsible for marketing activities, and for contacting and recruiting participants. Direct mail and company website information are effective channels for outreach activities. Education Overview The program will provide and leverage education provided by other groups to ensure that program channels and participants have the understanding and tools to make the

[2] Public Schools will be covered in the separately organized Schools Program as part of the State of Indiana Core Program delivery.

	program successful. These are mainly focused on educating equipment suppliers and contractors, and include: • Training sessions for trade allies and other providers of products and services — these are to provide technical information regarding the applicability and benefits of the measures, information about how the program works, and their role in and incentives for having their customers participate in the program. • Since referrals to auditors who can help identify energy efficiency opportunities is part of the program, having trained and qualified auditors available is important. Many utility-sponsored programs rely upon outside training organizations to ensure that auditors are well-versed in building science principles and whole-building concepts for energy performance. For example, the Building Performance Institute (BPI) and Residential Energy Services Network (RESNET) have set widely-used standards for auditor training.
Issues, Risks, and Risk Management Strategies	Key issues are identified below, along with how the Business Custom Incentives program can address them. • This is a very diverse market sector, both in size and makeup. The final program design should include multiple tracks, for smaller businesses and for larger commercial and industrial customers, in order to provide the structure to develop specific outreach activities and educational/promotional messages that resonate with each group. • The energy uses of industrial customers are also diverse and often site-specific. The implementation contractor must have expertise to understand or engage the services of process experts to assist industrial customers in particular with project development as well as to perform pre- and post-installation inspections. • Equipment vendors and installation contractors have considerable influence in equipment purchase decisions. This effectively makes these trade allies part of the participant target market. To engage them in promoting and having their clients' projects participate in the program, it may be necessary and appropriate to structure the incentive payments so that part or all the incentive is directed to them or split with the customer.
Marketing and Outreach	Effective implementation of the program depends on marketing and outreach activities working effectively. This includes making qualifying products available, distributing information about the products and the program, promoting the program adequately, and educating those influential in making product selection and purchasing decisions. Success of custom projects is dependent upon referrals and networking with trade allies and utility staff to identify projects. Trade allies receive reminder packets in mail and follow-up telephone calls, followed by in-person visits by the implementation contractor with market providers at their place of business in order to obtain support in providing referrals of custom incentive projects. • Product Supply o Equipment suppliers—Vendors are influential in equipment selection in commercial and industrial facilities. They can be and should be engaged to recommend equipment and controls that can reduce customers' energy use. As appropriate, the incentives for equipment purchased under the program can be split or directed to these vendors. o Other trade allies—Installation and maintenance contractors can

provide services associated with some of the qualifying measures. Again, as appropriate, incentives offered on qualifying measures can be directed to or split with these providers to encourage them to promote program participation.

- Program and Product Information Distribution
    - Trade allies—As both deliverers of program products and potential participants in the program, all vendors of high efficiency equipment, controls and service measures should be engaged to receive and also provide to their public sector clients information about the benefits of high efficiency, how the program works, and assistance with the incentive process.
    - Utility staff—While Vectren will engage a contractor to implement the program, the staff has ongoing contact with all key account customers. The staff will provide information about the program benefits, measures, and process.
    - The implementation contractor will develop and distribute information about the program and participation assistance by establishing and leveraging existing relationships with the product and service suppliers.
- Program Promotion
    - A key responsibility of the implementation contractor is outreach and effective promotion of the program to the target market. The implementation contractor will work with Vectren sales consultants to generate joint awareness of the prescriptive and custom programs through direct contact with key customers and service providers.
    - Outreach efforts will be focused on: Networking with Vectren Commercial Sales Consultants, product sales representatives, service contractors, and energy services companies. These efforts can be performed by Trade Ally Service Representatives who undertake recruitment of participants, provide sales assistance, and present at trade seminars.
    - Trade Ally Service Representatives will be an important channel to promote the program at industry events, contractor association meetings, and directly to trade allies. Examples of events for program promotion include: The Midwest Healthcare Engineering Conference, the Indiana Building Green Symposium, and the Midwest Petroleum and Convenience Show, along with monthly meetings with industry trades. In addition to attending and presenting at these seminars, program marketing materials can be distributed at other forums such as ASHRAE seminars.
    - Trade allies—All vendors of high efficiency equipment, controls and service measures should be engaged to make their clients aware of the program and encourage their participation by recommending high-efficiency equipment models and diagnostic services.
    - Facility auditors—Part of auditors' services can and should include making customers aware of this program and the incentives available for installation of high-efficiency measures.
    - Direct customer outreach targeting decision makers within the customers' organization including energy managers, facility managers,

	financial and operations managers, chief engineer and facility/property managers, maintenance supervisors and building operators. • Education: Opportunities to educate both the trade allies, who themselves are potential participants and delivery channels, and facility managers include: o Bill inserts and/or direct mail o Trade publication articles on the benefits of specific measures, technologies, and diagnostic tune-ups, as well as whole facility assessments o Trade industry meetings leveraged to include product and program education as part of them o Workshops provided by government agencies for commercial and industrial businesses to understand how to improve energy use in their facilities o Facility audit reports o Industry and technology experts who meet individually with facility decision makers during outreach and project development
Evaluation, Measurement and Verification Requirements	The evaluation methodology and data collection proposed for the program are guidelines that reflect current measurement and verification (M&V) practices. The ultimate M&V requirements for this program will conform with the state protocols. Metrics for Gauging Program Success Primary: • Number of program measures installed • Number of participating customers • Energy savings associated with installed measures • Customer satisfaction with the program and the products • Program implementation costs incurred Secondary: • Distribution of measure popularity and cost-effectiveness of program, to enable program improvement • Number and variety of suppliers/contractors who stock qualified products Data Collection Approaches Data for evaluating the program will come from the following sources: • Impact Evaluation o Tracking system data for all projects o On-site inspection and metering of a sample of projects to verify operation as reported. Data requirements will vary with project specifications. In certain cases, utility billing meter information may be sufficient, while in other cases spot metering or other types of assessment may be required. o Customer energy consumption data for engineering or statistical analyses of impacts • Process Evaluation Evaluation of program design and implementation process will be conducted by gathering and analyzing data through a variety of surveys and interviews, including:

	o Follow-up surveys of C&I customers contacted from customer information provided on the incentive applications and from customer information system (for nonparticipants) o Surveys of upstream suppliers engaged in promoting the program and assisting customers with project development and incentive application submittal o Interviews with the implementation contractor and program staff o Review of program documents and tracking system data <u>Impact Evaluation Methodology</u> The program will record energy savings and peak load reductions from the rebate applications processed. For custom measure projects, the gross savings need to be estimated based on engineering models and estimates. The M&V assessment will necessarily require pre/post building simulation modeling, billing analyses and/or metering to verify the project savings. For program impact assessment, this can be accomplished through verification of a sample of projects that account for a large portion of the reported savings and are most representative of projects by the different target market segments. Assessment of free-rider and free-driver effects, if deemed appropriate, may be conducted using customer billing and survey data in conjunction with established M&V methodologies and procedures. <u>Process Evaluation Methodology</u> Evaluation of the program implementation is important to ensure that the program is operating as intended and to provide information that can enable improvements in both the program design and implementation. Process evaluation will be undertaken and conducted throughout the program by the implementation and the M&V contractor(s) selected by Vectren. Process evaluation will assess customer understanding of, attitudes about, and satisfaction with both the program and with Vectren's broader educational activities. The evaluations will make use of survey data collected by the implementation and M&V contractors. These surveys will include both customers known to have participated in the program and eligible nonparticipants. The diversity of customers in this target market, including small businesses, master-metered multifamily housing facilities, general office as well as specialty facilities, and factories, means that survey content and fielding will need to accommodate a wide variety of participation experiences. Interviews with program service providers will be conducted to assess satisfaction with the program and to identify problems and possible program services/implementation improvements. The M&V contractor will also help Vectren assess the performance of the program design and delivery of the products and services featured in the program, including effectiveness of the educational materials, effectiveness of promotional campaigns and messages, effectiveness of the trade ally involvement, and whether implementation milestones are met adequately and on schedule. These evaluations will use sales and promotion data maintained by the implementation contractor, information provided by Vectren, and customer survey data.
Program Schedule	The Business Custom Incentives program will operate during PY 2015 through PY 2019. The following table provides a schedule of key milestones:

Key Milestones	Timing
Assign internal program manager and staff	Anticipated in late 2013 or early 2014.
Select and contract with program implementation contractor(s)	2014, Q2 or immediately upon program approval
Finalize program design	2014, Q2
Pre-rollout program development: Prepare marketing materials and incentive applications Develop activity and incentive processing protocols Identify qualified auditors, contractors, and trade allies	2014, Q3 and Q4
Program re-launch: Launch consumer education, marketing, and outreach All program services	2015, Q1
Prepare reports: Documentation of program activities and progress toward goals Reports to Commission	Monthly throughout program implementation period Quarterly, and annually
Conclude program operation for this planning cycle	2019

Estimated Participation

Participation and measure adoption estimates were developed based on the number of commercial and industrial customers in the service territory and an assessment of the attainable market potential in the area, as well as past program experience and the experience of other organizations that have offered this type of program.

Total Estimated Participation (# of SqFt or Employees)

Measure	No. of Gross Installations*	NTG Ratio	No. of Net Installations*
Total Business Custom Incentives	145,443,198	0.85	123,626,718

Projected Energy Savings

The estimated energy savings are given in terms of annual kWh by measure. The savings noted in each year are incremental, that is reflective of new measures installed by customers through the program in that year. This does *not* include the cumulative impact of measures still in operation from previous years.

Total Net Incremental Electricity Savings (kWh)

Total Net Incremental Energy Savings (kWh)					
Measure	**2015**	**2016**	**2017**	**2018**	**2019**
Total Business Custom Incentives	12,905,765	14,890,860	16,800,675	18,697,829	20,595,234
TOTAL	**12,905,765**	**14,890,860**	**16,800,675**	**18,697,829**	**20,595,234**

Customer Incentives

For implementation purposes, the incentive payout is $0.13 per annual kWh saved in the first year of the project life. This corresponds with a planning and budgeting assumption where the customer incentives are set to cover 40% of the incremental cost of measures.

Incentives are capped at $100,000 per customer. Research has shown that most C&I custom programs have an incentive cap as either a fixed amount or a percentage of project cost. Caps range from $67,000 - $250,000 and/or 30 – 70% of the project cost, with a percentage approach as more popular than the fixed amount. Vectren has current language in the tariff that gives some flexibility in making exceptions to the cap if necessary, but if program participation decreases or if requests are frequently received from customers with projects that would exceed the cap, it may be prudent to investigate raising or revisiting the caps.

Administrative Requirements

Program administrative staff's role will be to ensure that:

- the implementation contractor performs all the activities associated with delivery of all components or the program, and
- educational and program messages are delivered accurately and clearly to ensure the effectiveness of program delivery and maximize customer satisfaction with the program.

The program is expected to operate according to the following administrative and total utility budget:

Total Program Budget

Total Program Budget					
	2015	**2016**	**2017**	**2018**	**2019**
Program Staff Labor Cost	$75,000	$75,000	$75,000	$75,000	$75,000
Education & Marketing Cost	$168,812	$196,312	$223,118	$251,578	$277,124
Evaluation Cost	$118,168	$137,418	$156,183	$176,105	$193,987
Implementation Cost	$675,248	$785,247	$892,472	$1,006,312	$1,108,498
Incentive Costs	$1,688,121	$1,963,117	$2,231,180	$2,515,780	$2,771,245
Total Budget	**$2,725,350**	**$3,157,094**	**$3,577,953**	**$4,024,774**	**$4,425,855**

Cost-Effectiveness

The cost-effectiveness metrics of the Business Custom Incentives program are as follows:

Cost Effectiveness Tests						
	TRC Ratio	TRC Benefits	TRC Costs	UCT Ratio	PCT Ratio	RIM Ratio
Bus Custom Incentives	**2.52**	**$70,292,200**	**$27,918,583**	**4.87**	**5.25**	**0.82**

CHAPTER 14

BUSINESS RETROFIT AND UPGRADE FOR SCHOOLS

Program Description	The Business Retrofit and Upgrade program for Schools is essentially a combination of the Business Prescriptive and the Custom Incentives program, targeted toward public schools. This program offers the same financial incentives and technical assistance to reduce energy use as in other nonresidential facilities, along with providing assistance in identifying key improvement opportunities and addressing the special planning and purchasing protocols of public schools. The program has the following components: • Prescriptive and custom measure rebates—includes rebates for installation of a full array of energy efficiency improvements. Prescriptive measures include lighting, HVAC, motors, and building shell. Examples of custom measures include HVAC controls, energy management systems, water/wastewater efficiency upgrades, and very large or complex versions of any of the prescriptive measures listed above. • Audits with cost reimbursement for installation of recommended measures—designed to assist facility operators to identify energy-saving opportunities and prioritize projects to fit with planning cycles and leverage other funding sources in addition to Vectren incentives. The program is designed to make it as easy as possible for public schools and their contractors to obtain rebates for prescriptive measures, while also providing flexibility in accommodating the diversity of energy-savings opportunities and varying complexities of projects likely in this sector with custom measure incentives. The program provides something close to a one-stop shop for obtaining energy efficiency assistance through audits offered to help customers and their influential contractors in this target market identify and prioritize their energy-savings opportunities.
Objectives	The purpose of the Business Schools program is to achieve energy savings in this segment. The program has several objectives: • Substantially improve the energy efficiency of public school facilities. • Facilitate the monitoring of energy efficiency projects toward the goal. • Enable eligible customers to identify and implement all cost effective energy-saving opportunities. This program provides all of the same services offered to commercial customers in other programs. Additionally, it provides assistance with obtaining facility audits. The key difference is that for the public school segment, all the energy efficiency related services are offered within a single program. This includes retrofits and new construction.
Target Market	The target market for the Business Schools program is all public schools within the applicable service territory.
Implementation Strategy	<u>Overview of Activities</u> The implementers will be involved in several activity areas: • Development of relationships with public school equipment and maintenance suppliers to make incentive-eligible equipment and services available and to promote their participation in the program

	• Program marketing: including development and distribution of program materials and assistance with direct mail or other advertising in collaboration with other Vectren contractors • Participant recruitment and assistance: including scheduling audits with qualified auditors, assisting customers and contractors with incentive application submittal, and assisting customers and contractors with the development of estimates and documentation for approval of custom measure projects • Rebate processing: fulfillment house to receive, review and verify applications; and either pay or submit rebates to Vectren for payment • Program performance tracking and improvement: including tracking of all program activities, rebate submittals and payments, and opportunities to improve the program • Reporting: including reporting of program activities to meet regulatory and internal requirements, in particular progress toward program goals A single ESCO delivery model may be pursued for energy efficiency implementation in schools. This approach may help overcome barriers toward implementing energy efficiency measures in schools related to shortage of funds for energy efficiency upgrades and carrying through on energy efficiency plans. One of the unique features related to implementation of energy efficiency programs in schools is the development of a performance contract. The performance contracting vehicle will allow schools to “ride” the contract any year for specific energy efficiency projects. Education Overview The program will provide and leverage education provided by other groups to ensure that program channels and participants have the understanding and tools to make the program successful. These include: • Vectren will offer a series of forums designed to educate and inform public school leaders about programs and incentives. • Training sessions for trade allies and other providers of products and services — these are to provide technical information regarding the applicability and benefits of the measures, information about how the program works, customers’ role in and incentives for participating, and issues related to public school procurement practices. • The audit component of the program will also provide one-on-one customer education about energy efficiency benefits in general and the recommended measure benefits more specifically, the state’s commitment to reducing energy use in public schools, and the availability of resources designed to enable energy efficiency improvement projects. • Training and qualification of auditors is important. Many utility-sponsored programs rely upon outside training organizations to ensure that auditors are well-versed in building science principles and whole-building concepts for energy performance. For example, the Building Performance Institute (BPI) and Residential Energy Services Network (RESNET) have set widely-used standards for auditor training.
Issues, Risks, and Risk Management	There are several issues associated with providing an energy efficiency program to the public school segment. Key ones are identified below, along with how the Business Schools program can address them.

Strategies	• Similar to other public agencies, schools typically have more complex procurement practices than private businesses. For implementation of the program to be successful, the outreach, project scheduling, incentive fulfillment process, and trade ally involvement strategies used by the implementation contractor all need to reflect understanding and accommodation of these practices. • Public schools will need help identifying and prioritizing energy-saving opportunities. The audit component will directly address this need, but a full-scale commercial building audit often costs about $20,000. While the program will provide at least partial reimbursement of this cost to customers who install recommended measures, the up-front cost will be borne by the customer unless "bought down" by the contractor who will perform the work. • The program will require the availability of a sufficient number of qualified auditors. This means that training needs to be procured prior to the launch of other program components. This should not be difficult but needs immediate attention, well before program launch. Furthermore, the issue of how the training will be paid for needs to be worked out. In many areas with similar programs, contractors are fully responsible for the cost of their training, though the training provider or program sponsor may cover some or all of the cost if certain conditions are met; e.g., purchase of blower door or other diagnostic equipment, completion of a certain number of audits.
Marketing and Outreach	Effective implementation of the program depends on marketing and outreach activities working effectively. This includes distributing information about the products and the program, promoting the program adequately, and educating those influential in making product selection and purchasing decisions. Specialized outreach activities will be undertaken to promote and enable prescriptive measures best suited for schools to influence implementation of high efficiency equipment that would not have taken place without the program. For schools, a single contract ESCO approach may be followed, who works closely with customers in trying to overcome funding barriers for energy efficiency upgrades and difficulties carrying through on energy efficiency plans, commonly occurring in schools. The specialized program vendors will be primarily responsible for marketing activities, and for contacting and recruiting participants. Direct mail and company website information are effective channels for outreach activities. For schools, say, Vectren will need to work with schools and school districts to develop the program. The basic concept of the program will be addressed in the development of a memorandum of understanding between the two utilities and the school administration. A technical description and a promotional brochure for circulation to individual districts and schools will need to be developed. This program will engage the following channels for delivery of these key aspects the program: • Product Supply o Equipment suppliers—public agencies often have contracts or standing agreements with equipment vendors. These vendors are influential in equipment selection. They should be educated about energy-efficient alternatives and incentives available to make these alternatives cost-competitive. Suppliers provide the most direct link between the program and the consumers in this sector's existing facilities. As appropriate, the incentives for equipment purchased under the

program can be split or directed to these vendors.

  - Architects and engineers—for major renovations, expansions, and new building construction, the A&Es are most influential in the decisions that affect a facility's energy use. Properly educated and convinced to use building efficiency best practices, they can specify qualifying program measures to public sector construction projects.
  - Other trade allies—installation and maintenance contractors can provide services associated with some of the qualifying measures, such as HVAC diagnostic tune-ups, identifying and sealing air and duct leaks, and refrigeration system maintenance. Again, as appropriate, incentives offered on qualifying measures can be directed to or split with these providers to encourage them to promote program participation.
- Program and Product Information Distribution
  - Trade allies & affinity groups—as both deliverers of program products and potential participants in the program, all vendors of the qualifying equipment and service measures should be engaged to receive and also provide to their public school clients information about the program measure benefits, how the program works, and assistance with the incentive process.
  - Utility staff—while Vectren will engage a contractor to implement the program, the staff (e.g. account managers) has ongoing contact with many of these customers. The staff will provide information about the program benefits, measures, and process.
  - Implementation contractor will develop and distribute information about the qualifying products and participation assistance by establishing and leveraging existing relationships with the product and service suppliers.
- Program Promotion
  - Trade allies & affinity groups —all vendors of high efficiency equipment and service measures should be engaged to make their public school clients aware of the program and encourage their participation by recommending high-efficiency equipment models and diagnostic services.
  - Public agency news publications—leverage existing communication channels used by public schools to make facility managers aware of the program opportunities.
  - Direct mail—there is a limited and known target market that can be reached by mail with specially crafted letters, program applications, and other promotional materials.
  - A key responsibility of the implementation contractor is outreach and effective promotion of the program to the target market.
- Education

  Opportunities to educate both the trade allies, who themselves are both potential participants and delivery channels, and public school facility managers include:

  - Bill inserts and/or direct mail
  - Agency and industry training sessions (piggybacking program

	education on these meetings) o Industry and technology experts who meet individually with facility decision makers and provide auditor training o Facility audit reports
Evaluation, Measurement and Verification Requirements	The evaluation methodology and data collection proposed for the program are guidelines that reflect current measurement and verification (M&V) practices. The ultimate M&V requirements for this program will conform with the state protocols. Metrics for Gauging Program Success • Energy savings from completed projects • Number of participating facilities or projects • Number of facility audits requested/completed • The percent of recommended measures installed per completed audit • Understanding of and satisfaction with the program by target market customer and upstream providers/participants Data Collection Approaches Data for evaluating the program will come from the following sources: • Impact Evaluation o Tracking system data for all projects o On-site inspection and sub-metering of a sample of custom projects to verify operation as reported o customer energy consumption data for engineering or statistical analyses of impacts • Process Evaluation Evaluation of program design and implementation performance will be conducted by gathering and analyzing data through a variety of surveys and interviews, including: o Surveys of target market customers (participants and nonparticipants) o Surveys of public facility equipment suppliers and service providers who participate and/or promote the program o Interviews with the implementation contractor and program staff o Review of program documents and tracking system data Impact Evaluation Methodology The program will record energy savings and peak load reductions from the rebate applications processed. For prescriptive measures, recorded savings will use the per-unit deemed savings values. Because prescriptive measures are established technologies and data are available demonstrating the reliability of savings, it will not be necessary to conduct customer-level billing analyses or metering studies on these projects. However, some projects will be inspected for independent verification of installation and operation as reported. For custom measure projects, the gross savings need to be estimated based on engineering models and estimates. The M&V assessment will necessarily require pre/post building simulation modeling, billing analyses and/or sub-metering of select projects to verify savings. Assessment of free-rider and free-driver effects, if deemed appropriate, may be conducted using customer billing and survey data in conjunction with established M&V

	methodologies and procedures. <u>Process Evaluation Methodology</u> Evaluation of the program implementation is important to ensure that the program is operating as intended and to provide information that can enable improvements in both the program design and implementation. Process evaluations will be undertaken and conducted throughout the program by the implementation and the M&V contractor(s) selected by Vectren. Process evaluations will assess customer understanding, attitudes about, and satisfaction with both the program and with Vectren's broader educational activities. The evaluations will make use of survey data collected by the implementation and M&V contractors. These surveys will include both customers known to have participated in the program and eligible nonparticipants. The diversity of customers in this target market, including large and small government agencies, traffic signal and street light operators, local schools and public colleges, public health facilities, and other non-profit agencies means that survey content and fielding will need to accommodate a wide variety of participation experiences. Interviews with program service providers, including auditors, will be conducted to assess satisfaction with the program and to identify problems and possible program services/implementation improvements. The M&V contractor will also help Vectren assess the performance of the program design and delivery of the products and services featured in the program, including effectiveness of the marketing and educational materials, effectiveness of advertising and promotional campaigns and messages, effectiveness of the trade ally involvement, and whether implementation milestones are met adequately and on schedule. These evaluations will use data maintained by the implementation contractor, information provided by Vectren, and customer survey data.
Program Schedule	The Business Schools program is a Core program and is already part of the current Vectren portfolio and will continue to operate through PY 2019. The following table provides a schedule of key milestones:

Key Milestones	Timing
Assign internal program manager and staff	Anticipated in late 2013 or early 2014.
Select and contract with program implementation contractor(s)	2014, Q2 or immediately upon program approval
Finalize program design	2014, Q2
Pre-rollout program development: Prepare marketing materials and incentive applications Develop activity and incentive processing protocols Identify qualified auditors, contractors, and trade allies	2014, Q3 and Q4
Program re-launch: Launch consumer education, marketing, and outreach All program services	2015, Q1
Prepare reports: Documentation of program activities and progress toward	Monthly throughout program

goals Reports to Commission	implementation period Quarterly, and annually
Conclude program operation for this planning cycle	2019

Estimated Participation

Participation and measure adoption estimates were developed based on the number of commercial and industrial customers in the service territory and an assessment of the attainable market potential in the area, as well as past program experience and the experience of other organizations that have offered this type of program.

Total Estimated Participation (# of SqFt or Employees)

Measure	No. of Gross Installations*	NTG Ratio	No. of Net Installations*
Total Bus Schools Program	64,817,453	0.85	55,094,835

Projected Energy Savings

The estimated energy savings are given in terms of annual kWh by measure. The savings noted in each year are incremental, that is reflective of new measures installed by customers through the program in that year. This does *not* include the cumulative impact of measures still in operation from previous years.

Total Net Incremental Electricity Savings (kWh)

Total Net Incremental Energy Savings (kWh)					
Measure	2015	2016	2017	2018	2019
Total Bus Schools Program	719,028	839,189	919,210	938,075	1,027,002
TOTAL	**719,028**	**839,189**	**919,210**	**938,075**	**1,027,002**

Customer Incentives

The incentives for this program align with those from the Custom Program.

For implementation purposes, the incentive payout is $0.13 per annual kWh saved in the first year of the project life. This corresponds with a planning and budgeting assumption where the customer incentives are set to cover 40% of the incremental cost of measures.

Administrative Requirements

Program administrative staff's role will be to ensure that:

- the implementation contractor performs all the activities associated with delivery of all components or the program, and
- educational and program messages are delivered accurately and clearly to ensure the effectiveness of program delivery and maximize customer satisfaction with the program.

The program is expected to operate according to the following administrative and total utility budget:

Total Program Budget

Total Program Budget					
	2015	2016	2017	2018	2019
Program Staff Labor Cost	$10,000	$10,000	$10,000	$10,000	$10,000
Education & Marketing Cost	$-	$-	$-	$-	$-
Evaluation Cost	$8,009	$9,750	$11,211	$12,772	$13,753
Implementation Cost	$50,058	$60,939	$70,068	$79,824	$85,957
Incentive Costs	$200,233	$243,756	$280,271	$319,297	$343,827
Total Budget	**$268,301**	**$324,445**	**$371,549**	**$421,893**	**$453,537**

Cost-Effectiveness

The cost-effectiveness metrics of the Business Schools program are as follows:

Cost Effectiveness Tests						
	TRC Ratio	TRC Benefits	TRC Costs	UCT Ratio	PCT Ratio	RIM Ratio
Bus Schools Program	**0.69**	**$2,168,631**	**$3,155,364**	**1.46**	**1.96**	**0.45**

CHAPTER 15

BUSINESS STRATEGIC ENERGY MANAGEMENT PROGRAM

Program Description	The Business Strategic Energy Management program provides energy education, technical assistance, and company-wide coaching for large commercial and industrial customers in order to drive behavioral change and transformation of company culture; thereby producing measureable improvements in energy efficiency and utilization. We recommend two SEM Improvement program tracks that use different delivery mechanisms: • One-on-One Consultative Strategic Energy Management (Consultative SEM) provides the customer with access to an energy expert who works intensively with the customer to integrate energy management into the organization's business practices by helping the customer to set up an energy management process and to implement improvements. The participating customer receives frequent and personalized attention throughout the implementation period. Touch points and milestones are agreed upon between the two parties. • Strategic Energy Management Cohort (SEM Cohort) places companies into groups that work alongside each other for one year or longer, coming together in periodic workshops, approximately quarterly, and working on their own in-between these sessions. The group setting enhances participant action as they strive to perform in front of their peers. Structured groups are composed of approximately 5 to 12 program participants sharing best practices and learning together in a group setting. The cohort is typically filled with participants from non-competing industries; however, if mutual agreement is established, competitors may participate in the same cohort. The cohort is typically established for a geographic area, as the cohort participants are expected to convene in person for workshop events. A method is developed early in the engagement to forecast baseline levels of energy consumption for each participant, and savings goals are created and measured against this baseline. To isolate energy savings attributable to the SEM efforts, any savings from equipment measures installed under other programs in the portfolio can be netted out of these savings.
Objectives	The Business Strategic Energy Management program involves appointment of an energy liaison(s) and a team within participating organizations who will regularly correspond with program representatives. The SEM program supports a systematic approach to integrating energy management into an organization's business practices and creating lasting energy management processes that produce reliable energy savings. SEM has been shown to produce larger and longer lasting energy savings when compared to other energy management offerings. Few customers, however, have the internal resources to pursue and sustain these initiatives on their own, without the support of a utility program such as this.
Target Market	The target market for the SEM program includes customers with high energy use and who generally have a BMS or other monitoring systems. Based on experience with

	similar programs offered by other entities, the best possible candidates are likely to have the following attributes: • Large manufacturing companies or commercial facilities with greater than 300 kW peak demand. • Companies with multiple sites, with operations or offices in another state or country, as they are typically more accustomed to strategic types of efforts. These customer types may have an interest in translating their practices to other locations. • Institutional customers with multiple sites, such as government, universities, or school districts. • Customers with commitment to sustainability and environmental stewardship. • Customers in regulated industries, as they tend to have a high familiarity with process improvement. • Companies that have well established management systems like quality or safety, or those using continuous improvement practices like Lean or Six Sigma. • On-going participation in other EE programs in the portfolio, as they will already be familiar with the concepts. • Companies in a stable or rapid growth mode, as they are likely to have significant resources dedicated towards expansion and optimization. Market research completed for this study indicates that 35% of large C&I customers have an individual on staff that is charged with managing the efficiency of energy operations. This statistic shows that there are companies with an eye toward these issues already that may be prime candidates for participation. It also shows that there is much room for further expansion and adoption of these concepts.
Implementation Strategy	The design relies on a Program Administrator and Energy Management Providers, with roles as described below. **Program Administrator** refers to the staff that delivers the program and manages its administrative functions, such as marketing, customer recruitment, and results tracking. This will be handled by Vectren staff, along with a third-party contractor. **Energy Management Providers** (EMPs) are firms and personnel with specific knowledge and expertise who work with customers to achieve SEM savings. Due to the specialized nature of the SEM consulting, Energy Management Providers must have a combination of the following: • Experience in customer consulting and change management. • Experience with continuous improvement methodologies such as LEAN and Six Sigma. • Experience in engaging customer personnel at all levels, particularly executives. • Experience in using and deploying management systems such as quality, environmental impact, and safety; these can be at the third-party certification level, such as for ISO 9001, ISO 14001 or OSHAS 18001, respectively. Ideally the contractor would have familiarity in deploying the ISO 50001 standard for energy management systems. • Technical expertise for understanding production process and operations to identify energy savings opportunities. • Established track record in deploying utility-based SEM programs, driving energy savings along with customer change and customer satisfaction.

	<u>Overview of Activities</u> During the implementation of this program, the program staff will be involved in several activity areas: • Recruitment and screening of customers- The Program Administrator will create initial outreach plans and preliminary customer target lists. Potential SEM program participants will be screened on the size of their connected load and also on factors including history of implementing energy efficiency projects, experience with other continuous improvement programs, general responsiveness of plant personnel, etc. Screening will take place through discussions with account managers and preliminary conversations with prospective customers. • Gaining customer commitment- As part of the screening process, participating customers will commit to the following: o An on-site executive-level sponsor o Dedicated program budget o Access to key human resources (such as time allocation and training) o The inclusion of an energy continuous improvement statement within existing corporate goals o A training program for new and existing personnel • Assignment of an Energy Management Provider (EMP) – An Energy Management Provider will be assigned to each customer. In many cases, the Energy Management Provider will have been involved during customer recruitment. The Energy Management Provider will have primary responsibility for implementing the program and working with customers and will have three roles: o SEM Project manager — coordinate customer communication and meetings, develop all program reports o Organizational Facilitator(s) — conduct initial Energy Management Assessment (EMA), provide ongoing customer coaching, maintain customer satisfaction, and provide input to energy maps and savings models. The EMP will be responsible for identifying and cultivating an energy champion or team leader. o Savings modeler — develops energy maps and savings models, create energy savings memos. The EMP provides technical assistance to participating customers to understand current energy use, identify opportunities to reduce energy use, and to set energy-use reduction goals. <u>Integration with other programs</u> The SEM program delivery will be integrated with other programs. Customers that have already completed capital equipment upgrades under existing programs or are currently participating in capital measure programs can gain further efficiency gains through SEM programs. If capital measures are identified during the course of participation in SEM programs, they can be submitted for incentives under the appropriate existing capital measure programs.
Issues, Risks, and Risk Management Strategies	The most challenging aspect of a SEM program is maintaining long-term customer commitment because it directly affects savings persistence. To ensure customer commitment, the customer must clearly understand the following:

	• The level of staff time, management review, and other resources they are committing • The services such as consulting and training they will receive • The benefits they will obtain, such as a more systematic and proactive approach to managing energy In addition, the customer participation agreement, expectation management, and robust measurement and verification approach reinforce the customer commitment to the program. Managing Expectations Successful efforts involve setting rigorous expectations through ongoing meetings between the participating customer and the EMP, as well as the Program Administrator and Vectren staff. • Participating Customer and Program Administrator. To ensure that the customer maintains momentum and arrives at an agreed upon success point, a Stage-gate approach is recommended. This includes clearly defined stages based on progress indicators such as the existence of an energy goal, consistent meetings of an energy team, and the engagement of employees in energy awareness. • Program Administrator and Vectren. A periodic review meeting on a quarterly basis brings together Vectren staff, the Program Administrator, and the Energy Management Provider to discuss each SEM participant with respect to successes, challenges, and overall progress. If it is determined that a customer's progress is lagging, they will agree to next steps, including increased engagement scope and discussions with the customer to ensure that they understand program support may be withdrawn if they do not improve performance. Data Confidentiality Working with customers' energy and production data is vital to the tracking of progress in this program. These data are frequently proprietary and competition-sensitive, so steps must be taken to establish a secure mechanism and procedure for sharing and storage of data.
Marketing and Outreach	Customers will be recruited into the SEM program through one-on-one contacts. To achieve goals, the program will likely need to target two- to three-times the participation goal. This recruitment process will build an SEM customer participant pipeline, wherein potential SEM participants can be monitored as their priorities and business situations change over time. The one-on-one recruiting process builds on familiarity and trust, providing the basis for successful engagements. Often, utility relationships with customers are concentrated at the facility or maintenance-manager level. The strategic and organizational nature of SEM usually requires that the decision around program participation be made at the executive level. Therefore, customer recruiting requires a two-prong approach at both the facility management level and the executive level. Vectren should leverage the highest-level relationships it has with its large customers, including any peer relationships that Vectren executives may have with customer executives. Attendance or participation in meetings or conferences on sustainable business practices or on Lean Manufacturing, as well as participation in trade associations may also aid in recruiting participants. The key marketing message should be that Vectren is supporting customers to more strategically manage energy, and is asking that its customers invest in their future by

	building an organizational foundation for energy management. Vectren provides the consultative resources to support its customers as they go through this change, and will provide incentives for energy saved as a result of this effort. Given the specific and targeted nature of this effort, marketing will rely heavily upon presentations and letter templates, supported by brochures and case study materials. It is important for the marketing materials to: • Provide a basic understanding of the concept of SEM and the program. • Outline the compelling business case (benefits and costs) of participation. • Connect the SEM offering to the existing portfolio of Vectren programs. • Include case studies and success stories. • Identify the two tracks for participation in the program: Consultative and Cohort. For the Cohort SEM program, the message should reflect that via participation in the cohort, customers gain peer group benefits, such as sharing results and ideas and positive peer pressure from cohort presentations. This addresses the lower degree of the individualized support that is provided in Consultative SEM.
Evaluation, Measurement and Verification Requirements	A method is developed early in the engagement to forecast baseline levels of energy consumption for each participant, and savings goals are created and measured against this baseline. To isolate energy savings attributable to the SEM efforts, any savings from equipment measures installed under other programs in the portfolio can be netted out of these savings. <u>Site-Level Data Requirements</u> Ensuring that appropriate information is in place and subsequently managed will support the customer's use of data to manage energy as a controllable cost and enable to properly demonstrate true savings. Example data requirements include: • The customer authorizes Vectren to provide their energy usage data to the Program Administrator and Energy Management Provider. While hourly usage data are not required, the hourly data, together with hourly production data, enable development of better facility-wide energy models, provide more detailed information about actual facility performance, and also makes it easier to demonstrate change. If hourly usage data are available, but production data is only available monthly, then the hourly usage data are somewhat less valuable. • The customer will provide the Vectren Program Manager and Energy Management Provider with production data as well as any other energy driver data such as headcount, operating hours, and weather. • The customer will provide this data for the three years, or as much history as is available, preceding program participation. • The customer will work with the Energy Management Provider to develop a facility energy model. This effort involves supporting the program team during an onsite Energy Map exercise, providing information regarding energy efficiency measures installed prior to and during program participation, and answering other questions related to energy performance. • After participation in the Vectren energy management program, the customer will continue to acquire and analyze energy related data, and make energy management decisions based on this information.

EM&V Requirements

Because the program design recommends that incentives be paid on verified energy savings, third-party verification of reported project-level savings will be required. The program design assumes that this function will be provided by an independent evaluation firm under contract to the Program Administrator.

In addition, an independent third-party contractor will be hired to evaluate the impact of the program. The contractor will use the measurement and verification data collected by the program implementer to determine gross savings by project and customer for both demand and energy.

A comprehensive process evaluation will be conducted in the first year to develop program logic models, identify strategies that have been successful, customer satisfaction, and opportunities to improve program participation and increase savings. The evaluation contractor will use best practice methodologies when conducting process evaluations including, but not limited to, stakeholder interviews, customer surveys, program-ally interviews, tracking systems review, and assessment of quality assurance and quality control. Subsequent evaluation will be done in the third year to determine the effect of program improvements.

Impact evaluation data will include the hourly data collected as part of customer measurement and verification, production data, operating conditions, any significant changes to the facilities that would affect energy use, such as a new building addition or change in process.

Program Schedule

The Business Strategic Energy Management program is a newly recommended Core Plus program that would begin in PY 2015 and operate through PY 2019. The following table provides a schedule of key milestones:

Key Milestones	Timing
Assign internal program manager and staff	Anticipated in late 2013 or early 2014.
Select and contract with program implementation contractor(s)	2014, Q1
Finalize program design	2014, Q2
Pre-rollout program development: Prepare marketing materials and messaging Identify energy management partners/liaisons Identify list of likely participants	2014, Q3 and Q4
Program rollout: Launch consumer education, marketing, and outreach. All program services	2015, Q1
Prepare reports: Documentation of program activities and progress toward goals Reports to Commission	Monthly throughout program implementation period Quarterly, and annually
Conclude program operation for this planning cycle	2019

Estimated Participation

Participation and measure adoption estimates were developed based on the number of commercial and industrial customers in the service territory and an assessment of the attainable market potential in the area, as well as past program experience and the experience of other organizations that have offered this type of program.

Total Estimated Participation (# of SqFt or Employees)

Measure	No. of Gross Installations*	NTG Ratio	No. of Net Installations*
SEM	8,903,615	0.85	7,568,073

Projected Energy Savings

The estimated energy savings are given in terms of annual kWh by measure. The savings noted in each year are incremental, that is reflective of new measures installed by customers through the program in that year. This does *not* include the cumulative impact of measures still in operation from previous years.

Total Net Incremental Electricity Savings (kWh)

Total Net Incremental Energy Savings (kWh)					
Measure	2015	2016	2017	2018	2019
SEM	831,550	1,663,100	2,757,200	3,588,750	3,588,750
TOTAL	**831,550**	**1,663,100**	**2,757,200**	**3,588,750**	**3,588,750**

Customer Incentives

Incentives provided to the customer will cover the cost of supporting that customers' participation in program, including education, energy coaching, periodic meetings, and the like.

Administrative Requirements

The Business Strategic Energy Management program will be administered through an implementation contractor. The Utility's role will be to ensure that:

- the implementation contractor performs all the activities associated with delivery of all components or the program, and
- Vectren's educational and program messages are delivered accurately and clearly to ensure the effectiveness of program delivery and maximize customer satisfaction with the program.

The program is expected to operate according to the following administrative and total utility budget:

Total Program Budget

Total Program Budget					
	2015	2016	2017	2018	2019
Program Staff Labor Cost	$75,000	$75,000	$50,000	$50,000	$50,000
Education & Marketing Cost	$8,316	$16,631	$27,572	$35,888	$35,888
Evaluation Cost	$8,316	$16,631	$27,572	$35,888	$35,888
Implementation Cost	$16,631	$33,262	$55,144	$71,775	$71,775
Incentive Costs	$41,578	$83,155	$137,860	$179,438	$179,438
Total Budget	**$149,840**	**$224,679**	**$298,148**	**$372,988**	**$372,988**

Cost-Effectiveness

The cost-effectiveness metrics of the Business Strategic Energy Management program are as follows:

Cost Effectiveness Tests						
	TRC Ratio	TRC Benefits	TRC Costs	UCT Ratio	PCT Ratio	RIM Ratio
Bus SEM	1.61	$1,821,203	$1,133,881	1.61	-	0.43

CHAPTER 16

BUSINESS AND MULTIFAMILY NEW CONSTRUCTION PROGRAM

Program Description	The Business and Multi Family New Construction program is designed to accelerate the incorporation of energy efficient design, construction, and operation in new business and multifamily residential buildings. The program provides facility designers, builders, and owner-builders with training, design assistance, and incentives for installing high efficiency end-use equipment and building envelope measures in newly constructed and renovated facilities. The program has the following components, directed mainly to the commercial and industrial design and construction community: training, design assistance, and financial incentives. Training • General training in best practices—provides technical workshops and other technical developmental activities for the design and engineering community to familiarize and educate them on energy efficient design methods and new technologies. Design Assistance • Directed to upstream providers of design and construction services—architects and engineers (A&E), designers/builders, and contractors. • Project-specific assistance—will provide a participant with the services of a consulting engineer to evaluate the cost-effectiveness of energy-saving measures under consideration and to recommend measures that may have been overlooked. • The program will also provide design and engineering consultants with validation of their prospective energy efficiency projects in presentations to clients. Incentives • Directed to upstream providers of design and construction services but also available to facility owners. • Custom rebates payable on a per-kWh-saved basis when compared with “standard” design and equipment installations. • Participant must submit project energy savings generated by approved building energy modeling software to be eligible for installation rebate. The program is currently available to commercial and industrial customers, but would incorporate a new component to target the multifamily market in 2015.
Objectives	The purpose of the Business and Multi Family New Construction program is to greatly improve the energy efficiency of all newly constructed facilities and facilities that are completely renovated or reconstructed in the Vectren service territory. It aims to instill and accelerate adoption of design and construction practices so that new commercial and industrial facilities are more energy efficient than the current stock. The focus of the program is on integrated design.

	The program has several objectives: • Change building design and construction practices used by architects and engineers, contractors, and owners to include all cost-effective energy efficiency designs and equipment. • Capture "lost opportunities" to reduce electric demand and energy usage in the commercial and industrial sector by providing participants with design assistance and custom rebates or performance contracting for the construction of energy-efficient buildings and facilities.
Target Market	The target market for the Business and Multi Family New Construction program is decision makers for the design and/or construction of new facilities and renovation contractors and developers. This program will cover both new constructions and buildings/facilities undergoing "major renovation," defined as buildings where multiple major systems are undergoing significant upgrades. While the energy and peak load savings resulting from this program will be accrued by the building owners/tenants, the key target market of the program are the professionals most responsible for the design and equipment decisions—architects and engineers, design/builders, developers, and contractors.
Implementation Strategy	<u>Overview of Activities</u> The implementers will be involved in several activity areas: • Identification and recruitment of upstream market actors for program participation and delivery channel activities • Education: including development and operation of training seminars for A&Es, designers, builders, and developers; and development and distribution of educational publications • Marketing: including development and distribution of program materials in collaboration with Vectren, and design and construction professionals who will be both program participants and promoters • Design and Project Assistance: engineering and technical support for project development, and cost-effectiveness assessment, and estimation of financial incentives; design review and post-installation inspections • Rebate Processing: fulfillment house to receive, review and verify applications; and either pay or submit rebates to Vectren for payment • Program Performance Tracking and Improvement: including project tracking and documentation of project measures, rebate submittals and payments, opportunities to improve the program • Reporting: including reporting of program activities to meet regulatory and internal requirements, in particular progress toward program goals <u>Education Overview</u> Education is a key component of the Business and Multi Family New Construction program. The market will change through training, education and demonstration. The program will increase confidence in the performance and benefits of increased energy efficiency (better performance, lower fuel bills, increased comfort, reduced maintenance, etc.). Designers and builders will be encouraged to implement more energy-efficient strategies to increase energy efficiency through the program. Emphasis on the additional benefits of comprehensive energy efficiency improvements and continual maintenance to retain savings will demonstrate an overall cost-effectiveness that can be achieved without the need for financial incentives over the longer term.

	Ongoing deployment of these strategies will become "standard" practice by these same designers and builders in additional projects, affecting long-term market transformation. To accomplish this, the program will offer several forms of education as noted above: • Training seminars will be taught by experts in specific aspects of high-efficiency building design and construction. Many utilities offer these no-fee sessions on an ongoing basis. In addition to teaching key principles and an understanding of the program, they will provide Vectren with an excellent opportunity to develop strong relationships and build trust with this influential group, which is also the key target market for the program. • Vectren will consider linking the training activities with nationwide certification programs for builders, inspectors, lighting designers and with continuing education programs for architects and engineers. • Publications with technical information, practical advice, and persuasive messages will be developed. These can be included in newsletters directed to design/build, published in trade journals, sent in direct mail, distributed at seminars, and made available on a website page designed for this audience.
Issues, Risks, and Risk Management Strategies	Currently, several market barriers inhibit the participation in new construction programs. Such barriers, which the program implementation activities will address, include: • Perception of Increased Cost: Many designers and builders feel that increased building performance costs more, and that it is not cost-effective. • Risk Aversion: Historically, the commercial design and engineering community has been particularly slow to adopt new technologies or solutions. A&Es prefer to design and install systems and buildings using familiar technologies and designs. Liability issues are also a concern. • First Cost vs. Lifecycle Cost Considerations: Building developers are very concerned with first cost considerations as they often must build within a pre-determined budget. As such, they are reluctant to consider high-efficiency measures, which usually cost more. • Limited Technical Information: Designers and owners have limited familiarity with new products, technologies and their applications, and their associated benefits that extend beyond energy savings (comfort, durability, health, productivity and maintenance). ENERGY STAR and other available training programs are whittling away at this problem. • Inadequate Operational Procedures: Building systems are usually not tested to ensure that they perform as designed. In addition, owners frequently fail to implement an ongoing maintenance and quality assurance procedure to properly operate the equipment. <u>A special note on multifamily participants.</u> • Because multifamily buildings are a hybrid between residential and business customers, it is important to ensure that program tariffs and eligibility requirements are inclusive of both residential and commercial rate classes, such that potential participants are not stuck in limbo when they apply. Equally as important is to clearly delineate responsibility for implementation contractors who will be servicing this hybrid customer group.
Marketing and Outreach	Effective implementation of the program depends on marketing and outreach activities working effectively. • Because they are the key decision makers in new commercial and industrial facility design, it will be advantageous for Vectren to work "upstream"—with

	the design and construction community. Direct personal relationship building is a key component of outreach activities. For the program to be effective, Vectren must educate these professionals on how and why to upgrade their building practices. Once convinced, these design and construction influencers can promote the program and the efficiency benefits to their clients as well as to their suppliers and subcontractors. These professionals are really both participants and delivery channels for the program. • Articles and advertising in building design and engineering trade publications. • Bill inserts to existing commercial and industrial customers to alert them to opportunities available for major renovations and expansions to their facilities. • A program implementation contractor will implement the program on behalf of Vectren, including providing assistance with the utilities' direct marketing; recruiting and providing education to upstream channels; providing rebate fulfillment services; and tracking and reporting program activities and achievements toward goals.
Evaluation, Measurement and Verification Requirements	The data collection guidelines proposed for the program reflects current measurement and verification (M&V) practices. The M&V requirements and methods used to evaluate this program will conform to the state protocols. <u>Metrics for Gauging Program Success</u> • Number of projects completed • Energy savings associated with facilities built through participation in the program • Number of training seminar attendees and/or trades people certified in energy-efficient building principles • Increase in receptivity/adoption of energy-efficient building practices by designers, builders, and developers to measure the effectiveness of the marketing and education activities and progress towards market transformation <u>Data Collection Approaches</u> The data required for evaluating the program will depend on the methodology chosen. They will likely include the following sources and information: • Billing and/or metered use data • Engineering estimates of measure savings • Local weather data • Program tracking system for measures installed, rebates paid, and building characteristics • Upstream and building owner surveys regarding program awareness, satisfaction with the program and with the project results, understanding and perceived savings from measures, tenant characteristics, and program influence on design and construction decisions • Program implementer, and Vectren staff surveys <u>Impact Evaluation Methodology</u> The impact evaluation will likely use a variety of techniques to assess energy savings due to the program in new facilities/buildings. The analysis techniques will likely include performing engineering analyses and perhaps metering as well, to determine whether the participant facilities operate as designed and achieve the expected savings. Site visits will be conducted as part of the engineering and metering data collection; additional site visits may be added at a later date if any installation problems are identified. Site visits

	will be used to determine if measures were installed as expected and to gather data for the engineering analysis of the homes as built. For this program perhaps above all others, the understanding and availability of baseline values for facility consumption will be critical to an assessment of energy savings. Assessment of free-rider and free-driver effects, if deemed appropriate, may be conducted using survey data in conjunction with established M&V methodologies and procedures. Process Evaluation Methodology Program participants, local inspectors, and program implementation staff will be interviewed for the process evaluation. These interviews will focus on the construction and inspection processes of facilities built to new standards. In addition to obtaining information on facility characteristics, the participant (builder and/or owner) survey will ask questions about the effectiveness of program promotional activities, participant and occupant satisfaction with the facility, and whether the occupants have encountered any problems with their new equipment. During the first year, the process evaluation will focus on program implementation, administration, and delivery. Interviews will be used to determine if the program is encouraging new construction practices and if the upstream market stakeholders and facility owners are finding the education useful. If there are difficulties in obtaining participation during the first year, the evaluation may be expanded to include focus group interviews with a larger sample of designers, builders, developers, and facility owners. During the second year, the process evaluation will assess how well program changes recommended during the first-year process evaluation are being implemented.
Program Schedule	The Business and Multi Family New Construction program will operate during PY 2015 through PY 2019. This is a Core Plus program that is ongoing in Vectren's current portfolio, but a new multifamily component will come online in 2015. The following table provides a schedule of key milestones:

Key Milestones	Timing
Assign internal program manager and staff	Anticipated in late 2013 or early 2014.
Select and contract with program implementation contractor(s)	2014, Q1
Finalize program design	2014, Q2
Pre-rollout program development: Build designer/builder network Develop designer/builder training curriculum and schedule Develop marketing strategies Develop procedures for tracking activities and documenting results	2014, Q3 and Q4
Program re-launch: All program services Offer designer/builder education Offer design assistance and rebates	2015, Q1
Prepare reports: Documentation of program activities and progress toward goals	Monthly throughout program implementation period

Reports to Commission	Quarterly, and annually
Development of multifamily component	2014, Q1 to Q4
Program launch of multifamily component	2015, Q1
Conclude program operation for this planning cycle	2019

Estimated Participation

Participation and measure adoption estimates were developed based on the number of commercial and industrial customers in the service territory and an assessment of the attainable market potential in the area, as well as past program experience and the experience of other organizations that have offered this type of program.

Total Estimated Participation (# of SqFt or Employees)

Measure	No. of Gross Installations*	NTG Ratio	No. of Net Installations*
Total Bus & MF NC	38,226,677	0.95	36,315,343

Projected Energy Savings

The estimated energy savings are given in terms of annual kWh by measure. The savings noted in each year are incremental, that is reflective of new measures installed by customers through the program in that year. This does *not* include the cumulative impact of measures still in operation from previous years.

Total Net Incremental Electricity Savings (kWh)

Total Net Incremental Energy Savings (kWh)					
Measure	**2015**	**2016**	**2017**	**2018**	**2019**
Total Bus & MF NC	1,108,657	1,385,749	1,530,080	1,902,365	2,008,604
TOTAL	**1,108,657**	**1,385,749**	**1,530,080**	**1,902,365**	**2,008,604**

Customer Incentives

Customer incentives will cover 40% of the incremental cost of measures. Also, program administrators can express this as a certain dollar incentive per package or tier level.

Administrative Requirements

Program administrative staff's role will be to ensure that:

- the implementation contractor performs all the activities associated with delivery of all components or the program, and
- educational and program messages are delivered accurately and clearly to ensure the effectiveness of program delivery and maximize customer satisfaction with the program.

The program is expected to operate according to the following administrative and total utility budget:

Total Program Budget

Total Program Budget					
	2015	2016	2017	2018	2019
Program Staff Labor Cost	$25,000	$25,000	$25,000	$25,000	$25,000
Education & Marketing Cost	$22,523	$27,925	$30,468	$37,440	$38,576
Evaluation Cost	$10,511	$13,032	$14,218	$17,472	$18,002
Implementation Cost	$90,091	$111,700	$121,873	$149,762	$154,305
Incentive Costs	$150,151	$186,166	$203,121	$249,603	$257,174
Total Budget	**$298,276**	**$363,822**	**$394,680**	**$479,277**	**$493,057**

Cost-Effectiveness

The cost-effectiveness metrics of the Business and Multi Family New Construction program are as follows:

Cost Effectiveness Tests						
	TRC Ratio	TRC Benefits	TRC Costs	UCT Ratio	PCT Ratio	RIM Ratio
Bus & MF NC	**2.06**	**$5,972,921**	**$2,896,189**	**3.66**	**5.04**	**0.75**

CHAPTER 17

SMALL BUSINESS DIRECT INSTALL PROGRAM

Program Description	The Business Direct Install program provides a suite of targeted, highly cost-effective measures to small businesses in a quickly deployable program delivery mechanism, along with education and program support to help business customers reduce their energy bills. The program will provide several direct-install measures free of charge, such as lighting replacements, pre-rinse sprayers, programmable thermostats, pipe wrap, vending machine controls, and smart power strips. The program also connects customers with other programs in the portfolio and a network of qualified trade allies/contractors that can install follow-on measures to provide deeper energy savings. The Business Direct Install program has several components: • Walk-Through Audits—These are on-site assessments used to identify energy efficiency opportunities; audit reports contain specific recommendations, including expected costs, energy savings, and resource referrals. • Direct Installation of Measures—During the audit visit, the auditor will install a package of low-cost energy-saving measures, at no additional charge to the customer, to immediately improve the energy performance of the building. • Assistance with Additional Measure Installations—Vectren will provide cash rebates to audit participants who install additional measures recommended from the audit, as well as assistance on how to access rebates offered under other Vectren programs for additional recommended measures. • Workforce Training and Participation—The program will provide for the training and utilization of qualified auditors and contractors located within the community to provide program services. • Focus on Non-Profit Customers—Customers in the underserved category of qualifying 501c3, non-profit organizations will receive focused recruitment and technical assistance, enhanced direct-install measures suites, and higher incentive levels for follow-on measures.
Objectives	The program is part of a long-term strategy to raise awareness of energy savings opportunities among business customers and to help them take action using incentives offered by the utilities and state programs. The program will achieve several objectives: • Improve customer understanding of how their buildings use energy and how they can use it more effectively for less money • Procure immediate energy savings through installation of energy-saving measures • Encourage installation of additional energy-saving measures recommendations with additional incentives • Develop a workforce trained in assessing and improving building energy efficiency that can, ultimately, transform the market • Aid business customers' perception of Vectren as their partner in reducing energy use
Target Market	The target market for the Business Direct Install program is small business customers,

	defined as those who do not exceed 150 kW in energy demand per month. A special sub-focus of the program is helping non-profit businesses save energy. Contractors who can provide quality audits and installation of recommended measures are also targeted for participation to deliver the program services.
Implementation Strategy	The implementation strategy will incorporate the following components: <u>Walk-Through Audits</u> • Trained auditors provide businesses with a walk-through examination of their building using standard audit software for identifying existing conditions related to electric energy usage. The auditor will identify specific energy saving opportunities that could be installed by the contractor upon approval of a job scope by the customer. The auditor will review the billing history of the customer, anticipated costs and savings of the measures, along with information on financial resources available to help defray first-costs. <u>Direct Installation of Measures</u> • The auditor will install a package of measures, simple installations known to improve the energy efficiency of buildings, during the walk-through audit. • These measures will be installed at no charge to the audit participants. • These installations will provide immediate benefit to participants and savings attributable to the program. • At the conclusion of the site visit, customers will be provided with a check list of preliminary recommendations from the audit, to be followed within one week by a full report generated by the audit software. The program will take credit for only the installed measures at the time of the audit and verified installed measures recommended by the audit. <u>Assistance with Additional Measure Installations</u> • Providing customers with help in implementing the audit recommendations is key to the success of the program. The program will offer resources that include both financial incentives and installation assistance. • The customer will have access to incentives available from other Vectren programs to reduce the cost of installing remaining recommendations. • Vectren will contract with an implementation contractor who will manage and oversee that contractors are qualified/certified to install other measures recommended in the walk-through audit. <u>Workforce Training and Participation</u> Vectren will make use of auditors qualified to perform the walk-through audits and contractors knowledgeable about energy-efficient products and other measures likely to be recommended in the audit report. This can be achieved through development of relationships with electrical and general contracting trade allies, as well as community groups. Under the program, The implementers will: • Provide training to ensure the walk-through auditors demonstrate an understanding of building science principles and understanding of the Vectren programs. • Ensure that the walk-through auditors are familiar with all the incentives programs available to customers as well as provide education to customers. <u>Overview of Implementation Activities</u>

	During implementation, program staff will be involved in several activity areas: • Audits and customer reports: ensuring that auditors prepare reports that are comprehensive and comply with guidelines. • Recruitment and training of audit and installation contractors; verifying that all contractors on the qualified list have appropriate testing equipment and data analysis software. • Monitoring of auditors who perform the walk-through audit and contractors who install recommended measures. This includes scheduling of home audit appointments and verification of inspections and measure installations. • Program marketing: including development and distribution of program materials in collaboration with Vectren, and promotional campaigns in collaboration with upstream participants. • Program education and outreach: including development of promotional campaigns to promote in coordination with other incentive programs. • Incentive processing: this includes payments to contractors for the installation of the measures during audits and to customers for installation of recommended measures. • Program activity tracking: including tracking of audit requests, audit activities, customer actions, and incentive tracking. • Reporting: development of documentation to meet reporting requirements for the Commission. <u>Education Overview</u> Education is a large component of the Business Direct Install program, and will be both publicly distributed and customer-specific. • The customer reports generated following the walk-through audits provide one-on-one educational opportunities. Using data from their buildings, customers will learn how they use energy and how they can use it more wisely. • The workforce training provides an opportunity to educate equipment and construction contractors about the benefits of energy efficiency and about the program.

Issues, Risks, and Risk Management Strategies	All of the implementation activities—the educational component, together with outreach and marketing of the program, will address the following barriers to achieve the educational and energy savings goals of the program:
	• Contractor Participation—A limited supply of qualified contractors with the skills to diagnose and market energy efficiency improvements can limit program potential. A solution is the development of a local network of qualified professionals to provide audit and installation services and to promote the program to residential energy customers. The implementers will:
	  o Offer technical training to participating trade contractors, including classroom and field sessions and cover building science principles, diagnostic testing and installation best practices. Consider including certification to ensure the training is effective and valuable as a selling point for the contractors.
	  o Offer sales and business process training to help contractors succeed in selling and delivering energy efficiency services, including procedures for quality assurance, employee training, and understanding program incentives or financing.

	• Consumer Financing and Incentives—The up-front costs of making the recommended improvements may limit customer participation in the program or delay projects unless customers have a way to get them done and to pay for them.
	  o Some program sponsors partner with financial institutions to provide low-interest loans.
	  o Some program sponsors offer cash rebates directly through the program or in collaboration with other program.
	  o Additionally, having easy access to contractors who can complete the work provides incentive to act on the audit recommendations. Offering referrals or a list of qualified/participating contractors can be a help.
	• Marketing and Education—Customers may not be familiar with energy efficiency and the benefits it can provide for improving comfort, as well as saving energy. Marketing activities can educate them about the benefits.
	  o Vectren will communicate known partner offers and make customers aware through bill inserts, web site or some targeted direct mail. These tactics can help educate businesses about the benefits of the energy improvements and how they can take advantage of the program.
	  o The program implementation contractor will work to develop and enlist the help of participating contractors to promote and educate customers about the program.
	• Quality Assurance—Consumers should be assured that the program offers reliable, high quality services.
	  o The program should have a quality assurance plan to aid delivery of the program services, provide protocols for contractor reporting, and support program evaluation.
	  o Participating auditors and contractors have sufficient training to perform program audits and installations and sets standards for the number of work inspections completed by participation contractors.
	• Challenges with Customer Engagement – If participants begin to demonstrate that they are not engaging with follow-on measures or further audit recommendations, or that they are not fully invested in the program, the implementer may consider adding a nominal audit fee of $50, simply to discourage participation by businesses that have no intention of fully utilizing the program. The audit fee may be credited back to the customer if they proceed with further installation of the measures.

Marketing and Outreach	Marketing and outreach in the Business Direct Install program will employ the following strategies: • Vectren will develop awareness through direct marketing—e.g., bill inserts, newsletters, website, broadcast and print media, and direct mail. The program information may need to be mailed frequently to customers. • Walk-Through auditors—part of auditors' services can and should include making customers aware of this program and the incentives available for installation of high-efficiency measures. • Coordination of marketing efforts with the Business Prescriptive and other Vectren programs.
Evaluation,	The evaluation methodology and data collection proposed for the Business Direct Install

Measurement and Verification Requirements	program are guidelines that reflect current measurement and verification (M&V) practices. The ultimate M&V requirements for this program will conform with the State protocols. <u>Metrics for Gauging Program Success</u> Primary: • Improvement in customer understanding how to improving energy efficiency • Number of walk-through audits completed • Number of direct installation packages delivered • Number of audits that result in documented energy efficiency improvements in this and other Vectren programs • Number of participating audit and energy efficiency improvement contractors • Periodic summary of 'before' and 'after' audit data from the implementation contractor • Results of all diagnostics tests • Projected energy savings from the audit • Number of customer audit fees received and reimbursed • Customer satisfaction with the program and the products • Participation in other Vectren programs Secondary: • Information related to which of the recommended measures were installed • Energy usage reduction in buildings that have had audits • Program implementation costs incurred <u>Data Collection Approaches</u> Vectren will collect and submit data that meet the reporting requirements. The participating contractors who conduct the audits and/or perform the energy improvements will provide much of the data. The contractors should provide at least the following: • Name, address, and contact information (including email address if possible) of customer • Results of assessment and diagnostic tests • Recommended improvements • Estimated cost of improvement • Estimated energy savings • Summary of completed improvements and test-out results Data will also be collected through surveys of Vectren business customers and participating contractors to aid the process and impact evaluation, assess participant satisfaction, and identify opportunities for program improvement. The surveys may be conducted by the implementation and M&V contractors. Customer billing data prior to and following program participation will be required to assess energy use and improvement opportunities, and assess and/or verify savings for the payment of customer incentives. The program will have a tracking system to house the program activity information and enable regulatory reporting.

	<u>Impact Evaluation Methodology</u> The first step is to establish a pre-participation energy use "baseline" based on customer bills, followed by post-participation tracking of energy use through bills. This, together with information on exact measures installed during the audit and additional measures installed as provided by the installation contractors, would allow assessment of customer energy savings. The M&V contractor will determine the appropriate means of estimating savings attributable to the program; that is, net savings, including both free-ridership and spillover. Spillover may be particularly relevant to this program. Because the major thrust of the program is to encourage customers to think about the building as an entire system, it would not be surprising to find that customers continue to make additional energy-related improvements on their own (i.e., without incentives) after participation in the program. <u>Process Evaluation Methodology</u> The Business Direct Install program is a relatively complex program, involving audits, direct installation of measures, delivery of an audit report with additional recommendations, and even subsequent installations with either the implementation contractor or other contractors. Process evaluations throughout the program will be critical to ensure that the program is operating as intended and to provide information that can enable improvements in both the program design and delivery of services. Process evaluations will assess customer understanding, attitude about, and satisfaction with the program and with Vectren's other educational activities and materials. They will obtain feedback from the contractors who perform installations and audits. The evaluations will make use of survey data collected by the implementation and M&V contractors. Process evaluation will be conducted throughout the program by the implementation and M&V contractors selected by Vectren.
Program Schedule	The Business Direct Install program is already part of the current Vectren portfolio and will continue to operate through PY 2019. The following table provides a schedule of key milestones:

Key Milestones	Timing
Assign internal program manager and staff	Anticipated in late 2013 or early 2014.
Select and contract with program implementation contractor(s)	2014, Q2 or immediately upon program approval
Finalize program design	2014, Q2
Pre-rollout program development: Auditor/contractor training and recruitment	2014, Q3 and Q4
Program re-launch: Launch consumer marketing and outreach Perform audits and improvements	2015, Q1
Prepare reports: Documentation of program activities and progress toward goals Reports to Commission	Monthly throughout program implementation period Quarterly, and annually
Conclude program operation for this	2019

	planning cycle	

Estimated Participation

Participation and measure adoption estimates were developed based on the number of commercial and industrial customers in the service territory and an assessment of the attainable market potential in the area, as well as past program experience and the experience of other organizations that have offered this type of program.

Total Estimated Participation (# of SqFt or Employees)

Measure	Option	No. of Gross Installations*	NTG Ratio	No. of Net Installations*
Screw-in	Mix of LEDs/CFLs	16,830,146	1.00	16,830,146
High-Bay Fixtures	T5	2,202,586	1.00	2,202,586
Linear Fluorescent	T5	9,475,524	1.00	9,475,524
HID	T5	5,440,731	1.00	5,440,731
Air-Cooled Chiller - Maintenance		85,151	1.00	85,151
Water-Cooled Chiller - Maintenance		63,648	1.00	63,648
RTU - Maintenance		2,997,662	1.00	2,997,662
Heat Pump - Maintenance		2,215,022	1.00	2,215,022
Water Heater - Faucet Aerators/Low Flow Nozzles		7,781,406	1.00	7,781,406
Thermostat - Clock/Programmable		5,318,525	1.00	5,318,525
Pre-rinse Sprayer		386,913	1.00	386,913
Interior Lighting - LED Exit Lighting		18,904,650	1.00	18,904,650

Projected Energy Savings

The estimated energy savings are given in terms of annual kWh by measure. The savings noted in each year are incremental, that is reflective of new measures installed by customers through the program in that year. This does *not* include the cumulative impact of measures still in operation from previous years.

Total Net Incremental Electricity Savings (kWh)

Total Net Incremental Energy Savings (kWh)						
Measure	Option	2015	2016	2017	2018	2019
Screw-in	Mix of LEDs/CFLs	570,652	564,428	552,655	632,858	704,515
High-Bay Fixtures	T5	95,265	88,684	90,545	23,922	11,144
Linear Fluorescent	T5	431,375	534,412	625,594	764,478	818,081
HID	T5	276,246	253,897	227,170	68,226	33,529
Air-Cooled Chiller - Maintenance		7,633	8,766	9,902	11,522	12,176
Water-Cooled Chiller -		5,464	6,305	7,165	8,469	8,970

Maintenance						
RTU - Maintenance		278,696	320,036	361,465	420,353	442,040
Heat Pump - Maintenance		160,786	183,905	207,386	241,035	253,574
Water Heater - Faucet Aerators/Low Flow Nozzles		43,553	49,623	55,507	63,865	66,259
Thermostat - Clock/Programmable		92,950	107,546	122,423	143,494	153,889
Pre-rinse Sprayer		7,598	8,668	9,703	11,169	11,596
Interior Lighting - LED Exit Lighting		6,467	7,320	8,189	9,392	9,777
TOTAL		**1,976,684**	**2,133,588**	**2,277,704**	**2,398,782**	**2,525,551**

Customer Incentives

Under this program, incentives are provided in several forms and to both customers and contractors who provide the audit and direct installation services. Incentives go to customers in the form of direct installation of measures during the audit visit and in the form of rebates for installation of recommended, follow-on measures that fall under the umbrella of other programs.

Audit contractors are also eligible to receive incentives under this program. Vectren will pay for the cost of materials for the measures that auditors install during the audits. This means that the auditor receives payment from the customer for the cost of the audit and from Vectren for the cost of materials in the package of measures installed during the audit. Customers are also free to contract with the same contractor to install additional measures, for additional cost, if the contractor offers this service.

Administrative Requirements

Vectren will administer the Business Direct Install program through an implementation contractor. Vectren's role will be to ensure that

- the implementation contractor performs all the activities associated with delivery of all components or the program, and
- educational and program messages are delivered accurately and clearly to ensure the effectiveness of program delivery and maximize customer satisfaction with the program.

The program is expected to operate according to the following administrative and total utility budget:

Total Program Budget

Total Program Budget					
	2015	2016	2017	2018	2019
Program Staff Labor Cost	$25,000	$25,000	$25,000	$25,000	$25,000
Education & Marketing Cost	$50,847	$57,250	$63,079	$71,441	$73,621
Evaluation Cost	$25,423	$28,625	$31,540	$35,720	$36,810
Implementation Cost	$127,117	$143,125	$157,699	$178,602	$184,052
Incentive Costs	$508,468	$572,498	$630,794	$714,410	$736,206
Total Budget	**$736,856**	**$826,498**	**$908,112**	**$1,025,174**	**$1,055,689**

Cost-Effectiveness

The cost-effectiveness metrics of the Residential Home Energy Assessment program are as follows:

Cost Effectiveness Tests						
	TRC Ratio	TRC Benefits	TRC Costs	UCT Ratio	PCT Ratio	RIM Ratio
Bus Direct Install	**1.85**	**$6,808,569**	**$3,675,085**	**1.85**	**-**	**0.56**

About EnerNOC

EnerNOC's Utility Solutions Consulting team is part of EnerNOC's Utility Solutions, which provides a comprehensive suite of demand-side management (DSM) services to utilities and grid operators worldwide. Hundreds of utilities have leveraged our technology, our people, and our proven processes to make their energy efficiency (EE) and demand response (DR) initiatives a success. Utilities trust EnerNOC to work with them at every stage of the DSM program lifecycle – assessing market potential, designing effective programs, implementing those programs, and measuring program results.

EnerNOC's Utility Solutions deliver value to our utility clients through two separate practice areas – Implementation and Consulting.

- Our Implementation team leverages EnerNOC's deep "behind-the-meter expertise" and world-class technology platform to help utilities create and manage DR and EE programs that deliver reliable and cost-effective energy savings. We focus exclusively on the commercial and industrial (C&I) customer segments, with a track record of successful partnerships that spans more than a decade. Through a focus on high quality, measurable savings, EnerNOC has successfully delivered hundreds of thousands of MWh of energy efficiency for our utility clients, and we have thousands of MW of demand response capacity under management.
- The Consulting team provides expertise and analysis to support a broad range of utility DSM activities, including: potential assessments; end-use forecasts; integrated resource planning; EE, DR, and smart grid pilot and program design and administration; load research; technology assessments and demonstrations; evaluation, measurement and verification; and regulatory support.

The team has decades of combined experience in the utility DSM industry. The staff is comprised of professional electrical, mechanical, chemical, civil, industrial, and environmental engineers as well as economists, business planners, project managers, market researchers, load research professionals, and statisticians. Utilities view EnerNOC's experts as trusted advisors, and we work together collaboratively to make any DSM initiative a success.

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ELECTRIC DEMAND SIDE MANAGEMENT: MARKET POTENTIAL STUDY AND ACTION PLAN

Volume 3: Detailed Appendices: Market Potential Study

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MARKET PROFILES

Market profiles describe electricity use by sector, segment, end use and technology in the base year of the study (2011). The market profiles are given for average buildings and new vintages.

As explained in Chapter 2, a market profile includes the following elements:

- **Market size** is a representation of the number of customers in the segment. For the residential sector, it is number of households. In the commercial sector, it is floor space measured in square feet. For the industrial sector, it is number of employees.
- **Saturations** define the fraction of buildings with the specific technologies. (e.g., homes with electric space heating)
- **UEC (unit energy consumption) or EUI (energy-use index)** describes the amount of energy consumed in the base year by a specific technology in buildings that have the technology. We use UECs expressed in kWh/household for the residential sector, and EUIs expressed in kWh/square foot or kWh/employee for the commercial and industrial sectors respectively.
- **Intensity** for the residential sector represents the average energy use for the technology across all households in the base year. It is computed as the product of the saturation and the UEC and is defined as kWh/household for electricity. For the commercial and industrial sectors, intensity, computed as the product of the saturation and the EUI, represents the average use for the technology across all floor space or all employees in the base year.
- **Usage** is the annual energy use by a technology/end use in the segment. It is the product of the market size and intensity and is quantified in GWh for electricity.

This appendix presents the following market profiles:

- Residential market profiles by segment (Table A-1 through Table A-2)
- Commercial market profiles by building type (Table A-3 through Table A-13)
- Industrial market profiles (Table A-15 through Table A-18)

Table A-1 Single Family Electric Market Profile, 2011

		Average Market Profile				New Units			
End Use	**Technology**	**Saturation**	**UEC (kWh)**	**Intensity (kWh/HH)**	**Usage (GWh)**	**Saturation**	**UEC (kWh)**	**Intensity (kWh/HH)**	**Compared to Average**
Cooling	Central AC	80.6%	3,082.1	2,485.05	256.7	85.5%	2,335	1,995.68	-24%
Cooling	Room AC	9.1%	1,162.4	105.43	10.9	9.3%	998	92.36	-14%
Cooling	Air-Source Heat Pump	10.1%	2,431.3	245.04	25.3	11.1%	1,738	192.69	-29%
Cooling	Geothermal Heat Pump	0.1%	2,158.6	2.16	0.2	0.1%	2,028	2.03	-6%
Heating	Electric Resistance	6.4%	8,724.4	560.05	57.8	6.4%	6,548	420.33	-25%
Heating	Furnace	12.3%	9,160.6	1,127.06	116.4	12.3%	6,875	845.90	-25%
Heating	Air-Source Heat Pump	10.1%	9,226.5	627.54	64.8	11.1%	4,199	465.47	-33%
Heating	Geothermal Heat Pump	0.1%	3,559.1	3.56	0.4	0.1%	3,359	3.36	-6%
Water Heating	Water Heater <=55 gal	34.5%	2,144.3	1,085.47	112.1	36.2%	2,878	1,043.13	-8%
Water Heating	Water Heater > 55 gal	3.8%	3,351.6	128.56	13.3	4.0%	3,068	123.55	-8%
Interior Lighting	Screw-in	100.0%	1,068.7	1068.66	110.4	100.0%	1,149	1,148.56	7&
Interior Lighting	Linear Fluorescent	100.0%	123.6	123.60	12.8	100.0%	140	140.22	13%
Interior Lighting	Specialty	100.0%	473.9	473.94	49.0	100.0%	551	551.38	16%
Exterior Lighting	Screw-in	100.0%	260.3	260.30	26.9	100.0%	278	277.87	7%
Appliances	Clothes Washer	95.0%	70.0	66.48	6.9	96.9%	47	45.57	-33%
Appliances	Clothes Dryer	89.6%	538.3	482.41	49.8	92.3%	373	344.04	-31%
Appliances	Dishwasher	71.1%	291.3	207.02	21.4	73.2%	200	146.36	-31%
Appliances	Refrigerator	100.0%	756.1	756.10	78.1	100.0%	526	526.33	-30%
Appliances	Freezer	38.6%	602.3	232.33	24.0	39.7%	418	166.06	-31%
Appliances	Second Refrigerator	31.6%	792.6	250.19	25.8	32.5%	519	168.60	-35%
Appliances	Stove	67.9%	473.2	321.13	33.2	69.9%	473	330.81	0%
Appliances	Microwave	95.4%	112.1	106.91	11.0	97.3%	112	109.04	0%
Electronics	Personal Computers	71.2%	262.3	186.79	19.3	73.3%	270	197.81	3%
Electronics	Monitor	71.2%	52.2	37.17	3.8	73.3%	270	197.81	-3%
Electronics	Laptops	57.3%	113.0	64.79	6.7	59.1%	116	68.65	3%
Electronics	TVs	281.1%	213.3	599.45	61.9	289.5%	220	636.97	3%
Electronics	Printer/Fax/Copier	99.7%	40.2	40.07	4.1	102.7%	39	40.19	-3%
Electronics	Set-top Boxes/DVR	281.1%	135.5	308.81	39.3	289.5%	135	391.37	0%
Electronics	Devices and Gadgets	100.0%	60.0	60.00	6.2	103.0%	60	61.80	0%
Miscellaneous	Pool Pump	10.7%	1,500.0	160.71	16.6	10.7%	1,500	160.71	0%
Miscellaneous	Pool Heater	1.2%	4,981.0	59.30	6.1	1.2%	4,583	54.55	-8%
Miscellaneous	Hot Tub / Spa	4.9%	950.0	46.54	4.8	4.9%	950	46.54	0%
Miscellaneous	Well Pump	6.0%	561.0	33.39	3.4	6.0%	561	33.39	0%
Miscellaneous	Furnace Fan	73.4%	527.1	386.75	39.9	73.4%	526	386.07	0%
Miscellaneous	Miscellaneous	100.0%	17.4	17.39	1.8	100.0%	17	17.39	0%
Total				**12,792.2**	**1,321.3**			**11,272.0**	**-11.9%**

Table A-2 Multi Family Electric Market Profile, 2011

		Average Market Profile				New Units			
End Use	**Technology**	**Saturation**	**UEC (kWh)**	**Intensity (kWh/HH)**	**Usage (GWh)**	**Saturation**	**UEC (kWh)**	**Intensity (kWh/HH)**	**Compared to Average**
Cooling	Central AC	78.2%	1,042.2	815.46	16.0	82.9%	781	647.56	-25%
Cooling	Room AC	8.8%	435.9	38.37	0.8	9.0%	372	33.42	-15%
Cooling	Air-Source Heat Pump	9.8%	812.1	79.43	1.6	10.3%	581	59.66	-28%
Cooling	Geothermal Heat Pump	0.1%	674.1	0.67	0.0	0.1%	634	0.63	-6%
Heating	Electric Resistance	19.7%	2,777.2	548.12	10.8	19.7%	2,139	422.14	-23%
Heating	Furnace	31.6%	2,916.1	921.36	18.1	31.6%	2,246	709.59	-23%
Heating	Air-Source Heat Pump	9.8%	2,677.3	261.85	5.2	10.3%	1,806	185.49	-33%
Heating	Geothermal Heat Pump	0.1%	2,006.6	2.01	0.0	0.1%	1,895	1.90	-6%
Water Heating	Water Heater <=55 gal	55.0%	2,022.3	1,112.46	21.9	57.8%	1,853	1,070.38	-8%
Water Heating	Water Heater > 55 gal	6.1%	2,155.6	131.76	2.6	6.4%	1,975	126.77	-8%
Interior Lighting	Screw-in	100.0%	701.2	701.19	13.8	100.0%	764	763.73	9%
Interior Lighting	Linear Fluorescent	100.0%	103.7	103.66	2.0	100.0%	119	119.03	15%
Interior Lighting	Specialty	100.0%	294.1	294.11	5.8	100.0%	350	349.68	19%
Exterior Lighting	Screw-in	100.0%	113.2	113.24	2.2	100.0%	120	119.55	6%
Appliances	Clothes Washer	57.7%	59.9	34.59	0.7	58.9%	40	23.71	-33%
Appliances	Clothes Dryer	54.5%	478.5	260.90	5.1	56.2%	331	186.17	-31%
Appliances	Dishwasher	51.9%	291.3	151.26	3.0	53.5%	200	106.94	-31%
Appliances	Refrigerator	100.0%	755.8	755.83	14.9	100.0%	526	526.13	-30%
Appliances	Freezer	12.6%	602.1	76.1	1.5	13.0%	418	54.42	-31%
Appliances	Second Refrigerator	5.8%	616.3	35.50	0.7	5.9%	403	23.92	-35%
Appliances	Stove	87.4%	456.1	398.77	7.8	88.3%	456	402.81	0%
Appliances	Microwave	93.2%	112.1	104.45	2.1	95.0%	112	106.54	0%
Electronics	Personal Computers	57.4%	262.3	150.51	3.0	59.1%	270	159.39	3%
Electronics	Monitor	57.4%	112.1	104.45	2.1	59.1%	51	29.96	-3%
Electronics	Laptops	55.2%	113.0	62.41	1.2	56.9%	116	66.13	3%
Electronics	TVs	204.2%	213.3	435.56	8.6	210.3%	220	462.81	3%
Electronics	Printer/Fax/Copier	51.7%	40.2	20.78	0.4	53.3%	39	20.85	-3%
Electronics	Set-top Boxes/DVR	204.2%	135.5	276.69	5.4	210.3%	135	284.36	0%
Electronics	Devices and Gadgets	100.0%	30.0	30.00	0.6	103.0%	30	30.90	0%
Miscellaneous	Pool Pump	0.0%	1,500.0	-	-	0.0%	1,500	-	0%
Miscellaneous	Pool Heater	0.0%	4,981.0	-	-	0.0%	4583	-	-8%
Miscellaneous	Hot Tub / Spa	1.1%	950.0	10.47	0.2	1.1%	950.0	10.47	0%
Miscellaneous	Well Pump	0.0%	556.0	-	-	0.0%	556.0	-	0%
Miscellaneous	Furnace Fan	74.2%	273.3	202.88	4.0	74.2%	273	202.53	0%
Miscellaneous	Miscellaneous	100.0%	85.7	85.71	1.7	100.0%	86	85.71	0%
Total				**8,246.1**	**162.2**			**7,393.3**	**-10.3%**

Table A-3 Small Office Electric Market Profile, 2011

	Average Market Profiles					New Units			
End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Compared to Average
Cooling	Air-Cooled Chiller	6.3%	5.8	0.37	3.1	7.1%	5	0.32	-23%
Cooling	Water-Cooled Chiller	3.0%	6.3	0.19	1.6	3.4%	5	0.17	-19%
Cooling	Roof top AC	73.0%	5.2	3.80	31.7	82.7%	4	3.37	-22%
Cooling	Air Source Heat Pump	0.2%	5.3	0.01	0.1	0.2%	4	0.01	-26%
Cooling	Geothermal Heat Pump	0.0%	3.5	0.00	0.0	0.0%	3	0.00	-17%
Cooling	Other Cooling	3.3%	3.5	0.11	0.9	3.7%	3	0.12	-8%
Heating	Air Source Heat Pump	0.2%	5.5	0.01	0.1	0.2%	5	0.01	-13%
Heating	Geothermal Heat Pump	0.0%	3.7	0.00	0.0	0.0%	3	0.00	-18%
Heating	Electric Room Heat	3.2%	5.9	0.19	1.6	3.2%	5	0.17	-12%
Heating	Electric Furnace	28.2%	6.2	1.76	14.7	28.2%	6	1.55	-12%
Ventilation	Ventilation	100.0%	1.1	1.09	9.1	100.0%	1	0.88	-19%
Water Heating	Water Heating	58.0%	0.8	0.48	4.0	58.0%	1	0.46	-4%
Interior Lighting	Screw-in	100.0%	1.6	1.56	13.1	100.0%	1	1.16	-26%
Interior Lighting	High-Bay Fixtures	100.0%	0.3	0.29	2.4	100.0%	0	0.16	-46%
Interior Lighting	Linear Fluorescent	100.0%	2.5	2.49	20.8	100.0%	2	2.24	-10%
Exterior Lighting	Screw-in	100.0%	0.2	0.15	1.3	100.0%	0	0.09	-41%
Exterior Lighting	HID	100.0%	0.8	0.79	6.6	100.0%	1	0.54	-32%
Exterior Lighting	Linear Fluorescent	100.0%	0.1	0.06	0.5	140.0%	0	0.09	-3%
Refrigeration	Walk-in Refrigerator	5.1%	-	-	-	7.1%	-	-	0%
Refrigeration	Reach-in Refrigerator	5.1%	0.2	0.01	0.1	7.1%	0	0.01	-47%
Refrigeration	Glass Door Display	5.1%	-	-	-	7.1%	-	-	0%
Refrigeration	Open Display Case	5.1%	-	-	-	7.1%	-	-	0%
Refrigeration	Icemaker	5.1%	0.2	0.01	0.1	7.1%	0	0.01	-12%
Refrigeration	Vending Machine	5.1%	0.2	0.01	0.1	7.1%	0	0.01	-29%
Food Preparation	Oven	2.1%	0.3	0.01	0.1	2.9%	0	0.01	-1%
Food Preparation	Fryer	2.1%	-	-	-	2.9%	-	-	0%
Food Preparation	Dishwasher	2.1%	0.7	0.01	0.1	2.9%	1	0.02	-24%
Food Preparation	Hot Food Container	2.1%	-	-	-	2.9%	-	-	0%
Office Equipment	Desktop Computer	100.0%	1.0	0.96	8.0	140.0%	1	1.33	-1%
Office Equipment	Laptop	100.0%	0.1	0.15	1.2	140.0%	0	0.21	-1%
Office Equipment	Server	100.0%	0.7	0.68	5.7	140.0%	1	0.90	-5%
Office Equipment	Monitor	100.0%	0.2	0.18	1.5	140.0%	0	0.24	-3%
Office Equipment	Printer/Copier/Fax	100.0%	0.2	0.23	1.9	110.0%	0	0.24	-6%
Office Equipment	POS Terminal	20.5%	0.1	0.02	0.2	24.6%	0	0.02	-16%
Miscellaneous	Non-HVAC Motors	22.0%	0.6	0.14	1.1	30.8%	1	0.18	-5%
Miscellaneous	Pool Pump	0.0%	-	-	-	0.0%	-	-	0%
Miscellaneous	Pool Heater	0.0%	-	-	-	0.0%	-	-	0%
Miscellaneous	Miscellaneous	100.0%	0.9	0.93	7.8	100.0%	1	0.93	0%
Total				**16.7**	**139.2**			**15.4**	**-7.4%**

Table A-4 Large Office Electric Market Profile, 2011

End Use	Technology	Average Market Profiles: Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)	New Units: Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Compared to Average
Cooling	Air-Cooled Chiller	2.0%	4.4	0.09	0.8	2.3%	3	0.07	-29%
Cooling	Water-Cooled Chiller	38.5%	4.2	1.63	15.3	43.7%	3	1.46	-21%
Cooling	Roof top AC	36.4%	5.1	1.86	17.5	41.3%	4	1.62	-23%
Cooling	Air Source Heat Pump	5.2%	5.2	0.27	2.5	5.9%	4	0.23	-24%
Cooling	Geothermal Heat Pump	1.3%	3.4	0.04	0.4	1.5%	3	0.04	-16%
Cooling	Other Cooling	3.2%	3.4	0.11	1.0	3.7%	3	0.11	-8%
Heating	Air Source Heat Pump	5.2%	4.8	0.25	2.3	5.2%	4	0.21	-17%
Heating	Geothermal Heat Pump	1.3%	3.2	0.04	0.4	1.3%	3	0.03	-19%
Heating	Electric Room Heat	0.0%	5.0	-	-	0.0%	5	-	-9%
Heating	Electric Furnace	29.1%	5.3	1.53	14.4	29.1%	5	1.40	-9%
Ventilation	Ventilation	100.0%	2.7	2.70	25.4	100.0%	2	2.21	-18%
Water Heating	Water Heating	55.3%	0.9	0.50	4.7	55.3%	1	0.48	-4%
Interior Lighting	Screw-in	100.0%	1.2	1.21	11.4	100.0%	1	0.90	-25%
Interior Lighting	High-Bay Fixtures	100.0%	0.1	0.11	1.0	100.0%	0	0.06	-46%
Interior Lighting	Linear Fluorescent	100.0%	3.3	3.28	30.9	100.0%	3	2.96	-10%
Exterior Lighting	Screw-in	100.0%	0.1	0.11	1.1	100.0%	0	0.07	-40%
Exterior Lighting	HID	100.0%	0.4	0.43	4.1	100.0%	0	0.30	-32%
Exterior Lighting	Linear Fluorescent	100.0%	0.0	0.02	0.2	140.0%	0	0.03	-3%
Refrigeration	Walk-in Refrigerator	44.9%	-	-	-	62.9%	-	-	0%
Refrigeration	Reach-in Refrigerator	44.9%	0.0	0.02	0.2	62.9%	0	0.02	-47%
Refrigeration	Glass Door Display	44.9%	0.2	0.09	0.8	62.9%	0	0.12	0%
Refrigeration	Open Display Case	44.9%	0.1	0.04	0.4	62.9%	0	0.05	0%
Refrigeration	Icemaker	44.9%	0.1	0.02	0.2	62.9%	0	0.03	-12%
Refrigeration	Vending Machine	44.9%	0.1	0.04	0.4	62.9%	0	0.04	-32%
Food Preparation	Oven	25.8%	0.1	0.03	0.3	36.1%	0	0.04	-1%
Food Preparation	Fryer	25.8%	0.2	0.04	0.4	36.1%	0	0.06	-1%
Food Preparation	Dishwasher	25.8%	0.3	0.07	0.6	36.1%	0	0.07	-24%
Food Preparation	Hot Food Container	25.8%	0.1	0.02	0.2	36.1%	0	0.03	-4%
Office Equipment	Desktop Computer	100.0%	2.3	2.33	21.9	140.0%	2	3.23	-1%
Office Equipment	Laptop	100.0%	0.4	0.36	3.4	140.0%	0	0.50	-1%
Office Equipment	Server	100.0%	0.3	0.28	2.6	140.0%	0	0.37	-5%
Office Equipment	Monitor	100.0%	0.4	0.43	4.1	140.0%	0	0.59	-3%
Office Equipment	Printer/Copier/Fax	100.0%	0.2	0.19	1.7	100.0%	0	0.17	-6%
Office Equipment	POS Terminal	12.7%	0.0	0.00	0.0	13.9%	0	0.00	-16%
Miscellaneous	Non-HVAC Motors	89.6%	0.4	0.34	3.2	125.4%	0	0.46	-5%
Miscellaneous	Pool Pump	0.0%	-	-	-	0.0%	-	-	0%
Miscellaneous	Pool Heater	0.0%	-	-	-	0.0%	-	-	0%
Miscellaneous	Miscellaneous	100.0%	0.7	0.75	7.0	100.0%	1	0.75	0%
Total				**19.2**	**181.1**			**18.7**	**-2.7%**

Table A-5 Restaurant Electric Market Profile, 2011

End Use	Technology	Average Market Profiles: Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)	New Units: Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Compared to Average
Cooling	Air-Cooled Chiller	1.2%	7.4	0.09	0.2	1.2%	6	0.07	-20%
Cooling	Water-Cooled Chiller	1.0%	7.5	0.08	0.1	1.1%	6	0.07	-19%
Cooling	Roof top AC	68.9%	7.7	5.29	10.0	75.8%	6	4.46	-23%
Cooling	Air Source Heat Pump	0.5%	7.7	0.04	0.1	0.6%	6	0.03	-24%
Cooling	Geothermal Heat Pump	0.1%	5.2	0.01	0.0	0.1%	4	0.01	-20%
Cooling	Other Cooling	7.9%	5.1	0.40	0.8	9.5%	5	0.45	-8%
Heating	Air Source Heat Pump	0.5%	4.5	0.02	0.0	0.5%	4	0.02	-16%
Heating	Geothermal Heat Pump	0.1%	3.0	0.00	0.0	0.1%	2	0.00	-17%
Heating	Electric Room Heat	2.1%	5.8	0.12	0.2	2.1%	5	0.10	-12%
Heating	Electric Furnace	17.8%	6.1	1.08	2.0	17.8%	5	0.95	-12%
Ventilation	Ventilation	100.0%	2.5	2.46	4.7	100.0%	2	1.57	-36%
Water Heating	Water Heating	20.9%	8.7	1.82	3.5	20.9%	8	1.75	-4%
Interior Lighting	Screw-in	100.0%	6.1	6.10	11.6	100.0%	2	2.39	-61%
Interior Lighting	High-Bay Fixtures	100.0%	0.2	0.16	0.3	100.0%	0	0.09	-46%
Interior Lighting	Linear Fluorescent	100.0%	1.4	1.36	2.6	100.0%	1	1.13	-17%
Exterior Lighting	Screw-in	100.0%	0.2	0.19	0.4	100.0%	0	0.12	-36%
Exterior Lighting	HID	100.0%	2.0	2.00	3.8	100.0%	1	1.37	-32%
Exterior Lighting	Linear Fluorescent	100.0%	0.0	0.01	0.0	140.0%	0	0.01	11%
Refrigeration	Walk-in Refrigerator	97.3%	4.1	3.99	7.6	136.2%	2	3.30	-41%
Refrigeration	Reach-in Refrigerator	97.3%	0.6	0.61	1.2	136.2%	0	0.46	-46%
Refrigeration	Glass Door Display	97.3%	2.6	2.58	4.9	136.2%	3	3.61	0%
Refrigeration	Open Display Case	97.3%	1.2	1.16	2.2	136.2%	1	1.63	0%
Refrigeration	Icemaker	97.3%	0.7	0.71	1.3	136.2%	1	0.87	-12%
Refrigeration	Vending Machine	97.3%	0.6	0.63	1.2	136.2%	0	0.56	-36%
Food Preparation	Oven	38.5%	5.2	2.01	3.8	53.8%	5	2.77	-1%
Food Preparation	Fryer	38.5%	7.8	2.99	5.7	53.8%	8	4.15	-1%
Food Preparation	Dishwasher	38.5%	6.0	2.30	4.4	53.8%	5	2.44	-24%
Food Preparation	Hot Food Container	38.5%	1.7	0.66	1.2	42.3%	2	0.69	-4%
Office Equipment	Desktop Computer	100.0%	0.2	0.21	0.4	110.0%	0	0.23	-1%
Office Equipment	Laptop	100.0%	0.0	0.03	0.1	110.0%	0	0.03	-1%
Office Equipment	Server	100.0%	0.3	0.30	0.6	110.0%	0	0.32	-5%
Office Equipment	Monitor	100.0%	0.0	0.04	0.1	110.0%	0	0.04	-3%
Office Equipment	Printer/Copier/Fax	100.0%	0.0	0.04	0.1	110.0%	0	0.04	-6%
Office Equipment	POS Terminal	100.0%	0.1	0.08	0.2	120.0%	0	0.08	-16%
Miscellaneous	Non-HVAC Motors	20.0%	0.2	0.04	0.1	28.0%	0	0.06	-5%
Miscellaneous	Pool Pump	0.0%	-	-	-	0.0%	-	-	0%
Miscellaneous	Pool Heater	0.0%	-	-	-	0.0%	-	-	0%
Miscellaneous	Miscellaneous	100.0%	1.3	1.28	2.4	100.0%	1	1.28	0%
	Total			**40.9**	**77.5**			**37.2**	**-9.1%**

Table A-6 Retail Electric Market Profile, 2011

		Average Market Profiles				New Units			
End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Compared to Average
Cooling	Air-Cooled Chiller	2.7%	3.0	0.08	1.4	2.8%	2	0.07	-21%
Cooling	Water-Cooled Chiller	0.8%	2.9	0.02	0.4	0.9%	2	0.02	-18%
Cooling	Roof top AC	55.4%	4.7	2.60	46.3	58.2%	4	2.16	-21%
Cooling	Air Source Heat Pump	4.2%	4.7	0.20	3.5	4.4%	3	0.15	-27%
Cooling	Geothermal Heat Pump	1.0%	3.2	0.03	0.6	1.1%	3	0.03	-15%
Cooling	Other Cooling	6.4%	3.1	0.20	3.5	6.4%	3	0.18	-8%
Heating	Air Source Heat Pump	4.2%	5.8	0.24	4.3	4.2%	5	0.20	-18%
Heating	Geothermal Heat Pump	1.0%	3.8	0.04	0.7	1.0%	3	0.03	-16%
Heating	Electric Room Heat	2.8%	6.0	0.17	3.0	2.8%	6	0.15	-8%
Heating	Electric Furnace	19.7%	6.3	1.25	22.1	19.7%	6	1.14	-8%
Ventilation	Ventilation	100.0%	1.1	1.10	19.6	100.0%	1	0.89	-19%
Water Heating	Water Heating	52.4%	0.9	0.47	8.3	52.4%	1	0.45	-4%
Interior Lighting	Screw-in	100.0%	2.9	2.91	51.7	100.0%	1	1.49	-49%
Interior Lighting	High-Bay Fixtures	100.0%	0.4	0.41	7.2	100.0%	0	0.22	-46%
Interior Lighting	Linear Fluorescent	100.0%	2.3	2.34	41.6	100.0%	2	2.09	-11%
Exterior Lighting	Screw-in	100.0%	0.6	0.58	10.2	100.0%	1	0.70	21%
Exterior Lighting	HID	100.0%	0.3	0.32	5.7	100.0%	0	0.22	-32%
Exterior Lighting	Linear Fluorescent	100.0%	0.0	0.01	0.1	110.0%	0	0.01	1%
Refrigeration	Walk-in Refrigerator	52.4%	0.5	0.25	4.5	57.6%	0	0.17	-41%
Refrigeration	Reach-in Refrigerator	52.4%	0.1	0.04	0.7	57.6%	0	0.02	-46%
Refrigeration	Glass Door Display	52.4%	0.3	0.16	2.9	57.6%	0	0.18	0%
Refrigeration	Open Display Case	52.4%	0.1	0.07	1.3	57.6%	0	0.08	0%
Refrigeration	Icemaker	52.4%	0.2	0.09	1.6	57.6%	0	0.09	-12%
Refrigeration	Vending Machine	52.4%	0.2	0.08	1.4	73.4%	0	0.08	-29%
Food Preparation	Oven	23.5%	0.2	0.05	0.9	32.9%	0	0.07	-1%
Food Preparation	Fryer	23.5%	0.3	0.07	1.3	32.9%	0	0.10	-1%
Food Preparation	Dishwasher	23.5%	0.5	0.11	2.0	32.9%	0	0.12	-24%
Food Preparation	Hot Food Container	23.5%	0.1	0.03	0.6	29.3%	0	0.04	-4%
Office Equipment	Desktop Computer	100.0%	0.2	0.15	2.7	125.0%	0	0.19	-1%
Office Equipment	Laptop	100.0%	0.0	0.02	0.4	125.0%	0	0.03	-1%
Office Equipment	Server	100.0%	0.2	0.21	3.8	125.0%	0	0.26	-5%
Office Equipment	Monitor	100.0%	0.0	0.03	0.5	125.0%	0	0.03	-3%
Office Equipment	Printer/Copier/Fax	100.0%	0.0	0.01	0.3	110.0%	0	0.01	-6%
Office Equipment	POS Terminal	100.0%	0.1	0.06	1.0	120.0%	0	0.06	-16%
Miscellaneous	Non-HVAC Motors	40.2%	0.4	0.16	2.9	48.2%	0	0.19	-5%
Miscellaneous	Pool Pump	0.0%	-	-	-	0.0%	-	-	0%
Miscellaneous	Pool Heater	0.0%	-	-	-	0.0%	-	-	0%
Miscellaneous	Miscellaneous	100.0%	0.6	0.56	10.0	100.0%	1	0.56	0%
	Total			**15.2**	**269.3**			**12.5**	**-17.7%**

Table A-7 Grocery Electric Market Profile, 2011

	Average Market Profiles					New Units			
End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Compared to Average
Cooling	Air-Cooled Chiller	1.9%	5.4	0.10	0.3	1.9%	4	0.08	-23%
Cooling	Water-Cooled Chiller	1.9%	5.2	0.10	0.3	1.9%	4	0.08	-18%
Cooling	Roof top AC	61.6%	8.4	5.21	13.9	61.6%	7	4.03	-23%
Cooling	Air Source Heat Pump	4.6%	8.3	0.38	1.0	4.6%	6	0.30	-23%
Cooling	Geothermal Heat Pump	1.2%	5.5	0.06	0.2	1.2%	4	0.05	-22%
Cooling	Other Cooling	7.1%	5.6	0.40	1.1	7.1%	5	0.36	-8%
Heating	Air Source Heat Pump	4.6%	6.4	0.30	0.8	4.6%	5	0.25	-14%
Heating	Geothermal Heat Pump	1.2%	4.2	0.05	0.1	1.2%	3	0.04	-18%
Heating	Electric Room Heat	0.0%	7.1	-	-	0.0%	6	-	-12%
Heating	Electric Furnace	24.4%	7.5	1.83	4.9	24.4%	7	1.61	-12%
Ventilation	Ventilation	100.0%	2.3	2.32	6.2	100.0%	2	1.71	-26%
Water Heating	Water Heating	38.3%	2.4	0.93	2.5	38.3%	2	0.89	-4%
Interior Lighting	Screw-in	100.0%	3.1	3.09	8.3	100.0%	1	1.43	-54%
Interior Lighting	High-Bay Fixtures	100.0%	0.3	0.29	0.8	100.0%	0	0.16	-46%
Interior Lighting	Linear Fluorescent	100.0%	6.2	6.21	16.6	100.0%	6	5.78	-7%
Exterior Lighting	Screw-in	100.0%	0.3	0.28	0.7	100.0%	0	0.14	-49%
Exterior Lighting	HID	100.0%	1.0	0.95	2.6	100.0%	1	0.65	-32%
Exterior Lighting	Linear Fluorescent	100.0%	0.0	0.04	0.1	140.0%	0	0.05	0%
Refrigeration	Walk-in Refrigerator	98.9%	6.9	6.81	18.2	138.5%	4	5.64	-41%
Refrigeration	Reach-in Refrigerator	98.9%	0.3	0.30	0.8	138.5%	0	0.22	-47%
Refrigeration	Glass Door Display	98.9%	12.7	12.55	33.6	138.5%	13	17.57	0%
Refrigeration	Open Display Case	98.9%	5.7	5.67	15.2	138.5%	6	7.93	0%
Refrigeration	Icemaker	98.9%	0.2	0.17	0.5	138.5%	0	0.21	-12%
Refrigeration	Vending Machine	98.9%	0.3	0.31	0.8	138.5%	0	0.21	-52%
Food Preparation	Oven	32.8%	0.7	0.22	0.6	45.9%	1	0.30	-1%
Food Preparation	Fryer	32.8%	1.0	0.32	0.9	45.9%	1	0.45	-1%
Food Preparation	Dishwasher	32.8%	1.5	0.49	1.3	45.9%	1	0.52	-24%
Food Preparation	Hot Food Container	32.8%	0.4	0.14	0.4	41.0%	0	0.17	-4%
Office Equipment	Desktop Computer	100.0%	0.1	0.14	0.4	125.0%	0	0.18	-1%
Office Equipment	Laptop	100.0%	0.0	0.02	0.1	125.0%	0	0.03	-1%
Office Equipment	Server	100.0%	0.1	0.10	0.3	125.0%	0	0.12	-5%
Office Equipment	Monitor	100.0%	0.0	0.03	0.1	125.0%	0	0.03	-3%
Office Equipment	Printer/Copier/Fax	100.0%	0.0	0.01	0.0	110.0%	0	0.01	-6%
Office Equipment	POS Terminal	100.0%	0.1	0.07	0.2	120.0%	0	0.07	-16%
Miscellaneous	Non-HVAC Motors	34.6%	0.3	0.12	0.3	41.6%	0	0.13	-5%
Miscellaneous	Pool Pump	0.0%	-	-	-	0.0%	-	-	0%
Miscellaneous	Pool Heater	0.0%	-	-	-	0.0%	-	-	0%
Miscellaneous	Miscellaneous	100.0%	0.8	0.80	2.1	100.0%	1	0.80	0%
	Total			**50.8**	**136.0**			**52.2**	**2.8%**

Table A-8 College Electric Market Profile, 2011

End Use	Technology	Average Market Profiles: Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)	New Units: Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Compared to Average
Cooling	Air-Cooled Chiller	4.6%	4.9	0.22	1.3	4.6%	4	0.18	-21%
Cooling	Water-Cooled Chiller	21.8%	4.7	1.02	5.9	21.8%	4	0.81	-21%
Cooling	Roof top AC	28.0%	4.1	1.15	6.6	28.0%	3	0.92	-20%
Cooling	Air Source Heat Pump	2.2%	3.6	0.08	0.5	2.2%	3	0.06	-22%
Cooling	Geothermal Heat Pump	0.6%	2.4	0.01	0.1	0.6%	2	0.01	-20%
Cooling	Other Cooling	3.8%	2.7	0.10	0.6	3.8%	2	0.09	-11%
Heating	Air Source Heat Pump	2.2%	6.7	0.15	0.8	2.2%	6	0.13	-15%
Heating	Geothermal Heat Pump	0.6%	4.5	0.02	0.1	0.6%	4	0.02	-19%
Heating	Electric Room Heat	2.0%	8.1	0.17	1.0	2.0%	7	0.15	-9%
Heating	Electric Furnace	15.7%	8.5	1.34	7.7	15.7%	8	1.21	-9%
Ventilation	Ventilation	100.0%	1.3	1.30	7.5	100.0%	1	1.06	-19%
Water Heating	Water Heating	30.9%	1.8	0.55	3.2	30.9%	2	0.53	-4%
Interior Lighting	Screw-in	100.0%	1.7	1.67	9.6	100.0%	1	1.48	-12%
Interior Lighting	High-Bay Fixtures	100.0%	0.2	0.16	0.9	100.0%	0	0.09	-46%
Interior Lighting	Linear Fluorescent	100.0%	2.8	2.77	15.9	100.0%	3	2.52	-9%
Exterior Lighting	Screw-in	100.0%	0.1	0.12	0.7	100.0%	0	0.05	-59%
Exterior Lighting	HID	100.0%	0.6	0.62	3.5	100.0%	0	0.42	-32%
Exterior Lighting	Linear Fluorescent	100.0%	0.0	0.00	0.0	110.0%	0	0.00	4%
Refrigeration	Walk-in Refrigerator	26.6%	0.2	0.05	0.3	29.3%	0	0.03	-41%
Refrigeration	Reach-in Refrigerator	26.6%	0.1	0.01	0.1	29.3%	0	0.01	-47%
Refrigeration	Glass Door Display	26.6%	0.1	0.03	0.2	29.3%	0	0.03	0%
Refrigeration	Open Display Case	26.6%	0.1	0.01	0.1	29.3%	0	0.01	0%
Refrigeration	Icemaker	26.6%	0.1	0.02	0.1	37.2%	0	0.02	-12%
Refrigeration	Vending Machine	26.6%	0.1	0.01	0.1	34.6%	0	0.01	-29%
Food Preparation	Oven	12.5%	0.2	0.03	0.2	16.3%	0	0.04	-1%
Food Preparation	Fryer	12.5%	0.4	0.04	0.3	16.3%	0	0.06	-1%
Food Preparation	Dishwasher	12.5%	0.5	0.07	0.4	16.3%	0	0.07	-24%
Food Preparation	Hot Food Container	12.5%	0.2	0.02	0.1	15.6%	0	0.02	-4%
Office Equipment	Desktop Computer	100.0%	0.4	0.39	2.3	125.0%	0	0.49	-1%
Office Equipment	Laptop	100.0%	0.1	0.06	0.4	125.0%	0	0.08	-1%
Office Equipment	Server	100.0%	0.2	0.19	1.1	125.0%	0	0.22	-5%
Office Equipment	Monitor	100.0%	0.1	0.07	0.4	125.0%	0	0.09	-3%
Office Equipment	Printer/Copier/Fax	100.0%	0.1	0.06	0.4	110.0%	0	0.07	-6%
Office Equipment	POS Terminal	20.8%	0.1	0.01	0.1	24.9%	0	0.01	-16%
Miscellaneous	Non-HVAC Motors	88.8%	0.2	0.14	0.8	106.6%	0	0.16	-5%
Miscellaneous	Pool Pump	4.9%	0.0	0.00	0.0	5.8%	0	0.00	3%
Miscellaneous	Pool Heater	1.2%	0.0	0.00	0.0	1.2%	0	0.00	9%
Miscellaneous	Miscellaneous	100.0%	0.3	0.34	2.0	100.0%	0	0.34	0%
Total				**13.0**	**74.8**			**11.5**	**-11.9%**

Table A-9 School Electric Market Profile, 2011

		Average Market Profiles				New Units			
End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Compared to Average
Cooling	Air-Cooled Chiller	9.7%	3.0	0.29	2.4	9.7%	2	0.23	-21%
Cooling	Water-Cooled Chiller	9.7%	2.9	0.28	2.3	9.7%	2	0.22	-21%
Cooling	Roof top AC	20.5%	2.5	0.52	4.3	20.5%	2	0.41	-20%
Cooling	Air Source Heat Pump	1.6%	2.2	0.04	0.3	1.6%	2	0.03	-22%
Cooling	Geothermal Heat Pump	0.4%	1.5	0.01	0.0	0.4%	1	0.00	-20%
Cooling	Other Cooling	2.8%	1.7	0.05	0.4	2.8%	1	0.04	-11%
Heating	Air Source Heat Pump	1.6%	4.6	0.08	0.6	1.6%	4	0.06	-15%
Heating	Geothermal Heat Pump	0.4%	3.1	0.01	0.1	0.4%	2	0.01	-19%
Heating	Electric Room Heat	0.9%	5.6	0.05	0.4	0.9%	5	0.05	-9%
Heating	Electric Furnace	6.2%	5.9	0.37	3.0	6.2%	5	0.33	-9%
Ventilation	Ventilation	100.0%	0.8	0.80	6.6	100.0%	1	0.65	-19%
Water Heating	Water Heating	23.6%	1.1	0.26	2.2	23.6%	1	0.25	-4%
Interior Lighting	Screw-in	100.0%	2.0	2.02	16.6	100.0%	2	1.78	-12%
Interior Lighting	High-Bay Fixtures	100.0%	0.3	0.33	2.7	100.0%	0	0.18	-46%
Interior Lighting	Linear Fluorescent	100.0%	1.5	1.49	12.2	100.0%	1	1.35	-9%
Exterior Lighting	Screw-in	100.0%	0.1	0.07	0.6	100.0%	0	0.03	-59%
Exterior Lighting	HID	100.0%	0.5	0.48	4.0	100.0%	0	0.33	-32%
Exterior Lighting	Linear Fluorescent	100.0%	0.0	0.00	0.0	140.0%	0	0.00	4%
Refrigeration	Walk-in Refrigerator	65.7%	0.2	0.13	1.1	92.0%	0	0.11	-41%
Refrigeration	Reach-in Refrigerator	65.7%	0.1	0.04	0.3	92.0%	0	0.03	-47%
Refrigeration	Glass Door Display	65.7%	0.1	0.09	0.7	92.0%	0	0.12	0%
Refrigeration	Open Display Case	65.7%	0.1	0.04	0.3	92.0%	0	0.06	0%
Refrigeration	Icemaker	65.7%	0.1	0.05	0.4	92.0%	0	0.06	-12%
Refrigeration	Vending Machine	65.7%	0.1	0.04	0.4	78.8%	0	0.04	-29%
Food Preparation	Oven	30.2%	0.2	0.05	0.4	36.3%	0	0.05	-1%
Food Preparation	Fryer	30.2%	0.2	0.07	0.6	36.3%	0	0.08	-1%
Food Preparation	Dishwasher	30.2%	0.3	0.10	0.9	36.3%	0	0.09	-24%
Food Preparation	Hot Food Container	30.2%	0.1	0.03	0.2	42.3%	0	0.04	-4%
Office Equipment	Desktop Computer	100.0%	0.2	0.20	1.6	140.0%	0	0.28	-1%
Office Equipment	Laptop	100.0%	0.0	0.02	0.2	140.0%	0	0.03	-1%
Office Equipment	Server	100.0%	0.2	0.19	1.5	140.0%	0	0.25	-5%
Office Equipment	Monitor	100.0%	0.0	0.04	0.3	140.0%	0	0.05	-3%
Office Equipment	Printer/Copier/Fax	100.0%	0.1	0.06	0.5	110.0%	0	0.07	-6%
Office Equipment	POS Terminal	4.2%	0.0	0.00	0.0	5.1%	0	0.00	-16%
Miscellaneous	Non-HVAC Motors	43.7%	0.1	0.05	0.4	43.7%	0	0.05	-5%
Miscellaneous	Pool Pump	1.2%	0.0	0.00	0.0	1.2%	0	0.00	3%
Miscellaneous	Pool Heater	0.3%	0.0	0.00	0.0	0.3%	0	0.00	9%
Miscellaneous	Miscellaneous	100.0%	0.2	0.23	1.9	100.0%	0	0.23	0%
	Total			**8.6**	**70.5**			**7.6**	**-11.2%**

Table A-10 Health Electric Market Profile, 2011

		Average Market Profiles				New Units			
End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Compared to Average
Cooling	Air-Cooled Chiller	19.0%	6.4	1.22	6.3	22.7%	5	1.16	-20%
Cooling	Water-Cooled Chiller	19.0%	6.1	1.17	6.0	22.7%	5	1.10	-21%
Cooling	Roof top AC	38.5%	9.0	3.47	18.0	46.1%	8	3.50	-16%
Cooling	Air Source Heat Pump	3.5%	9.0	0.32	1.6	4.2%	7	0.29	-23%
Cooling	Geothermal Heat Pump	0.9%	6.0	0.05	0.3	1.1%	7	0.08	22%
Cooling	Other Cooling	5.1%	6.0	0.31	1.6	6.0%	5	0.32	-11%
Heating	Air Source Heat Pump	3.5%	8.9	0.31	1.6	3.5%	7	0.26	-17%
Heating	Geothermal Heat Pump	0.9%	5.9	0.05	0.3	0.9%	5	0.04	-18%
Heating	Electric Room Heat	2.4%	10.6	0.25	1.3	2.4%	9	0.22	-11%
Heating	Electric Furnace	16.9%	11.1	1.88	9.7	16.9%	10	1.67	-11%
Ventilation	Ventilation	100.0%	3.5	3.55	18.4	100.0%	3	2.71	-24%
Water Heating	Water Heating	8.9%	3.1	0.27	1.4	8.9%	3	0.26	-4%
Interior Lighting	Screw-in	100.0%	1.7	1.72	8.9	100.0%	1	1.50	-13%
Interior Lighting	High-Bay Fixtures	100.0%	0.0	0.04	0.2	100.0%	0	0.02	-46%
Interior Lighting	Linear Fluorescent	100.0%	3.9	3.88	20.1	100.0%	4	3.61	-7%
Exterior Lighting	Screw-in	100.0%	0.0	0.04	0.2	100.0%	0	0.02	-53%
Exterior Lighting	HID	100.0%	0.5	0.47	2.4	100.0%	0	0.32	-32%
Exterior Lighting	Linear Fluorescent	100.0%	0.0	0.00	0.0	130.0%	0	0.00	5%
Refrigeration	Walk-in Refrigerator	87.0%	0.3	0.23	1.2	113.1%	0	0.18	-41%
Refrigeration	Reach-in Refrigerator	87.0%	0.0	0.04	0.2	113.1%	0	0.02	-47%
Refrigeration	Glass Door Display	87.0%	0.2	0.15	0.8	113.1%	0	0.20	0%
Refrigeration	Open Display Case	87.0%	0.1	0.07	0.4	113.1%	0	0.09	0%
Refrigeration	Icemaker	87.0%	0.1	0.08	0.4	113.1%	0	0.10	-12%
Refrigeration	Vending Machine	87.0%	0.1	0.07	0.4	108.8%	0	0.08	-13%
Food Preparation	Oven	35.2%	0.6	0.21	1.1	44.0%	1	0.26	-1%
Food Preparation	Fryer	35.2%	0.9	0.31	1.6	44.0%	1	0.39	-1%
Food Preparation	Dishwasher	35.2%	1.4	0.48	2.5	44.0%	1	0.45	-24%
Food Preparation	Hot Food Container	35.2%	0.4	0.14	0.7	49.3%	0	0.18	-4%
Office Equipment	Desktop Computer	100.0%	0.5	0.49	2.5	140.0%	0	0.68	-1%
Office Equipment	Laptop	100.0%	0.1	0.08	0.4	140.0%	0	0.10	-1%
Office Equipment	Server	100.0%	0.2	0.17	0.9	140.0%	0	0.23	-5%
Office Equipment	Monitor	100.0%	0.1	0.09	0.5	135.0%	0	0.12	-3%
Office Equipment	Printer/Copier/Fax	100.0%	0.1	0.12	0.6	110.0%	0	0.12	-6%
Office Equipment	POS Terminal	5.5%	0.1	0.01	0.0	6.1%	0	0.01	-16%
Miscellaneous	Non-HVAC Motors	74.1%	1.3	0.93	4.8	74.1%	1	0.88	-5%
Miscellaneous	Pool Pump	0.9%	0.0	0.00	0.0	0.9%	0	0.00	3%
Miscellaneous	Pool Heater	0.2%	0.0	0.00	0.0	0.2%	0	0.00	9%
Miscellaneous	Miscellaneous	100.0%	3.1	3.07	15.9	100.0%	3	3.07	0%
Total				**25.7**	**133.1**			**24.2**	**-5.8%**

Table A-11 Lodging Electric Market Profile, 2011

		Average Market Profiles				New Units			
End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Compared to Average
Cooling	Air-Cooled Chiller	0.3%	1.8	0.01	0.0	0.4%	1	0.01	-16%
Cooling	Water-Cooled Chiller	5.6%	1.7	0.09	0.2	6.3%	1	0.08	-20%
Cooling	Roof top AC	35.4%	4.3	1.52	3.1	40.1%	3	1.38	-19%
Cooling	Air Source Heat Pump	3.8%	4.2	0.16	0.3	4.4%	3	0.15	-19%
Cooling	Geothermal Heat Pump	1.0%	2.8	0.03	0.1	1.1%	2	0.02	-18%
Cooling	Other Cooling	39.4%	2.8	1.12	2.3	43.3%	3	1.10	-11%
Heating	Air Source Heat Pump	3.8%	3.8	0.15	0.3	3.8%	3	0.13	-15%
Heating	Geothermal Heat Pump	1.0%	2.6	0.02	0.1	1.0%	2	0.02	-15%
Heating	Electric Room Heat	5.0%	4.0	0.20	0.4	5.0%	4	0.18	-11%
Heating	Electric Furnace	40.2%	4.2	1.70	3.5	40.2%	4	1.51	-11%
Ventilation	Ventilation	100.0%	1.2	1.22	2.5	100.0%	1	0.98	-19%
Water Heating	Water Heating	17.3%	4.1	0.71	1.5	17.3%	4	0.68	-4%
Interior Lighting	Screw-in	100.0%	4.5	4.47	9.3	100.0%	3	2.78	-38%
Interior Lighting	High-Bay Fixtures	100.0%	0.1	0.09	0.2	100.0%	0	0.05	-46%
Interior Lighting	Linear Fluorescent	100.0%	0.6	0.57	1.2	100.0%	0	0.47	-17%
Exterior Lighting	Screw-in	100.0%	0.2	0.24	0.5	100.0%	0	0.13	-47%
Exterior Lighting	HID	100.0%	0.5	0.46	1.0	100.0%	0	0.31	-32%
Exterior Lighting	Linear Fluorescent	100.0%	0.0	0.00	0.0	120.0%	0	0.00	2%
Refrigeration	Walk-in Refrigerator	58.9%	0.4	0.25	0.5	70.7%	0	0.18	-41%
Refrigeration	Reach-in Refrigerator	58.9%	0.1	0.04	0.1	70.7%	0	0.02	-47%
Refrigeration	Glass Door Display	58.9%	0.3	0.16	0.3	70.7%	0	0.20	0%
Refrigeration	Open Display Case	58.9%	0.1	0.07	0.2	70.7%	0	0.09	0%
Refrigeration	Icemaker	58.9%	0.1	0.04	0.1	70.7%	0	0.05	-12%
Refrigeration	Vending Machine	58.9%	0.1	0.08	0.2	73.6%	0	0.06	-36%
Food Preparation	Oven	18.3%	0.3	0.05	0.1	22.9%	0	0.07	-1%
Food Preparation	Fryer	18.3%	0.4	0.08	0.2	22.9%	0	0.10	-1%
Food Preparation	Dishwasher	18.3%	0.7	0.12	0.3	22.9%	1	0.12	-24%
Food Preparation	Hot Food Container	18.3%	0.2	0.04	0.1	20.2%	0	0.04	-4%
Office Equipment	Desktop Computer	100.0%	0.1	0.08	0.2	110.0%	0	0.09	-1%
Office Equipment	Laptop	100.0%	0.0	0.01	0.0	110.0%	0	0.01	-1%
Office Equipment	Server	100.0%	0.1	0.06	0.1	110.0%	0	0.06	-5%
Office Equipment	Monitor	100.0%	0.0	0.01	0.0	110.0%	0	0.02	-3%
Office Equipment	Printer/Copier/Fax	100.0%	0.0	0.01	0.0	120.0%	0	0.01	-6%
Office Equipment	POS Terminal	100.0%	0.0	0.01	0.0	120.0%	0	0.01	-16%
Miscellaneous	Non-HVAC Motors	91.3%	0.1	0.12	0.2	91.3%	0	0.11	-5%
Miscellaneous	Pool Pump	39.5%	0.0	0.01	0.0	39.5%	0	0.01	3%
Miscellaneous	Pool Heater	9.9%	0.0	0.00	0.0	9.9%	0	0.00	9%
Miscellaneous	Miscellaneous	100.0%	1.0	0.95	2.0	100.0%	1	0.95	0%
	Total			**15.0**	**31.1**			**12.2**	**-18.6%**

Table A-12 Warehouse Electric Market Profile, 2011

End Use	Technology	Average Market Profiles: Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)	New Units: Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Compared to Average
Cooling	Air-Cooled Chiller	0.0%	2.3	-	-	0.0%	2	-	-22%
Cooling	Water-Cooled Chiller	0.2%	2.2	0.00	0.1	0.2%	2	0.00	-13%
Cooling	Roof top AC	18.4%	3.6	0.66	11.9	22.0%	3	0.63	-20%
Cooling	Air Source Heat Pump	0.2%	3.6	0.01	0.1	0.2%	3	0.01	-22%
Cooling	Geothermal Heat Pump	0.0%	2.4	0.00	0.0	0.1%	2	0.00	-18%
Cooling	Other Cooling	0.8%	2.4	0.02	0.3	0.9%	2	0.02	-11%
Heating	Air Source Heat Pump	0.2%	9.0	0.02	0.3	0.2%	8	0.01	-15%
Heating	Geothermal Heat Pump	0.0%	6.0	0.00	0.0	0.0%	5	0.00	-20%
Heating	Electric Room Heat	0.5%	9.4	0.05	0.9	0.5%	9	0.04	-8%
Heating	Electric Furnace	4.3%	9.9	0.43	7.7	4.3%	9	0.40	-8%
Ventilation	Ventilation	100.0%	0.4	0.36	6.6	100.0%	0	0.29	-20%
Water Heating	Water Heating	45.6%	0.3	0.15	2.7	45.6%	0	0.15	-4%
Interior Lighting	Screw-in	100.0%	0.8	0.76	13.8	100.0%	1	0.52	-31%
Interior Lighting	High-Bay Fixtures	100.0%	0.2	0.16	2.9	100.0%	0	0.09	-46%
Interior Lighting	Linear Fluorescent	100.0%	2.2	2.22	40.1	100.0%	2	2.08	-6%
Exterior Lighting	Screw-in	100.0%	0.0	0.00	0.0	100.0%	0	0.00	-43%
Exterior Lighting	HID	100.0%	0.6	0.60	10.8	100.0%	0	0.41	-32%
Exterior Lighting	Linear Fluorescent	100.0%	0.0	0.00	0.0	120.0%	0	0.00	0%
Refrigeration	Walk-in Refrigerator	18.0%	1.4	0.24	4.4	21.6%	1	0.17	-41%
Refrigeration	Reach-in Refrigerator	18.0%	-	-	-	21.6%	-	-	0%
Refrigeration	Glass Door Display	18.0%	-	-	-	21.6%	-	-	0%
Refrigeration	Open Display Case	18.0%	-	-	-	21.6%	-	-	0%
Refrigeration	Icemaker	18.0%	1.0	0.17	3.1	21.6%	1	0.18	-12%
Refrigeration	Vending Machine	18.0%	0.9	0.15	2.8	22.5%	1	0.14	-29%
Food Preparation	Oven	3.4%	0.3	0.01	0.2	4.2%	0	0.01	-1%
Food Preparation	Fryer	3.4%	-	-	-	4.2%	-	-	0%
Food Preparation	Dishwasher	3.4%	-	-	-	4.2%	-	-	0%
Food Preparation	Hot Food Container	3.4%	-	-	-	3.7%	-	-	0%
Office Equipment	Desktop Computer	100.0%	0.1	0.09	1.6	110.0%	0	0.10	-1%
Office Equipment	Laptop	100.0%	0.0	0.01	0.2	120.0%	0	0.01	-1%
Office Equipment	Server	100.0%	0.1	0.13	2.3	110.0%	0	0.13	-5%
Office Equipment	Monitor	100.0%	0.0	0.02	0.3	110.0%	0	0.02	-3%
Office Equipment	Printer/Copier/Fax	100.0%	0.0	0.01	0.2	125.0%	0	0.01	-6%
Office Equipment	POS Terminal	1.9%	0.0	0.00	0.0	2.3%	0	0.00	-16%
Miscellaneous	Non-HVAC Motors	49.9%	0.3	0.16	2.9	49.9%	0	0.15	-5%
Miscellaneous	Pool Pump	0.0%	-	-	-	0.0%	-	-	0%
Miscellaneous	Pool Heater	0.0%	-	-	-	0.0%	-	-	0%
Miscellaneous	Miscellaneous	100.0%	0.4	0.41	7.4	100.0%	0	0.41	0%
Total				**6.8**	**123.8**			**6.0**	**-12.4%**

Table A-13 Miscellaneous Commercial Electric Market Profile, 2011

		Average Market Profiles				New Units			
End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Compared to Average
Cooling	Air-Cooled Chiller	0.6%	1.7	0.01	0.1	0.7%	1	0.01	-20%
Cooling	Water-Cooled Chiller	10.5%	1.6	0.17	1.7	12.5%	1	0.17	-20%
Cooling	Roof top AC	34.5%	2.7	0.93	9.2	41.3%	2	0.86	-23%
Cooling	Air Source Heat Pump	1.7%	2.7	0.05	0.5	2.0%	2	0.04	-27%
Cooling	Geothermal Heat Pump	0.4%	1.8	0.01	0.1	0.5%	1	0.01	-20%
Cooling	Other Cooling	3.4%	1.8	0.06	0.6	4.1%	2	0.07	-8%
Heating	Air Source Heat Pump	1.7%	3.7	0.06	0.6	1.7%	3	0.06	-7%
Heating	Geothermal Heat Pump	0.4%	2.5	0.01	0.1	0.4%	2	0.01	-17%
Heating	Electric Room Heat	1.1%	3.9	0.04	0.4	1.1%	4	0.04	-8%
Heating	Electric Furnace	7.4%	4.1	0.30	3.0	7.4%	4	0.28	-8%
Ventilation	Ventilation	100.0%	0.6	0.55	5.4	100.0%	0	0.44	-20%
Water Heating	Water Heating	31.9%	1.0	0.33	3.3	31.9%	1	0.32	-4%
Interior Lighting	Screw-in	100.0%	0.9	0.94	9.3	100.0%	1	0.66	-30%
Interior Lighting	High-Bay Fixtures	100.0%	1.7	1.71	16.9	100.0%	1	0.93	-46%
Interior Lighting	Linear Fluorescent	100.0%	0.6	0.58	5.7	100.0%	1	0.52	-11%
Exterior Lighting	Screw-in	100.0%	0.2	0.24	2.4	100.0%	0	0.21	-12%
Exterior Lighting	HID	100.0%	0.5	0.50	5.0	100.0%	0	0.34	-32%
Exterior Lighting	Linear Fluorescent	100.0%	0.3	0.27	2.7	120.0%	0	0.36	11%
Refrigeration	Walk-in Refrigerator	21.6%	0.3	0.07	0.7	25.9%	0	0.05	-41%
Refrigeration	Reach-in Refrigerator	21.6%	0.0	0.01	0.1	25.9%	0	0.01	-46%
Refrigeration	Glass Door Display	21.6%	0.2	0.04	0.4	25.9%	0	0.05	0%
Refrigeration	Open Display Case	21.6%	0.1	0.02	0.2	25.9%	0	0.02	0%
Refrigeration	Icemaker	21.6%	0.1	0.01	0.1	25.9%	0	0.01	-12%
Refrigeration	Vending Machine	21.6%	0.1	0.02	0.2	23.8%	0	0.02	-29%
Food Preparation	Oven	9.1%	0.1	0.01	0.1	10.0%	0	0.01	-1%
Food Preparation	Fryer	9.1%	0.2	0.02	0.2	10.0%	0	0.02	-1%
Food Preparation	Dishwasher	9.1%	0.3	0.03	0.3	10.0%	0	0.02	-24%
Food Preparation	Hot Food Container	9.1%	0.1	0.01	0.1	10.0%	0	0.01	-4%
Office Equipment	Desktop Computer	100.0%	0.2	0.16	1.5	110.0%	0	0.17	-1%
Office Equipment	Laptop	100.0%	0.0	0.02	0.2	120.0%	0	0.03	-1%
Office Equipment	Server	100.0%	0.1	0.11	1.1	110.0%	0	0.12	-5%
Office Equipment	Monitor	100.0%	0.0	0.03	0.3	110.0%	0	0.03	-3%
Office Equipment	Printer/Copier/Fax	100.0%	0.0	0.03	0.3	125.0%	0	0.04	-6%
Office Equipment	POS Terminal	30.5%	0.1	0.02	0.2	36.6%	0	0.02	-16%
Miscellaneous	Non-HVAC Motors	59.9%	0.4	0.22	2.2	71.9%	0	0.25	-5%
Miscellaneous	Pool Pump	4.3%	0.0	0.00	0.0	5.1%	0	0.00	3%
Miscellaneous	Pool Heater	1.1%	0.0	0.00	0.0	1.1%	0	0.00	9%
Miscellaneous	Miscellaneous	100.0%	0.6	0.56	5.6	100.0%	1	0.56	0%
	Total			**8.2**	**80.5**			**6.7**	**-17.4%**

Table A-14 Traffic Signals Electric Market Profile, 2011

Average Market Profiles						New Units			
End Use	**Technology**	**Saturation**	**EUI (kWh)**	**Intensity (kWh/Sqft.)[1]**	**Usage (GWh)**	**Saturation**	**EUI (kWh)**	**Intensity (kWh/Sqft.)**	**Compared to Average**
Exterior Lighting	Traffic Lights	100.0%	323.5	323.53	0.9	100.0%	324	323.53	0%
Exterior Lighting	Crosswalk Lights	100.0%	176.5	176.46	0.5	100.0%	176	176.46	0%
Total				**500.0**	**1.3**			**500.0**	**0.0%**

[1] The overall kWh usage for traffic signals was allocated using Vectren's customer database. KWh/sqft is not a meaningful metric for traffic signals, but square footage is the unit of market size for the commercial sector, so it is translated into these terms and presented here as such solely for modeling consistency.

Table A-15 Chemicals Electric Market Profile, 2011

		Average Market Profile				New Units			
End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/empl)	Usage (GWh)	Saturation	UEC (kWh)	Intensity (kWh/empl)	Compared to Average
Cooling	Air-Cooled Chiller	2.5%	16,457.2	411.43	1.3	2.5%	12,980	324.49	-21%
Cooling	Water-Cooled Chiller	2.6%	15,784.2	415.74	1.3	2.6%	11,585	305.13	-27%
Cooling	Roof top AC	12.1%	25,313.9	3,057.03	9.9	12.1%	18,837	2,274.80	-26%
Cooling	Air-Source Heat Pump	0.1%	25,583.9	36.69	0.1	0.1%	18,988	27.23	-26%
Cooling	Geothermal Heat Pump	0.0%	17,064.4	6.12	0.0	0.0%	12,540	4.50	-27%
Cooling	Other Cooling	0.7%	16,708.8	109.19	0.4	0.7%	12,767	83.43	-24%
Heating	Air-Source Heat Pump	0.1%	63,919.0	91.66	0.3	0.1%	52,381	75.11	-18%
Heating	Geothermal Heat Pump	0.0%	42,634.0	15.28	0.0	0.0%	34,864	12.50	-18%
Heating	Electric Room Heat	0.2%	66,882.4	154.51	0.5	0.2%	62,468	144.31	-7%
Heating	Electric Furnace	1.9%	70,226.5	1,334.26	4.3	1.9%	65,592	1,246.20	-7%
Ventilation	Ventilation	100.0%	2,565.4	2,565.36	8.3	100.0%	2,264	2,263.61	-12%
Interior Lighting	Screw-in	100.0%	1,221.6	1,221.57	3.9	100.0%	842	841.91	-31%
Interior Lighting	High-Bay Fixtures	100.0%	260.0	260.01	0.8	100.0%	178	177.59	-32%
Interior Lighting	Linear Fluorescent	100.0%	3,558.5	3,558.47	11.5	100.0%	3,264	3,263.72	-8%
Exterior Lighting	Screw-in	100.0%	2.3	2.28	0.0	100.0%	1	1.31	-43%
Exterior Lighting	HID	100.0%	962.4	962.38	3.1	100.0%	683	683.05	-29%
Exterior Lighting	Linear Fluorescent	100.0%	0.3	0.28	0.0	100.0%	0	0.24	-13%
Motors	Pumps	100.0%	20,441.4	20,441.39	66.0	100.0%	20,233	20,232.79	-1%
Motors	Fans & Blowers	100.0%	5,678.2	5,678.16	18.3	100.0%	5,620	5,620.19	-1%
Motors	Compressed Air	100.0%	22,712.7	22,712.65	73.4	100.0%	22,481	22,481.45	-1%
Motors	Matl Handling	100.0%	5,678.2	5,678.16	18.3	100.0%	5,620	5,620.21	-1%
Motors	Matl Processing	100.0%	34,069.0	34,068.98	110.1	100.0%	33,721	33,721.24	-1%
Motors	Other Motors	100.0%	3,406.9	3,406.90	11.0	100.0%	3,372	3,372.12	-1%
Process	Process Heating	100.0%	10,450.8	10,450.80	33.8	100.0%	10,451	10,450.80	0%
Process	Process Cooling and Refrigeration	100.0%	11,500.0	11,499.97	37.1	100.0%	11,500	11,499.97	0%
Process	Electro-Chemical Processes	100.0%	7,281.3	7,281.32	23.5	100.0%	7,281	7,281.32	0%
Process	Other Process	100.0%	1,104.6	1,104.55	3.6	100.0%	1,105	1,104.55	0%
Miscellaneous	Miscellaneous	100.0%	3,122.0	3,122.02	10.1	100.0%	3,122	3,122.02	0%
Total				**139,647.2**	**451.1**			**136,235.8**	**-2.4%**

Table A-16 Plastics Electric Market Profile, 2011

		Average Market Profile				New Units			
End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/empl)	Usage (GWh)	Saturation	UEC (kWh)	Intensity (kWh/empl)	Compared to Average
Cooling	Air-Cooled Chiller	2.5%	19,577.3	489.43	6.3	2.5%	15,441	386.01	-21%
Cooling	Water-Cooled Chiller	2.6%	18,776.7	494.56	6.4	2.6%	13,781	362.98	-27%
Cooling	Roof top AC	12.1%	30,113.2	3,636.61	47.1	12.1%	22,408	2,706.08	-26%
Cooling	Air-Source Heat Pump	0.1%	30,434.3	43.64	0.6	0.1%	22,588	32.39	-26%
Cooling	Geothermal Heat Pump	0.0%	20,299.7	7.28	0.1	0.0%	14,917	5.35	-27%
Cooling	Other Cooling	0.7%	19,876.6	129.89	1.7	0.7%	15,188	99.25	-24%
Heating	Air-Source Heat Pump	0.1%	76,037.4	109.04	1.4	0.1%	62,311	89.35	-18%
Heating	Geothermal Heat Pump	0.0%	50,716.9	18.18	0.2	0.0%	41,474	14.87	-18%
Heating	Electric Room Heat	0.2%	79,562.6	183.81	2.4	0.2%	74,311	171.68	-7%
Heating	Electric Furnace	1.9%	83,540.8	1,587.23	20.5	1.9%	78,027	1,482.47	-7%
Ventilation	Ventilation	100.0%	3,051.7	3,051.72	39.5	100.0%	2,693	2,692.77	-12%
Interior Lighting	Screw-in	100.0%	1,773.0	1,772.96	22.9	100.0%	1,222	1,221.93	-31%
Interior Lighting	High-Bay Fixtures	100.0%	377.4	377.37	4.9	100.0%	258	257.74	-32%
Interior Lighting	Linear Fluorescent	100.0%	5,164.7	5,164.66	66.8	100.0%	4,737	4,736.87	-8%
Exterior Lighting	Screw-in	100.0%	3.3	3.31	0.0	100.0%	2	1.89	-43%
Exterior Lighting	HID	100.0%	1,396.8	1,396.77	18.1	100.0%	991	991.36	-29%
Exterior Lighting	Linear Fluorescent	100.0%	0.4	0.40	0.0	100.0%	0	0.35	-13%
Motors	Pumps	100.0%	13,210.5	13,210.52	170.9	100.0%	13,076	13,075.72	-1%
Motors	Fans & Blowers	100.0%	2,955.9	2,955.91	38.2	100.0%	2,926	2,925.73	-1%
Motors	Compressed Air	100.0%	6,836.9	6,836.89	88.5	100.0%	6,767	6,767.29	-1%
Motors	Matl Handling	100.0%	3,937.1	3,937.12	50.9	100.0%	3,897	3,896.94	-1%
Motors	Matl Processing	100.0%	23,622.7	23,622.74	305.7	100.0%	23,382	23,381.63	-1%
Motors	Other Motors	100.0%	1,944.7	1,944.74	25.2	100.0%	1,925	1,924.89	-1%
Process	Process Heating	100.0%	14,810.5	14,810.48	191.6	100.0%	14,810	14,810.48	0%
Process	Process Cooling and Refrigeration	100.0%	8,509.7	8,509.70	110.1	100.0%	8,510	8,509.70	0%
Process	Electro-Chemical Processes	100.0%	67.8	67.76	0.9	100.0%	68	67.76	0%
Process	Other Process	100.0%	1,232.9	1,232.92	16.0	100.0%	1,233	1,232.92	0%
Miscellaneous	Miscellaneous	100.0%	3,639.2	3,639.22	47.1	100.0%	3,639	3,639.22	0%
Total				**99,234.9**	**1,284.0**			**95,485.6**	**-3.8%**

Table A-17 Transportation Electric Market Profile, 2011

		Average Market Profile				New Units			
End Use	**Technology**	**Saturation**	**UEC (kWh)**	**Intensity (kWh/empl)**	**Usage (GWh)**	**Saturation**	**UEC (kWh)**	**Intensity (kWh/empl)**	**Compared to Average**
Cooling	Air-Cooled Chiller	2.5%	15,921.4	398.03	2.6	2.5%	12,557	313.93	-21%
Cooling	Water-Cooled Chiller	2.6%	15,270.3	402.21	2.7	2.6%	11,208	295.20	-27%
Cooling	Roof top AC	12.1%	24,489.7	2,957.50	19.6	12.1%	18,223	2,200.74	-26%
Cooling	Air-Source Heat Pump	0.1%	24,750.9	35.49	0.2	0.1%	18,370	26.34	-26%
Cooling	Geothermal Heat Pump	0.0%	16,508.8	5.92	0.0	0.0%	12,131	4.35	-27%
Cooling	Other Cooling	0.7%	16,164.7	105.64	0.7	0.7%	12,351	80.71	-24%
Heating	Air-Source Heat Pump	0.1%	61,837.9	88.68	0.6	0.1%	50,675	72.67	-18%
Heating	Geothermal Heat Pump	0.0%	41,245.9	14.79	0.1	0.0%	33,729	12.09	-18%
Heating	Electric Room Heat	0.2%	64,704.8	149.48	1.0	0.2%	60,434	139.62	-7%
Heating	Electric Furnace	1.9%	67,940.0	1,290.82	8.6	1.9%	63,456	1,205.63	-7%
Ventilation	Ventilation	100.0%	2,481.8	2,481.83	16.5	100.0%	2,190	2,189.91	-12%
Interior Lighting	Screw-in	100.0%	1,352.7	1,352.66	9.0	100.0%	932	932.26	-31%
Interior Lighting	High-Bay Fixtures	100.0%	287.9	287.91	1.9	100.0%	197	196.64	-32%
Interior Lighting	Linear Fluorescent	100.0%	3,940.3	3,940.32	26.1	100.0%	3,614	3,613.94	-8%
Exterior Lighting	Screw-in	100.0%	2.5	2.53	0.0	100.0%	1	1.45	-43%
Exterior Lighting	HID	100.0%	1,065.6	1,065.65	7.1	100.0%	756	756.35	-29%
Exterior Lighting	Linear Fluorescent	100.0%	0.3	0.30	0.0	100.0%	0	0.26	-13%
Motors	Pumps	100.0%	-	-	-	100.0%	-	-	0%
Motors	Fans & Blowers	100.0%	2,679.3	2,679.35	17.8	100.0%	2,652	2,651.99	-1%
Motors	Compressed Air	100.0%	1,004.8	1,004.75	6.7	100.0%	995	994.53	-1%
Motors	Matl Handling	100.0%	4,510.9	4,510.90	29.9	100.0%	4,465	4,464.86	-1%
Motors	Matl Processing	100.0%	8,038.0	8,038.04	53.3	100.0%	7,956	7,956.00	-1%
Motors	Other Motors	100.0%	1,004.8	1,004.75	6.7	100.0%	994	994.50	-1%
Process	Process Heating	100.0%	6,074.7	6,074.68	40.3	100.0%	6,075	6,074.68	0%
Process	Process Cooling and Refrigeration	100.0%	2,697.6	2,697.58	17.9	100.0%	2,698	2,697.58	0%
Process	Electro-Chemical Processes	100.0%	181.4	181.41	1.2	100.0%	181	181.41	0%
Process	Other Process	100.0%	993.0	993.05	6.6	100.0%	993	993.05	0%
Miscellaneous	Miscellaneous	100.0%	2,170.4	2,170.43	14.4	100.0%	2,170	2,170.43	0%
Total				**43,934.7**	**291.4**			**41,221.1**	**-6.2%**

Table A-18 Other Industrial Electric Market Profile, 2011

		Average Market Profile				New Units			
End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/empl)	Usage (GWh)	Saturation	UEC (kWh)	Intensity (kWh/empl)	Compared to Average
Cooling	Air-Cooled Chiller	2.5%	17,637.5	440.94	9.3	2.5%	13,911	347.77	-21%
Cooling	Water-Cooled Chiller	2.6%	16,916.3	445.56	9.4	2.6%	12,416	327.02	-27%
Cooling	Roof top AC	12.1%	27,129.5	3,276.29	69.1	12.1%	20,188	2,437.95	-26%
Cooling	Air-Source Heat Pump	0.1%	27,418.8	39.32	0.8	0.1%	20,350	29.18	-26%
Cooling	Geothermal Heat Pump	0.0%	18,288.3	6.56	0.1	0.0%	13,439	4.82	-27%
Cooling	Other Cooling	0.7%	17,907.1	117.02	2.5	0.7%	13,683	89.42	-24%
Heating	Air-Source Heat Pump	0.1%	68,503.3	98.23	2.1	0.1%	56,137	80.50	-18%
Heating	Geothermal Heat Pump	0.0%	45,691.7	16.38	0.3	0.0%	37,364	13.40	-18%
Heating	Electric Room Heat	0.2%	71,679.3	165.59	3.5	0.2%	66,948	154.67	-7%
Heating	Electric Furnace	1.9%	75,263.2	1,429.96	30.2	1.9%	70,296	1,335.58	-7%
Ventilation	Ventilation	100.0%	2,749.3	2,749.35	58.0	100.0%	2,426	2,425.96	-12%
Interior Lighting	Screw-in	100.0%	1,362.2	1,362.18	28.7	100.0%	939	938.83	-31%
Interior Lighting	High-Bay Fixtures	100.0%	289.9	289.94	6.1	100.0%	198	198.03	-32%
Interior Lighting	Linear Fluorescent	100.0%	3,968.1	3,968.07	83.7	100.0%	3,639	3,639.40	-8%
Exterior Lighting	Screw-in	100.0%	2.5	2.55	0.1	100.0%	1	1.46	-43%
Exterior Lighting	HID	100.0%	1,073.2	1,073.15	22.6	100.0%	762	761.68	-29%
Exterior Lighting	Linear Fluorescent	100.0%	0.3	0.31	0.0	100.0%	0	0.27	-13%
Motors	Pumps	100.0%	2,680.8	2,680.82	56.5	100.0%	2,653	2,653.47	-1%
Motors	Fans & Blowers	100.0%	3,219.5	3,219.51	67.9	100.0%	3,187	3,186.64	-1%
Motors	Compressed Air	100.0%	2,603.3	2,603.26	54.9	100.0%	2,577	2,576.76	-1%
Motors	Matl Handling	100.0%	1,109.2	1,109.15	23.4	100.0%	1,098	1,097.83	-1%
Motors	Matl Processing	100.0%	4,397.0	4,396.99	92.7	100.0%	4,352	4,352.11	-1%
Motors	Other Motors	100.0%	92.4	92.40	1.9	100.0%	91	91.45	-1%
Process	Process Heating	100.0%	4,330.2	4,330.17	91.3	100.0%	4,330	4,330.17	0%
Process	Process Cooling and Refrigeration	100.0%	2,268.4	2,268.37	47.8	100.0%	2,268	2,268.37	0%
Process	Electro-Chemical Processes	100.0%	108.0	108.04	2.3	100.0%	108	108.04	0%
Process	Other Process	100.0%	285.8	285.83	6.0	100.0%	286	285.83	0%
Miscellaneous	Miscellaneous	100.0%	2,207.6	2,207.59	46.6	100.0%	2,208	2,207.59	0%
Total				**38,783.5**	**818.0**			**35,944.1**	**-7.3%**

APPENDIX | **B**

RESIDENTIAL ENERGY EFFICIENCY EQUIPMENT AND MEASURE DATA

This appendix presents detailed information for all energy-efficiency measures (*equipment* and *non-equipment* measures per the LoadMAP taxonomy) that were evaluated as part of this study. Several sets of tables are provided.

Measure Descriptions

Table B-1 and Table B-2 provide brief descriptions for all equipment and non-equipment measures that were assessed for potential.

Equipment Measure Data

Table B-3 through Table B-6 list the detailed unit-level data for the equipment measures for each of the housing type segments — Single Family, Multi Family, and for existing and new construction, respectively. Savings are in annual kWh per household, and incremental costs are in $/household ($/HH), unless noted otherwise. The BC ratio shown in the tables are for the first year of savings potential, although the B/C ratio is calculated within LoadMAP for each year of the forecast. The B/C ratio in the tables is 1.00 if the measure represents the baseline technology, and zero if the technology is not available in the first year. The final data item in these tables is the levelized cost of conserved energy, which is defined as the cost of the measure divided by the cumulative amount of energy savings accrued over the measure's lifetime ($/kWh).

Non-Equipment Measure Data

Table B-7 through Table B-10 list the detailed unit-level data for the non-equipment energy efficiency measures for each of the housing type segments and for existing and new construction, respectively. Because these measures can produce energy-use savings for multiple end-use loads (e.g., insulation affects heating and cooling energy use) savings are expressed as a net percentage of all the relevant, combined end-use loads. Base saturation indicates the percentage of homes in which the measure is already installed. Applicability is a factor that account for whether the measure is applicable to the building. Cost is expressed in $/household. The detailed measure-level tables present the results of the benefit/cost (B/C) analysis for the first year of the analysis although the B/C ratio is calculated within LoadMAP for each year of the forecast. These tables also contain the levelized cost of conserved energy, which is defined as the cost of the measure divided by the cumulative amount of energy savings accrued over the measure's lifetime, given in terms of $/kWh.

Table B-1 Residential Energy Efficiency Equipment Measure Descriptions

End Use	Technology	Measure Description
Cooling	Central AC	Central air conditioners consist of a refrigeration system using a direct expansion cycle. Equipment includes a compressor, an air-cooled condenser (located outdoors), an expansion valve, and an evaporator coil. A supply fan near the evaporator coil distributes supply air through air ducts to the building. Cooling efficiencies vary based on materials used, equipment size, condenser type, and system configuration. CACs may be unitary (all components housed in a factory-built assembly) or split system (an outdoor condenser section and an indoor evaporator section connected by refrigerant lines and with the compressor either indoors or outdoors). Energy efficiency is rated according to the size of the unit using the Seasonal Energy Efficiency Rating (SEER). Ductless systems with Variable Refrigerant Flow further improve the operating efficiency.
Cooling	Room AC	Room air conditioners are designed to cool a single room or space. They incorporate a complete air-cooled refrigeration and air-handling system in an individual package. Room air conditioners come in several forms, including window, split-type, and packaged terminal units. Energy efficiency is rated according to the size of the unit using the Energy Efficiency Rating (EER).
Cooling / Heating	Air-Source Heat Pump	A central heat pump consists of components similar to a CAC system, but is usually designed to function both as a heat pump and an air conditioner. It consists of a refrigeration system using a direct expansion (DX) cycle. Equipment includes a compressor, an air-cooled condenser (located outdoors), an expansion valve, and an evaporator coil (located in the supply air duct near the supply fan) and a reversing valve to change the DX cycle from cooling to heating when required. The cooling and heating efficiencies vary based on the materials used, equipment size, condenser type, and system configuration. Heat pumps may be unitary (all components housed in a factory-built assembly) or a split system (an outdoor condenser section and an indoor evaporator section connected by refrigerant lines, with either outdoors or indoors. A high-efficiency option for a ductless mini-split system is also analyzed.
Cooling / Heating	Geothermal Heat Pump	Geothermal heat pumps are similar to air-source heat pumps, but use the ground or groundwater instead of outside air to provide a heat source/sink. A geothermal heat pump system generally consists of three major subsystems or parts: a geothermal heat pump to move heat between the building and the fluid in the earth connection, an earth connection for transferring heat between the fluid and the earth, and a distribution subsystem for delivering heating or cooling to the building. The system may also have a desuperheater to supplement the building's water heater, or a full-demand water heater to meet all of the building's hot water needs.
Heating	Electric Resistance	Resistive heating elements are used to convert electricity directly to heat. Conductive fins surrounding the element or another mechanism is used to deliver the heat directly to the surrounding room or area. These are typically either baseboard or wall-mounted units.
Heating	Furnace	Furnaces heat air and distribute the heated air through the building using ducts. Efficiency improvements can include: exhaust fan controls, electronic ignition (no pilot light), compact size and lighter weight to reduce cycling losses, smaller-diameter flue pipe, and sealed combustion. Very high efficiency units, or condensing units, condense the water vapor

End Use	Technology	Measure Description
		produced in the combustion process and also use the heat from this condensation.
Water Heating	Water Heater	For electric hot water heating, the most common type is a storage heater, which incorporates an electric heating element, storage tank, outer jacket, insulation, and controls in a single unit. Efficient units are characterized by a high recovery or thermal efficiency and low standby losses (the ratio of heat lost per hour to the content of the stored water). A further efficiency gain is available through a heat pump water heater (HPWH), which uses a vapor-compression thermodynamic cycle similar to that found in an air-conditioner or refrigerator to extract heat from an available source (e.g., air) and reject that heat to a higher temperature sink, in this case, the water in the water heater. Electric instantaneous water heaters are available, but are excluded from this study due to potentially high instantaneous demand concerns. For natural gas hot water heating, the most common type is a storage heater, which incorporates a burner, storage tank, outer jacket, insulation, and controls in a single unit. Efficient units are characterized by a high recovery or thermal efficiency and low standby losses (the ratio of heat lost per hour to the content of the stored water). A further efficiency gain is available in condensing units, which condense the water vapor produced in the combustion process and also use the heat from this condensation.
Interior Lighting	Screw-in	Infrared halogen lamps are designed to be a replacement for standards incandescent lamps. Also referred to as advanced incandescent lamps, these products meet the Energy Independence and Security Act (EISA) lighting standards and are phased in as the baseline technology screw-in lamp technology to reflect the timeline over which the EISA lighting standards take effect. Compact fluorescent lamps are designed to be a replacement for standard incandescent lamps and use about 25% of the energy used by standard incandescent lamps to produce the same lumen output. They can use either electronic or magnetic ballasts. Integral compact fluorescent lamps have the ballast integrated into the base of the lamp and have a standard screw-in base that permits installation into existing incandescent fixtures. Light-emitting diode (LED) lighting has seen recent penetration in specific applications such as traffic lights and exit signs. With the potential for extremely high efficiency, LEDs show promise to provide general-use lighting for interior spaces. Current models commercially available have efficacies comparable to CFLs. However, theoretical efficiencies are significantly higher. LED models under development are expected to provide improved efficacies.
Interior Lighting	Linear Fluorescent	T8 fluorescent lamps are smaller in diameter than standard T12 lamps, resulting in greater light output per watt. T8 lamps also operate at a lower current and wattage, which increases the efficiency of the ballast but requires the lamps to be compatible with the ballast. Fluorescent lamp fixtures can include a reflector that increases the light output from the fixture, and thus make it possible to use a fewer number of lamps in each fixture. T5 lamps further increase efficiency by reducing the lamp diameter to 5/8”. Light-emitting diode (LED) lighting has seen recent penetration in specific applications such as traffic lights and exit signs. With the potential for extremely high efficiency, LEDs show promise to provide general-use lighting for interior spaces. Current models commercially available have efficacies comparable to CFLs. However, theoretical efficiencies are significantly higher. LED models under development are expected to

End Use	Technology	Measure Description
		provide improved efficacies.
Interior Lighting	Specialty Lighting	Bulbs that the DOE does not consider conventional and are not covered by federal efficiency standards. These include: appliance bulbs, heavy-duty bulbs, dimmable bulbs, three-way bulbs, G shape (globe) lamps, candelabra base, and others.
Exterior Lighting	Exterior Lighting	Infrared halogen lamps are designed to be a replacement for standards incandescent lamps. Also referred to as advanced incandescent lamps, these products meet the Energy Independence and Security Act (EISA) lighting standards and are phased in as the baseline technology screw-in lamp technology to reflect the timeline over which the EISA lighting standards take effect. Compact fluorescent lamps are designed to be a replacement for standard incandescent lamps and use about 25% of the energy used by standard incandescent lamps to produce the same lumen output. They can use either electronic or magnetic ballasts. Integral compact fluorescent lamps have the ballast integrated into the base of the lamp and have a standard screw-in base that permits installation into existing incandescent fixtures. Light-emitting diode (LED) lighting has seen recent penetration in specific applications such as traffic lights and exit signs. With the potential for extremely high efficiency, LEDs show promise to provide general-use lighting for interior spaces. Current models commercially available have efficacies comparable to CFLs. However, theoretical efficiencies are significantly higher. LED models under development are expected to provide improved efficacies.
Appliances	Refrigerator	Energy-efficient refrigerators/freezers incorporate features such as improved cabinet insulation, more efficient compressors and evaporator fans, defrost controls, mullion heaters, oversized condenser coils, and improved door seals. Further efficiency increases can be obtained by reducing the volume of refrigerated space, or adding multiple compartments to reduce losses from opening doors.
Appliances	Second Refrigerator	Energy-efficient refrigerators/freezers incorporate features such as improved cabinet insulation, more efficient compressors and evaporator fans, defrost controls, mullion heaters, oversized condenser coils, and improved door seals. Further efficiency increases can be obtained by reducing the volume of refrigerated space, or adding multiple compartments to reduce losses from opening doors.
Appliances	Freezer	Energy-efficient refrigerators/freezers incorporate features such as improved cabinet insulation, more efficient compressors and evaporator fans, defrost controls, mullion heaters, oversized condenser coils, and improved door seals. Further efficiency increases can be obtained by reducing the volume of refrigerated space, or adding multiple compartments to reduce losses from opening doors.
Appliances	Clothes Washer	High efficiency clothes washers use superior designs that require less water. Sensors match the hot water needs to the size and soil level of the load, preventing energy waste. Further energy and water savings can be achieved through advanced technologies such as inverter-drive or combination washer-dryer units. MEF is the official energy efficiency metric used to compare relative efficiencies of different clothes washers. MEF considers the energy used to run the washer, heat the water, and run the dryer. The higher the MEF, the more efficient the clothes washer.
Appliances	Clothes Dryer	An energy-efficient clothes dryer has a moisture-sensing device to

End Use	Technology	Measure Description
		terminate the drying cycle rather than using a timer and an energy-efficient motor is used for spinning the dryer tub. Application of a heat pump cycle for extracting the moisture from clothes leads to additional energy savings.
Appliances	Dishwasher	High efficiency dishwashers save by using both improved technology for the primary wash cycle, and by using less hot water. Construction includes more effective washing action, energy-efficient motors, and other advanced technology such as sensors that determine the length of the wash cycle and the temperature of the water necessary to clean the dishes.
Appliances	Stove	These products have additional insulation in the oven compartment and tighter-fitting oven door gaskets and hinges to save energy. Conventional ovens must first heat up about 35 pounds of steel and a large amount of air before they heat up the food. Higher efficiency options include convection ovens, halogen burners, and induction burners.
Appliances	Microwave	Appliance that heats food with microwave radiation. No high efficiency option is modeled.
Electronics	Personal Computers	Improved power management can significantly reduce the annual energy consumption of PCs and monitors in both standby and normal operation. ENERGY STAR and Climate Savers labeled products provide increasing level of energy efficiency.
Electronics	Monitor	High efficiency electronics use efficient components and employ sleep/powersave modes.
Electronics	Laptops	High efficiency electronics use efficient components and employ sleep/powersave modes.
Electronics	Printer/Fax/Copier	High efficiency electronics use efficient components and employ sleep/powersave modes.
Electronics	TVs	In the average home, electronic products consumed significant energy, even when they are turn off, to maintain features like clocks, remote control, and channel/station memory. ENERGY STAR labeled consumer electronics can drastically reduce consumption during standby mode, in addition to saving energy through advanced power management during normal use.
Electronics	Devices and Gadgets	High efficiency electronics can use efficient components and employ sleep/powersave modes.
Electronics	Set-top Boxes/DVR	High efficiency electronics can use efficient components and employ sleep/powersave modes.
Miscellaneous	Pool Heater	Efficient pool heaters can make use of heat pump technology to achieve significantly higher coefficients of performance in the COP=5.0 range. Gas pool heaters have a burner to heat water in a loop. Efficiency improvements can include: exhaust fan controls, electronic ignition (no pilot light), compact size and lighter weight to reduce cycling losses, and sealed combustion. Very high efficiency units, or condensing units, condense the water vapor produced in the combustion process and also use the heat from this condensation.
Miscellaneous	Pool Pump	High-efficiency motors and two-speed pumps provide improved energy efficiency for this load.

End Use	Technology	Measure Description
Miscellaneous	Furnace Fan	In homes heated by a furnace, there is still substantial energy use by the fan responsible for moving the hot air throughout the ductwork. Application of an Electronically Commutating Motor (ECM) ensures that motor speed matches the heating requirements of the system and saves energy when compared to a continuously operating standard motor.
Miscellaneous	Well Pump	Existing well pumps can achieve efficiency improvements by using optimized system components and more efficient motors. Efficiencies: Baseline 40% EF, High Efficiency 60% EF
Miscellaneous	Hot Tub/Spa	High-efficiency motors and two-speed pumps provide improved energy efficiency for this load.
Miscellaneous	Miscellaneous	Improvement of miscellaneous electricity uses.

Table B-2 Residential Energy Efficiency Non-Equipment Measure Descriptions

End Use	Measure	Description
HVAC (All)	Insulation - Ceiling	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation above ceilings can conserve energy by reducing the heat loss or gain into attics and/or through roofs. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose, loose-fill (blown) fiberglass, and rigid polystyrene.
Cooling	Insulation - Ducting	Air distribution ducts can be insulated to reduce heating or cooling losses. Best results can be achieved by covering the entire surface area with insulation. Several types of ducts and duct insulation are available, including flexible duct, pre-insulated duct, duct board, duct wrap, tacked, or glued rigid insulation, and waterproof hard shell materials for exterior ducts. This analysis assumes that installing duct insulation can reduce the temperature drop/gain in ducts by 50%.
HVAC (All)	Insulation - Foundation	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation can conserve energy by reducing heat loss or gain from a building. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose, loose-fill (blown) fiberglass, and rigid polystyrene. Foundation insulation is modeled for new construction / major retrofits only.
HVAC (All)	Insulation - Infiltration Control	Lowering the air infiltration rate by caulking small leaks and weather-stripping around window frames, doorframes, power outlets, plumbing, and wall corners can provide significant energy savings. Weather-stripping doors and windows will create a tight seal and further reduce air infiltration.
HVAC (All)	Insulation - Radiant Barrier	Radiant barriers are materials installed to reduce the heat gain in buildings. Radiant barriers are made from materials that are highly reflective and have low emissivity like aluminum. The closer the emissivity is to 0 the better they will perform. Radiant barriers can be placed above the insulation or on the roof rafters.
HVAC (All)	Insulation - Wall Cavity	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation can conserve energy by reducing heat loss or gain from a building. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose, loose-fill (blown) fiberglass, and rigid polystyrene. Wall insulation is modeled for new construction / major retrofits only.
HVAC (All)	Insulation - Wall Sheathing	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation can conserve energy by reducing heat loss or gain from a building. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose, loose-fill (blown) fiberglass, and rigid polystyrene. Wall sheathing is modeled for new construction / major retrofits only.
Cooling	Ducting - Repair and Sealing	Leakage in unsealed ducts varies considerably because of the differences in fabricating machinery used, the methods for assembly, installation workmanship, and age of the ductwork. Air leaks from the system to the outdoors result in a direct loss proportional to the amount of leakage and the difference in enthalpy between the outdoor air and the conditioned air. To seal ducts, a wide variety of sealing methods and products exist. Each has a relatively short shelf life, and no documented research has identified the aging characteristics of sealant applications.
HVAC (All)	Windows - High Efficiency/ENERGY STAR	High-efficiency windows, such as those labeled under the ENERGY STAR Program, are designed to reduce energy use and increase occupant comfort. High-efficiency windows reduce the amount of heat transfer through the

End Use	Measure	Description
		glazing surface. For example, some windows have a low-E coating, a thin film of metallic oxide coating on the glass surface that allows passage of short-wave solar energy through glass and prevents long-wave energy from escaping. Another example is double-pane glass that reduces conductive and convective heat transfer. Some double-pane windows are gas-filled (usually argon) to further increase the insulating properties of the window.
HVAC (All)	Windows - Install Reflective Film	Reflective films applied to the window interior help reduce solar gain into the space and thus lower cooling energy use.
HVAC (All)	Doors - Storm and Thermal	Like other components of the shell, doors are subject to several types of heat loss: conduction, infiltration, and radiant losses. Similar to a storm window, a storm door creates an insulating air space between the storm and primary doors. A tight fitting storm door can also help reduce air leakage or infiltration. Thermal doors have exceptional thermal insulation properties and also are provided with weather-stripping on the doorframe to reduce air leakage.
HVAC (All)	Roofs - High Reflectivity	The color and material of a building structure surface will determine the amount of solar radiation absorbed by that surface and subsequently transferred into a building. This is called solar absorptance. By using a living roof or a roofing material with a light color (and a lower solar absorptance), the roof will absorb less solar radiation and consequently reduce the cooling load. Living roofs also reduce stormwater runoff.
HVAC (All)	Attic Fan - Installation	Attic fans can reduce the need for AC by reducing heat transfer from the attic through the ceiling of the house. A well-ventilated attic can be several degrees cooler than a comparable, unventilated attic. An option for an attic fan equipped with a small solar photovoltaic generator is also modeled.
HVAC (All)	Attic Fan - Photovoltaic - Installation	Attic fans can reduce the need for AC by reducing heat transfer from the attic through the ceiling of the house. A well-ventilated attic can be several degrees cooler than a comparable, unventilated attic. An option for an attic fan equipped with a small solar photovoltaic generator is also modeled.
HVAC (All)	Whole-House Fan - Installation	Whole-house fans can reduce the need for AC on moderate-weather days or on cool evenings. The fan facilitates a quick air change throughout the entire house. Several windows must be open to achieve the best results. The fan is mounted on the top floor of the house, usually in a hallway ceiling.
HVAC (All)	Ceiling Fan - Installation	Ceiling fans can reduce the need for air conditioning. However, the house occupants must also select a ceiling fan with a high-efficiency motor and either shutoff the AC system or setup the thermostat temperature of the air conditioning system to realize the potential energy savings. Some ceiling fans also come with lamps. In this analysis, it is assumed that there are no lamps, and installing a ceiling fan will allow occupants to increase the thermostat cooling setpoint up by 2°F.
HVAC (All)	Thermostat - Clock/Programmable	A programmable thermostat can be added to most heating/cooling systems. They are typically used during winter to lower temperatures at night and in summer to increase temperatures during the afternoon. The energy savings from this type of thermostat are identical to those of a "setback" strategy with standard thermostats, but the convenience of a programmable thermostat makes it a much more attractive option. In this analysis, the baseline is assumed to have no thermostat setback.
HVAC (All)	Home Energy Management System	A centralized home energy management system can be used to control and schedule cooling, space heating, lighting, and possibly appliances as well. Some designs also allow the homeowner to remotely control loads via the Internet.
Cooling	Central AC - Early Replacement	CAC systems currently on the market are significantly more efficient that older units, due to technology improvement and stricter appliance standards. This measure incents homeowners to replace an aging but still working unit with a new, higher-efficiency one.
Cooling	Central AC - Maintenance and Tune-Up	An air conditioner's filters, coils, and fins require regular cleaning and maintenance for the unit to function effectively and efficiently throughout its life. Neglecting necessary maintenance leads to a steady decline in

End Use	Measure	Description
		performance, requiring the AC unit to use more energy for the same cooling load.
Cooling / Heating	Central Heat Pump - Maintenance	A heat pump's filters, coils, and fins require regular cleaning and maintenance for the unit to function effectively and efficiently throughout its life. Neglecting necessary maintenance ensures a steady decline in performance while energy use steadily increases.
Cooling	Room AC - Removal of Second Unit	Homeowners may have a second room AC unit that is extremely inefficient. This measure incents homeowners to recycle the second unit and thus also eliminates associated electricity use.
Water Heating	Water Heater - Drainwater Heat Recovery	Drainwater Heat Recovery is a system in which drain water is used to preheat cold water entering the water heater. While these systems themselves are relatively inexpensive, upgrading an existing system could be unreasonable because of demolition costs. Thus they are modeled for new vintage only.
Water Heating	Water Heater - Faucet Aerators	Water faucet aerators are threaded screens that attach to existing faucets. They reduce the volume of water coming out of faucets while introducing air into the water stream. This measure provides energy saving by reducing hot water use, as well as water conservation for both hot and cold water.
Water Heating	Water Heater - Low-Flow Showerheads	Similar to faucet aerators, low-flow showerheads reduce the consumption of hot water, which in turn decreases water heating energy use.
Water Heating	Water Heater - Pipe Insulation	Insulating hot water pipes decreases energy losses from piping that distributes hot water throughout the building. It also results in quicker delivery of hot water and may allow the lowering of the hot water set point, which saves energy. The most common insulation materials for this purpose are polyethylene and neoprene.
Water Heating	Water Heater - Timer	These measures use either a programmable thermostat or a timer to adjust the water heater setpoint at times of low usage, typically when a home is unoccupied.
Water Heating	Water Heater - Desuperheater	A desuperheater can be added to an existing geothermal heat pump system (typically installed with the primary function of space heating and cooling) in order to draw off a portion of the geothermal heat for water heating purposes. The system can either supplement the building's water heater, or be a full-demand water heater that meets all of the building's hot water needs.
Water Heating	Water Heater - Solar System	Solar water heating systems can be used in residential buildings that have an appropriate near-south-facing roof or nearby unshaded grounds for installing a collector. Although system types vary, in general these systems use a solar absorber surface within a solar collector or an actual storage tank. Either a heat-transfer fluid or the actual potable water flows through tubes attached to the absorber and transfers heat from it. (Systems with a separate heat-transfer-fluid loop include a heat exchanger that then heats the potable water.) The heated water is stored in a separate preheat tank or a conventional water heater tank. If additional heat is needed, it is provided by a conventional water-heating system.
Interior Lighting	Interior Lighting - Occupancy Sensors	Occupancy sensors turn lights off when a space is unoccupied. They are appropriate for areas with intermittent use, such as bathrooms or storage areas.
Exterior Lighting	Exterior Lighting - Photosensor Control	Photosensor controls turn exterior lighting on or off based on ambient lighting levels. Compared with manual operation, this can reduce the operation of exterior lighting during daylight hours.
Exterior Lighting	Exterior Lighting - Photovoltaic Installation	Solar photovoltaic generation may be used to power exterior lighting and thus eliminate all or part of the electrical energy use.
Exterior Lighting	Exterior Lighting - Timeclock Installation	Lighting timers turn exterior lighting on or off based on a preset schedule. Compared with manual operation, this can reduce the operation of exterior lighting during daylight hours.
Appliances	Refrigerator - Early	Refrigerators/freezers currently on the market are significantly more efficient

End Use	Measure	Description
	Replacement	that older units, due to technology improvement and stricter appliance standards. This measure incents homeowners to replace an aging but still working unit with a new, higher-efficiency one.
Appliances	Refrigerator - Maintenance	This measure includes repairing and recharging refrigerant lines, cleaning condenser coils, and replacing the oil. This reduces energy consumption by improving the rate at which the system can compress and cool refrigerant as it moves through the system.
Appliances	Refrigerator - Remove Second Unit	Homeowners may have a second refrigerator or freezer that is not used to full capacity and that, because of its age, is extremely inefficient. This measure incents homeowners to recycle the second unit and thus also eliminates associated electricity use.
Appliances	Freezer - Remove Second Unit	Homeowners may have a second refrigerator or freezer that is not used to full capacity and that, because of its age, is extremely inefficient. This measure incents homeowners to recycle the second unit and thus also eliminates associated electricity use.
Appliances	Freezer - Early Replacement	Refrigerators/freezers currently on the market are significantly more efficient that older units, due to technology improvement and stricter appliance standards. This measure incents homeowners to replace an aging but still working unit with a new, higher-efficiency one.
Appliances	Freezer - Maintenance	This measure includes repairing and recharging refrigerant lines, cleaning condenser coils, and replacing the oil. This reduces energy consumption by improving the rate at which the system can compress and cool refrigerant as it moves through the system.
Electronics	Electronics - Smart Power Strips	Representing a growing portion of home electricity consumption, plug-in electronics such as set-top boxes, DVD players, gaming systems, digital video recorders, and even battery chargers for mobile phones and laptop computers are often designed to supply a set voltage. When the units are not in use, this voltage could be dropped significantly (~1 W) and thereby generate a significant energy savings, assumed for this analysis to be between 4-5% on average. These savings are in excess of the measures already discussed for computers and televisions.
Miscellaneous	Pool Pump - Timer	A pool pump timer allows the pump to turn off automatically, eliminating the wasted energy associated with unnecessary pumping.
Miscellaneous	Pool Heater - Solar System	This measure replaces a conventional pool heater with a solar system.
HVAC (All)	ENERGY STAR Home Design	ENERGY STAR home design uses an integrated approach to the design of new buildings to account for the interaction of building systems. Designs may specify the building orientation, building shell, proper sizing of equipment and systems, and controls strategies with the goal of optimizing building energy efficiency and comfort. Options that may be evaluated and incorporated include passive solar strategies, increased thermal mass, natural ventilation, energy recovery ventilation, daylighting strategies, and shading strategies; but with specific requirements that adhere to the ENERGY STAR standard and measurement system. This measure is modeled for new vintage only.
Cooling (All)	Dehumidifier	A dehumidifier decreases the humidity of the surrounding area by collecting water vapor from the air. Dryer air feels cooler, meaning occupants can set their thermostat to a higher cooling temperature and still feel comfortable, thus reducing the energy use of the cooling system.
Electronics	PC Power Management Software	This measure employs software and policies designed to minimize monitor and peripheral run times, and maximize the use of sleep and hibernation modes.

Table B-3 Energy Efficiency Equipment Data, Electric—Single Family, Existing Vintage

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Central AC	SEER 13	-	$0.00	15	1.00	$0.00
Cooling	Central AC	SEER 14 (ESTAR)	235.17	$427.37	15	0.99	$0.17
Cooling	Central AC	SEER 15 (CEE Tier 2)	334.10	$1,068.41	15	0.93	$0.30
Cooling	Central AC	SEER 16 (CEE Tier 3)	416.81	$1,121.83	15	0.94	$0.25
Cooling	Central AC	Ductless Minisplit	487.36	$3,766.16	15	0.71	$0.71
Cooling	Central AC	SEER 21	935.61	$3,632.60	15	0.77	$0.36
Cooling	Room AC	EER 9.8	-	$0.00	10	1.00	$0.00
Cooling	Room AC	EER 10.8 (ESTAR)	104.30	$95.26	10	1.02	$0.11
Cooling	Room AC	EER 11.0	122.94	$121.73	10	1.02	$0.12
Cooling	Room AC	EER 11.5	166.69	$148.19	10	1.03	$0.11
Cooling	Room AC	EER 12.0	206.82	$624.51	10	0.82	$0.37
Cooling	Air Source HP	SEER 13, HSPF 7.7	-	$0.00	16	1.00	$0.00
Cooling	Air Source HP	SEER 14, HSPF 8.0	156.78	$413.78	16	0.97	$0.23
Cooling	Air Source HP	SEER 15, HSPF 8.2	225.21	$646.53	16	0.95	$0.25
Cooling	Air Source HP	SEER 16, HSPF 8.5	281.90	$1,086.18	16	0.89	$0.34
Cooling	Air Source HP	Ductless Minisplit	330.93	$3,258.53	16	0.66	$0.87
Cooling	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.00
Cooling	Geo Heat Pump	EER 16, COP 3.5	143.95	$416.55	16	0.99	$0.26
Cooling	Geo Heat Pump	EER 18, COP 3.8	362.75	$1,110.81	16	0.96	$0.27
Cooling	Geo Heat Pump	EER 30, COP 5.0	1,062.91	$2,499.33	16	0.95	$0.21
Heating	Elec. Resistance	Standard	-	$0.00	20	1.00	$0.00
Heating	Furnace	Standard	-	$0.00	15	1.00	$0.00
Heating	Air Source HP	SEER 13, HSPF 7.7	-	$0.00	16	1.00	$0.00
Heating	Air Source HP	SEER 14, HSPF 8.0	308.71	$249.59	16	0.99	$0.07
Heating	Air Source HP	SEER 15, HSPF 8.2	554.39	$389.98	16	0.99	$0.06
Heating	Air Source HP	SEER 16, HSPF 8.5	742.96	$655.17	16	0.96	$0.08
Heating	Air Source HP	Ductless Minisplit	887.47	$1,965.50	16	0.77	$0.20
Heating	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.00
Heating	Geo Heat Pump	EER 16, COP 3.5	106.13	$380.98	16	0.97	$0.32
Heating	Geo Heat Pump	EER 18, COP 3.8	383.50	$1,015.95	16	0.93	$0.23
Heating	Geo Heat Pump	EER 30, COP 5.0	1,160.13	$2,285.89	16	0.88	$0.17
Water Heating	W. Htr <= 55 gal	EF 0.9	-	$0.00	15	1.00	$0.00
Water Heating	W. Htr <= 55 gal	EF 0.95	159.10	$67.00	15	1.02	$0.04
Water Heating	W. Htr <= 55 gal	EF 2.3 (HP)	1,835.67	$1,614.00	15	0.89	$0.08
Water Heating	W. Htr > 55 gal	EF 0.9	-	$0.00	15	1.00	$0.00
Water Heating	W. Htr > 55 gal	EF 0.95	171.22	$67.00	15	1.02	$0.04
Water Heating	W. Htr > 55 gal	EF 2.3 (HP)	1,975.54	$1,614.00	15	0.92	$0.08
Int Lighting	Screw-in	Incandescent	-	$0.00	3	1.00	$0.00
Int Lighting	Screw-in	Inf. Halogen	286.86	$132.63	4	-	$0.12
Int Lighting	Screw-in	Inf. Halogen (2020)	882.34	$132.63	4	-	$0.04
Int Lighting	Screw-in	CFL	1,033.71	$56.20	6	2.40	$0.01
Int Lighting	Screw-in	LED	1,099.50	$1,587.66	15	0.49	$0.13
Int Lighting	Screw-in	LED (2020)	1,165.29	$509.17	15	-	$0.04
Int Lighting	Screw-in	LED Nightlight	31	$3	6	>1.0	$0.02
Int Lighting	Lin. Fluor.	T12	-	$0.00	10	-	$0.00
Int Lighting	Lin. Fluor.	T8	11.59	-$3.70	10	1.00	-$0.04
Int Lighting	Lin. Fluor.	Super T8	34.71	$29.56	10	0.81	$0.11
Int Lighting	Lin. Fluor.	LED (2011)	34.50	$168.59	20	0.48	$0.38
Int Lighting	Lin. Fluor.	T5	35.21	$50.71	10	0.64	$0.18
Int Lighting	Lin. Fluor.	LED (2020)	135.19	$439.48	20	-	$0.25
Int Lighting	Specialty	Incandescent	-	$0.00	3	1.00	$0.00
Int Lighting	Specialty	Inf. Halogen	131.79	$176.46	4	-	$0.36
Int Lighting	Specialty	Inf. Halogen (2020)	405.37	$176.46	4	-	$0.12
Int Lighting	Specialty	CFL	474.92	$74.77	6	1.45	$0.03
Int Lighting	Specialty	LED	505.14	$2,112.33	15	0.20	$0.39
Int Lighting	Specialty	LED (2020)	535.37	$677.43	15	-	$0.12
Ext Lighting	Screw-in	Incandescent	-	$0.00	3	1.00	$0.00
Ext Lighting	Screw-in	Inf. Halogen	34.32	$28.13	4	-	$0.22
Ext Lighting	Screw-in	Inf. Halogen (2020)	212.34	$28.13	4	-	$0.04
Ext Lighting	Screw-in	CFL	245.11	$14.51	6	2.28	$0.01

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Ext Lighting	Screw-in	LED	272.70	$307.64	15	0.59	$0.10
Ext Lighting	Screw-in	LED (2020)	299.25	$98.94	15	-	$0.03
Appliances	Clothes Washer	Standard (1.26)	-	$0.00	10	1.00	$0.00
Appliances	Clothes Washer	ESTAR (1.72)	30.63	$75.00	10	-	$0.30
Appliances	Clothes Washer	AHAM (MEF 1.72)	30.63	$75.00	10	-	$0.30
Appliances	Clothes Washer	ESTAR (MEF 2.0)	34.92	$115.00	10	0.86	$0.41
Appliances	Clothes Washer	AHAM (MEF 2.0)	34.92	$115.00	10	-	$0.41
Appliances	Clothes Washer	Compact (MEF 2.79)	42.38	$225.00	10	0.75	$0.66
Appliances	Clothes Dryer	Baseline	-	$0.00	13	1.00	$0.00
Appliances	Clothes Dryer	High Eff.	18.76	$100.00	13	0.87	$0.54
Appliances	Clothes Dryer	Baseline (2015+)	19.70	$75.00	13	-	$0.39
Appliances	Clothes Dryer	High Eff. (2015+)	44.11	$175.00	13	-	$0.40
Appliances	Clothes Dryer	HP (EF 4.52)	135.22	$458.00	13	0.62	$0.35
Appliances	Dishwasher	Standard (EF 0.63)	-	$0.00	9	-	$0.00
Appliances	Dishwasher	ESTAR (EF 0.69)	17.39	$5.00	9	-	$0.04
Appliances	Dishwasher	ESTAR (EF 0.73)	27.39	$80.00	9	-	$0.39
Appliances	Dishwasher	AHAM (EF 0.73)	27.39	$80.00	9	1.00	$0.39
Appliances	Dishwasher	Ultra Eff. (EF 1.1)	92.34	$255.00	9	0.84	$0.37
Appliances	Refrigerator	Standard	-	$0.00	13	1.00	$0.00
Appliances	Refrigerator	ESTAR	49.08	$25.00	13	1.01	$0.05
Appliances	Refrigerator	High Eff.	69.44	$425.00	13	0.72	$0.62
Appliances	Refrigerator	AHAM (2014)	104.15	$218.00	13	-	$0.21
Appliances	Refrigerator	High Eff. (2014)	134.08	$695.00	13	-	$0.53
Appliances	Freezer	Standard	-	$0.00	11	1.00	$0.00
Appliances	Freezer	ESTAR	47.02	$50.00	11	0.96	$0.12
Appliances	Freezer	High Eff.	98.31	$198.00	11	0.81	$0.23
Appliances	Freezer	AHAM (2014)	99.37	$198.00	11	-	$0.23
Appliances	Freezer	High Eff. (2014)	123.95	$352.00	11	-	$0.33
Appliances	2nd Fridge	Standard	-	$0.00	13	1.00	$0.00
Appliances	2nd Fridge	ESTAR	48.36	$25.00	13	1.00	$0.05
Appliances	2nd Fridge	High Eff.	68.41	$425.00	13	0.72	$0.63
Appliances	2nd Fridge	AHAM (2014)	102.62	$218.00	13	-	$0.22
Appliances	2nd Fridge	High Eff. (2014)	132.11	$695.00	13	-	$0.54
Appliances	Stove	Baseline	-	$0.00	13	1.00	$0.00
Appliances	Stove	Convection	1.36	$121.00	13	0.91	$9.10
Appliances	Stove	Halogen Burner	4.48	$580.00	13	0.68	$13.22
Appliances	Stove	Induction	25.14	$898.00	13	0.58	$3.64
Appliances	Microwave	Standard	-	$0.00	9	1.00	$0.00
Electronics	PCs	Standard	-	$0.00	5	1.00	$0.00
Electronics	PCs	ESTAR	99.63	$0.01	5	1.03	$0.00
Electronics	Monitor	Standard	-	$0.00	5	1.00	$0.00
Electronics	Monitor	ESTAR	12.32	$0.01	5	1.02	$0.00
Electronics	Laptops	Standard	-	$0.00	4	1.00	$0.00
Electronics	Laptops	ESTAR	45.89	$0.01	4	1.02	$0.00
Electronics	TVs	Standard	-	$0.00	11	1.00	$0.00
Electronics	TVs	ESTAR (4.1)	127.82	$0.02	11	-	$0.00
Electronics	TVs	ESTAR (5.1)	143.93	$0.03	11	1.12	$0.00
Electronics	Print/Fax/Copy	Standard	-	$0.00	5	1.00	$0.00
Electronics	Print/Fax/Copy	ESTAR	12.56	$0.01	5	1.02	$0.00
Electronics	Set-top Box/DVR	Standard	-	$0.00	5	1.00	$0.00
Electronics	Set-top Box/DVR	ESTAR (2009)	50.90	$0.01	5	-	$0.00
Electronics	Set-top Box/DVR	ESTAR (2011)	67.87	$0.02	5	1.05	$0.00
Electronics	Devices/Gadget	Standard	-	$0.00	5	1.00	$0.00
Miscellaneous	Pool Pump	Standard	-	$0.00	15	1.00	$0.00
Miscellaneous	Pool Pump	High Eff.	150.00	$85.00	15	1.01	$0.05
Miscellaneous	Pool Pump	Two-Speed	600.00	$579.00	15	0.90	$0.09
Miscellaneous	Pool Heater	Electric Resistance	-	$0.00	15	1.00	$0.00
Miscellaneous	Pool Heater	Heat Pump (COP 5.0)	3,984.80	$2,550.00	15	1.04	$0.06
Miscellaneous	Hot Tub / Spa	Standard	-	$0.00	15	1.00	$0.00
Miscellaneous	Hot Tub / Spa	Efficient Pumps	146.15	$300.00	15	0.94	$0.19
Miscellaneous	Hot Tub / Spa	Imp. Controls/Pumps	194.87	$350.00	15	0.94	$0.17
Miscellaneous	Well Pump	Baseline (40% EF)	-	$0.00	10	1.00	$0.00

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Miscellaneous	Well Pump	High Eff. (60% EF)	200.36	$110.00	10	0.97	$0.07
Miscellaneous	Furnace Fan	Standard	-	$0.00	18	1.00	$0.00
Miscellaneous	Furnace Fan	ECM	380	$200	18	>1.0	$0.04
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.00

Table B-4 Energy Efficiency Equipment Data, Electric—Single Family, New Vintage

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Central AC	SEER 13	-	$0.00	15	1.00	$0.00
Cooling	Central AC	SEER 14 (ESTAR)	193.45	$487.05	15	0.97	$0.23
Cooling	Central AC	SEER 15 (CEE Tier 2)	272.45	$1,217.63	15	0.90	$0.41
Cooling	Central AC	SEER 16 (CEE Tier 3)	338.38	$1,278.51	15	0.90	$0.35
Cooling	Central AC	Ductless Minisplit	394.98	$4,292.15	15	0.65	$1.00
Cooling	Central AC	SEER 21	764.53	$4,139.95	15	0.70	$0.50
Cooling	Room AC	EER 9.8	-	$0.00	10	1.00	$0.00
Cooling	Room AC	EER 10.8 (ESTAR)	99.72	$95.26	10	1.02	$0.12
Cooling	Room AC	EER 11.0	117.56	$121.73	10	1.01	$0.13
Cooling	Room AC	EER 11.5	159.26	$148.19	10	1.03	$0.12
Cooling	Room AC	EER 12.0	197.34	$624.51	10	0.81	$0.39
Cooling	Air Source HP	SEER 13, HSPF 7.7	-	$0.00	16	1.00	$0.00
Cooling	Air Source HP	SEER 14, HSPF 8.0	144.39	$422.91	16	0.96	$0.26
Cooling	Air Source HP	SEER 15, HSPF 8.2	203.35	$660.80	16	0.93	$0.29
Cooling	Air Source HP	SEER 16, HSPF 8.5	252.56	$1,110.15	16	0.88	$0.39
Cooling	Air Source HP	Ductless Minisplit	294.81	$3,330.44	16	0.64	$1.00
Cooling	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.00
Cooling	Geo Heat Pump	EER 16, COP 3.5	130.24	$425.75	16	0.98	$0.29
Cooling	Geo Heat Pump	EER 18, COP 3.8	341.39	$1,135.32	16	0.96	$0.29
Cooling	Geo Heat Pump	EER 30, COP 5.0	1,017.07	$2,554.48	16	0.94	$0.22
Heating	Elec. Resistance	Standard	-	$0.00	20	1.00	$0.00
Heating	Furnace	Standard	-	$0.00	15	1.00	$0.00
Heating	Air Source HP	SEER 13, HSPF 7.7	-	$0.00	16	1.00	$0.00
Heating	Air Source HP	SEER 14, HSPF 8.0	229.93	$255.09	16	0.97	$0.10
Heating	Air Source HP	SEER 15, HSPF 8.2	406.19	$398.58	16	0.97	$0.09
Heating	Air Source HP	SEER 16, HSPF 8.5	543.07	$669.61	16	0.93	$0.11
Heating	Air Source HP	Ductless Minisplit	647.94	$2,008.84	16	0.72	$0.27
Heating	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.00
Heating	Geo Heat Pump	EER 16, COP 3.5	68.14	$389.38	16	0.97	$0.51
Heating	Geo Heat Pump	EER 18, COP 3.8	328.14	$1,038.36	16	0.93	$0.28
Heating	Geo Heat Pump	EER 30, COP 5.0	1,056.13	$2,336.31	16	0.87	$0.20
Water Heating	W. Htr <= 55 gal	EF 0.9	-	$0.00	15	1.00	$0.00
Water Heating	W. Htr <= 55 gal	EF 0.95	152.98	$67.00	15	1.01	$0.04
Water Heating	W. Htr <= 55 gal	EF 2.3 (HP)	1,765.07	$1,614.00	15	0.87	$0.08
Water Heating	W. Htr > 55 gal	EF 0.9	-	$0.00	15	1.00	$0.00
Water Heating	W. Htr > 55 gal	EF 0.95	163.07	$67.00	15	1.02	$0.04
Water Heating	W. Htr > 55 gal	EF 2.3 (HP)	1,881.46	$1,614.00	15	0.90	$0.08
Int Lighting	Screw-in	Incandescent	-	$0.00	3	1.00	$0.00
Int Lighting	Screw-in	Inf. Halogen	251.88	$150.68	4	-	$0.16
Int Lighting	Screw-in	Inf. Halogen (2020)	774.72	$150.68	4	-	$0.05
Int Lighting	Screw-in	CFL	907.64	$63.85	6	2.16	$0.01
Int Lighting	Screw-in	LED	965.40	$1,803.76	15	0.39	$0.17
Int Lighting	Screw-in	LED (2020)	1,023.17	$578.47	15	-	$0.05
Int Lighting	Lin. Fluor.	T12	-	$0.00	10	-	$0.00
Int Lighting	Lin. Fluor.	T8	13.16	-$4.20	10	1.00	-$0.04
Int Lighting	Lin. Fluor.	Super T8	39.44	$33.59	10	0.81	$0.11
Int Lighting	Lin. Fluor.	LED (2011)	39.19	$191.54	20	0.48	$0.38
Int Lighting	Lin. Fluor.	T5	40.00	$57.61	10	0.64	$0.18
Int Lighting	Lin. Fluor.	LED (2020)	153.59	$499.29	20	-	$0.25
Int Lighting	Specialty	Incandescent	-	$0.00	3	1.00	$0.00
Int Lighting	Specialty	Inf. Halogen	138.49	$200.48	4	-	$0.39

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Int Lighting	Specialty	Inf. Halogen (2020)	425.97	$200.48	4	-	$0.13
Int Lighting	Specialty	CFL	499.05	$84.95	6	1.39	$0.03
Int Lighting	Specialty	LED	530.81	$2,399.84	15	0.19	$0.42
Int Lighting	Specialty	LED (2020)	562.57	$769.64	15	-	$0.13
Ext Lighting	Screw-in	Incandescent	-	$0.00	3	1.00	$0.00
Ext Lighting	Screw-in	Inf. Halogen	39.00	$31.96	4	-	$0.22
Ext Lighting	Screw-in	Inf. Halogen (2020)	241.28	$31.96	4	-	$0.04
Ext Lighting	Screw-in	CFL	278.52	$16.49	6	2.28	$0.01
Ext Lighting	Screw-in	LED	309.86	$349.51	15	0.59	$0.10
Ext Lighting	Screw-in	LED (2020)	340.04	$112.41	15	-	$0.03
Appliances	Clothes Washer	Standard (1.26)	-	$0.00	10	1.00	$0.00
Appliances	Clothes Washer	ESTAR (1.72)	30.63	$75.00	10	-	$0.30
Appliances	Clothes Washer	AHAM (MEF 1.72)	30.63	$75.00	10	-	$0.30
Appliances	Clothes Washer	ESTAR (MEF 2.0)	34.92	$115.00	10	0.86	$0.41
Appliances	Clothes Washer	AHAM (MEF 2.0)	34.92	$115.00	10	-	$0.41
Appliances	Clothes Washer	Compact (MEF 2.79)	42.38	$225.00	10	0.75	$0.66
Appliances	Clothes Dryer	Baseline	-	$0.00	13	1.00	$0.00
Appliances	Clothes Dryer	High Eff.	18.76	$100.00	13	0.87	$0.54
Appliances	Clothes Dryer	Baseline (2015+)	19.70	$75.00	13	-	$0.39
Appliances	Clothes Dryer	High Eff. (2015+)	44.11	$175.00	13	-	$0.40
Appliances	Clothes Dryer	HP (EF 4.52)	135.22	$458.00	13	0.62	$0.35
Appliances	Dishwasher	Standard (EF 0.63)	-	$0.00	9	-	$0.00
Appliances	Dishwasher	ESTAR (EF 0.69)	17.39	$5.00	9	-	$0.04
Appliances	Dishwasher	ESTAR (EF 0.73)	27.39	$80.00	9	-	$0.39
Appliances	Dishwasher	AHAM (EF 0.73)	27.39	$80.00	9	1.00	$0.39
Appliances	Dishwasher	Ultra Eff. (EF 1.1)	92.34	$255.00	9	0.84	$0.37
Appliances	Refrigerator	Standard	-	$0.00	13	1.00	$0.00
Appliances	Refrigerator	ESTAR	49.08	$25.00	13	1.01	$0.05
Appliances	Refrigerator	High Eff.	69.44	$425.00	13	0.72	$0.62
Appliances	Refrigerator	AHAM (2014)	104.15	$218.00	13	-	$0.21
Appliances	Refrigerator	High Eff. (2014)	134.08	$695.00	13	-	$0.53
Appliances	Freezer	Standard	-	$0.00	11	1.00	$0.00
Appliances	Freezer	ESTAR	47.02	$50.00	11	0.96	$0.12
Appliances	Freezer	High Eff.	98.31	$198.00	11	0.81	$0.23
Appliances	Freezer	AHAM (2014)	99.37	$198.00	11	-	$0.23
Appliances	Freezer	High Eff. (2014)	123.95	$352.00	11	-	$0.33
Appliances	2nd Fridge	Standard	-	$0.00	13	1.00	$0.00
Appliances	2nd Fridge	ESTAR	48.36	$25.00	13	1.00	$0.05
Appliances	2nd Fridge	High Eff.	68.41	$425.00	13	0.72	$0.63
Appliances	2nd Fridge	AHAM (2014)	102.62	$218.00	13	-	$0.22
Appliances	2nd Fridge	High Eff. (2014)	132.11	$695.00	13	-	$0.54
Appliances	Stove	Baseline	-	$0.00	13	1.00	$0.00
Appliances	Stove	Convection	1.36	$121.00	13	0.91	$9.10
Appliances	Stove	Halogen Burner	4.48	$580.00	13	0.68	$13.22
Appliances	Stove	Induction	25.14	$898.00	13	0.58	$3.64
Appliances	Microwave	Standard	-	$0.00	9	1.00	$0.00
Electronics	PCs	Standard	-	$0.00	5	1.00	$0.00
Electronics	PCs	ESTAR	99.63	$0.01	5	1.03	$0.00
Electronics	Monitor	Standard	-	$0.00	5	1.00	$0.00
Electronics	Monitor	ESTAR	13.16	$0.01	5	1.02	$0.00
Electronics	Laptops	Standard	-	$0.00	4	1.00	$0.00
Electronics	Laptops	ESTAR	45.89	$0.01	4	1.02	$0.00
Electronics	TVs	Standard	-	$0.00	11	1.00	$0.00
Electronics	TVs	ESTAR (4.1)	127.82	$0.02	11	-	$0.00
Electronics	TVs	ESTAR (5.1)	143.93	$0.03	11	1.12	$0.00
Electronics	Print/Fax/Copy	Standard	-	$0.00	5	1.00	$0.00
Electronics	Print/Fax/Copy	ESTAR	12.56	$0.01	5	1.02	$0.00
Electronics	Set-top Box/DVR	Standard	-	$0.00	5	1.00	$0.00
Electronics	Set-top Box/DVR	ESTAR (2009)	50.90	$0.01	5	-	$0.00
Electronics	Set-top Box/DVR	ESTAR (2011)	67.87	$0.02	5	1.05	$0.00
Electronics	Devices/Gadget	Standard	-	$0.00	5	1.00	$0.00
Miscellaneous	Pool Pump	Standard	-	$0.00	15	1.00	$0.00

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Miscellaneous	Pool Pump	High Eff.	154.64	$85.00	15	1.02	$0.05
Miscellaneous	Pool Pump	Two-Speed	618.56	$579.00	15	0.91	$0.09
Miscellaneous	Pool Heater	Electric Resistance	-	$0.00	15	1.00	$0.00
Miscellaneous	Pool Heater	Heat Pump (COP 5.0)	3,984.80	$2,550.00	15	1.04	$0.06
Miscellaneous	Hot Tub / Spa	Standard	-	$0.00	15	1.00	$0.00
Miscellaneous	Hot Tub / Spa	Efficient Pumps	146.15	$300.00	15	0.94	$0.19
Miscellaneous	Hot Tub / Spa	Imp. Controls/Pumps	194.87	$350.00	15	0.94	$0.17
Miscellaneous	Well Pump	Baseline (40% EF)	-	$0.00	10	1.00	$0.00
Miscellaneous	Well Pump	High Eff. (60% EF)	204.00	$110.00	10	0.98	$0.07
Miscellaneous	Furnace Fan	Standard	-	$0.00	18	1.00	$0.00
Miscellaneous	Furnace Fan	ECM	92.27	$769.00	18	0.45	$0.68
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.00

Table B-5 Energy Efficiency Equipment Data, Electric—Multi Family, Existing Vintage

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Central AC	SEER 13	-	$0.00	15	1.00	$0.00
Cooling	Central AC	SEER 14 (ESTAR)	79.53	$144.51	15	0.99	$0.17
Cooling	Central AC	SEER 15 (CEE Tier 2)	155.33	$361.28	15	0.95	$0.21
Cooling	Central AC	SEER 16 (CEE Tier 3)	219.01	$379.34	15	0.98	$0.16
Cooling	Central AC	Ductless Minisplit	273.31	$1,273.51	15	0.74	$0.43
Cooling	Central AC	SEER 21	404.20	$1,228.35	15	0.79	$0.28
Cooling	Room AC	EER 9.8	-	$0.00	10	1.00	$0.00
Cooling	Room AC	EER 10.8 (ESTAR)	40.16	$143.72	10	0.90	$0.44
Cooling	Room AC	EER 11.0	47.33	$183.64	10	0.88	$0.48
Cooling	Room AC	EER 11.5	64.14	$223.56	10	0.86	$0.43
Cooling	Room AC	EER 12.0	79.55	$942.14	10	0.53	$1.47
Cooling	Air Source HP	SEER 13, HSPF 7.7	-	$0.00	16	1.00	$0.00
Cooling	Air Source HP	SEER 14, HSPF 8.0	54.96	$138.21	16	0.97	$0.22
Cooling	Air Source HP	SEER 15, HSPF 8.2	78.95	$215.95	16	0.95	$0.24
Cooling	Air Source HP	SEER 16, HSPF 8.5	98.82	$362.80	16	0.89	$0.32
Cooling	Air Source HP	Ductless Minisplit	116.01	$1,088.39	16	0.66	$0.83
Cooling	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.00
Cooling	Geo Heat Pump	EER 16, COP 3.5	42.70	$131.45	16	0.98	$0.27
Cooling	Geo Heat Pump	EER 18, COP 3.8	107.61	$350.54	16	0.96	$0.29
Cooling	Geo Heat Pump	EER 30, COP 5.0	315.33	$788.71	16	0.93	$0.22
Heating	Elec. Resistance	Standard	-	$0.00	20	1.00	$0.00
Heating	Furnace	Standard	-	$0.00	15	1.00	$0.00
Heating	Air Source HP	SEER 13, HSPF 7.7	-	$0.00	16	1.00	$0.00
Heating	Air Source HP	SEER 14, HSPF 8.0	132.74	$107.32	16	0.99	$0.07
Heating	Air Source HP	SEER 15, HSPF 8.2	238.38	$167.69	16	0.99	$0.06
Heating	Air Source HP	SEER 16, HSPF 8.5	319.46	$281.71	16	0.96	$0.08
Heating	Air Source HP	Ductless Minisplit	381.60	$845.14	16	0.77	$0.20
Heating	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.00
Heating	Geo Heat Pump	EER 16, COP 3.5	57.44	$214.12	16	0.97	$0.33
Heating	Geo Heat Pump	EER 18, COP 3.8	207.56	$570.98	16	0.93	$0.24
Heating	Geo Heat Pump	EER 30, COP 5.0	627.91	$1,284.72	16	0.87	$0.18
Water Heating	W. Htr <= 55 gal	EF 0.9	-	$0.00	15	1.00	$0.00
Water Heating	W. Htr <= 55 gal	EF 0.95	97.56	$67.00	15	1.00	$0.06
Water Heating	W. Htr <= 55 gal	EF 2.3 (HP)	1,128.00	$1,614.00	15	0.68	$0.13
Water Heating	W. Htr > 55 gal	EF 0.9	-	$0.00	15	1.00	$0.00
Water Heating	W. Htr > 55 gal	EF 0.95	104.66	$67.00	15	1.00	$0.06
Water Heating	W. Htr > 55 gal	EF 2.3 (HP)	1,210.09	$1,614.00	15	0.71	$0.12
Int Lighting	Screw-in	Incandescent	-	$0.00	3	1.00	$0.00
Int Lighting	Screw-in	Inf. Halogen	188.45	$88.43	4	-	$0.13
Int Lighting	Screw-in	Inf. Halogen (2020)	579.62	$88.43	4	-	$0.04
Int Lighting	Screw-in	CFL	679.06	$37.47	6	2.39	$0.01
Int Lighting	Screw-in	LED	722.28	$1,058.63	15	0.48	$0.14
Int Lighting	Screw-in	LED (2020)	765.50	$339.51	15	-	$0.04

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Int Lighting	Lin. Fluor.	T12	-	$0.00	10	-	$0.00
Int Lighting	Lin. Fluor.	T8	9.72	-$3.22	10	1.00	-$0.04
Int Lighting	Lin. Fluor.	Super T8	29.11	$25.71	10	0.80	$0.11
Int Lighting	Lin. Fluor.	LED (2011)	28.93	$146.63	20	0.47	$0.39
Int Lighting	Lin. Fluor.	T5	29.53	$44.10	10	0.63	$0.19
Int Lighting	Lin. Fluor.	LED (2020)	113.38	$382.24	20	-	$0.26
Int Lighting	Specialty	Incandescent	-	$0.00	3	1.00	$0.00
Int Lighting	Specialty	Inf. Halogen	76.37	$111.28	4	-	$0.39
Int Lighting	Specialty	Inf. Halogen (2020)	234.91	$111.28	4	-	$0.13
Int Lighting	Specialty	CFL	275.21	$47.15	6	1.38	$0.03
Int Lighting	Specialty	LED	292.73	$1,332.10	15	0.19	$0.42
Int Lighting	Specialty	LED (2020)	310.24	$427.21	15	-	$0.13
Ext Lighting	Screw-in	Incandescent	-	$0.00	3	1.00	$0.00
Ext Lighting	Screw-in	Inf. Halogen	13.41	$13.51	4	-	$0.27
Ext Lighting	Screw-in	Inf. Halogen (2020)	82.99	$13.51	4	-	$0.04
Ext Lighting	Screw-in	CFL	95.80	$6.97	6	2.10	$0.01
Ext Lighting	Screw-in	LED	106.59	$147.69	15	0.50	$0.13
Ext Lighting	Screw-in	LED (2020)	116.97	$47.50	15	-	$0.04
Appliances	Clothes Washer	Standard (1.26)	-	$0.00	10	1.00	$0.00
Appliances	Clothes Washer	ESTAR (1.72)	26.22	$75.00	10	-	$0.35
Appliances	Clothes Washer	AHAM (MEF 1.72)	26.22	$75.00	10	-	$0.35
Appliances	Clothes Washer	ESTAR (MEF 2.0)	29.89	$115.00	10	0.86	$0.48
Appliances	Clothes Washer	AHAM (MEF 2.0)	29.89	$115.00	10	-	$0.48
Appliances	Clothes Washer	Compact (MEF 2.79)	36.28	$225.00	10	0.75	$0.77
Appliances	Clothes Dryer	Baseline	-	$0.00	13	1.00	$0.00
Appliances	Clothes Dryer	High Eff.	16.67	$100.00	13	0.87	$0.61
Appliances	Clothes Dryer	Baseline (2015+)	17.51	$75.00	13	-	$0.44
Appliances	Clothes Dryer	High Eff. (2015+)	39.20	$175.00	13	-	$0.46
Appliances	Clothes Dryer	HP (EF 4.52)	120.18	$458.00	13	0.60	$0.39
Appliances	Dishwasher	Standard (EF 0.63)	-	$0.00	9	-	$0.00
Appliances	Dishwasher	ESTAR (EF 0.69)	17.39	$5.00	9	-	$0.04
Appliances	Dishwasher	ESTAR (EF 0.73)	27.39	$80.00	9	-	$0.39
Appliances	Dishwasher	AHAM (EF 0.73)	27.39	$80.00	9	1.00	$0.39
Appliances	Dishwasher	Ultra Eff. (EF 1.1)	92.33	$255.00	9	0.84	$0.37
Appliances	Refrigerator	Standard	-	$0.00	13	1.00	$0.00
Appliances	Refrigerator	ESTAR	49.07	$25.00	13	1.00	$0.05
Appliances	Refrigerator	High Eff.	69.41	$425.00	13	0.72	$0.62
Appliances	Refrigerator	AHAM (2014)	104.12	$218.00	13	-	$0.21
Appliances	Refrigerator	High Eff. (2014)	134.03	$695.00	13	-	$0.53
Appliances	Freezer	Standard	-	$0.00	11	1.00	$0.00
Appliances	Freezer	ESTAR	46.99	$50.00	11	0.96	$0.12
Appliances	Freezer	High Eff.	98.26	$198.00	11	0.81	$0.23
Appliances	Freezer	AHAM (2014)	99.33	$198.00	11	-	$0.23
Appliances	Freezer	High Eff. (2014)	123.89	$352.00	11	-	$0.33
Appliances	2nd Fridge	Standard	-	$0.00	13	1.00	$0.00
Appliances	2nd Fridge	ESTAR	35.00	$25.00	13	1.00	$0.07
Appliances	2nd Fridge	High Eff.	49.51	$425.00	13	0.69	$0.88
Appliances	2nd Fridge	AHAM (2014)	74.26	$218.00	13	-	$0.30
Appliances	2nd Fridge	High Eff. (2014)	95.60	$695.00	13	-	$0.74
Appliances	Stove	Baseline	-	$0.00	13	1.00	$0.00
Appliances	Stove	Convection	1.31	$121.00	13	0.91	$9.44
Appliances	Stove	Halogen Burner	4.31	$580.00	13	0.68	$13.71
Appliances	Stove	Induction	24.23	$898.00	13	0.58	$3.78
Appliances	Microwave	Standard	-	$0.00	9	1.00	$0.00
Electronics	PCs	Standard	-	$0.00	5	1.00	$0.00
Electronics	PCs	ESTAR	99.63	$0.01	5	1.03	$0.00
Electronics	Monitor	Standard	-	$0.00	5	1.00	$0.00
Electronics	Monitor	ESTAR	13.16	$0.01	5	1.02	$0.00
Electronics	Laptops	Standard	-	$0.00	4	1.00	$0.00
Electronics	Laptops	ESTAR	45.89	$0.01	4	1.02	$0.00
Electronics	TVs	Standard	-	$0.00	11	1.00	$0.00
Electronics	TVs	ESTAR (4.1)	130.30	$0.02	11	-	$0.00

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Electronics	TVs	ESTAR (5.1)	146.73	$0.03	11	1.12	$0.00
Electronics	Print/Fax/Copy	Standard	-	$0.00	5	1.00	$0.00
Electronics	Print/Fax/Copy	ESTAR	12.56	$0.01	5	1.02	$0.00
Electronics	Set-top Box/DVR	Standard	-	$0.00	5	1.00	$0.00
Electronics	Set-top Box/DVR	ESTAR (2009)	50.90	$0.01	5	-	$0.00
Electronics	Set-top Box/DVR	ESTAR (2011)	67.87	$0.02	5	1.05	$0.00
Electronics	Devices/Gadget	Standard	-	$0.00	5	1.00	$0.00
Miscellaneous	Pool Pump	Standard	-	$0.00	15	1.00	$0.00
Miscellaneous	Pool Pump	High Eff.	154.64	$85.00	15	1.02	$0.05
Miscellaneous	Pool Pump	Two-Speed	618.56	$579.00	15	0.91	$0.09
Miscellaneous	Pool Heater	Electric Resistance	-	$0.00	15	1.00	$0.00
Miscellaneous	Pool Heater	Heat Pump (COP 5.0)	3,984.80	$2,550.00	15	1.04	$0.06
Miscellaneous	Hot Tub / Spa	Standard	-	$0.00	15	1.00	$0.00
Miscellaneous	Hot Tub / Spa	Efficient Pumps	144.67	$300.00	15	0.94	$0.19
Miscellaneous	Hot Tub / Spa	Imp. Controls/Pumps	192.89	$350.00	15	0.94	$0.17
Miscellaneous	Well Pump	Baseline (40% EF)	-	$0.00	10	1.00	$0.00
Miscellaneous	Well Pump	High Eff. (60% EF)	198.57	$110.00	10	0.97	$0.07
Miscellaneous	Furnace Fan	Standard	-	$0.00	18	1.00	$0.00
Miscellaneous	Furnace Fan	ECM	47.85	$769.00	18	0.33	$1.32
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.00

Table B-6 Energy Efficiency Equipment Data, Electric—Multi Family, New Vintage

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Central AC	SEER 13	-	$0.00	15	1.00	$0.00
Cooling	Central AC	SEER 14 (ESTAR)	65.25	$164.70	15	0.97	$0.23
Cooling	Central AC	SEER 15 (CEE Tier 2)	127.26	$411.74	15	0.91	$0.30
Cooling	Central AC	SEER 16 (CEE Tier 3)	179.37	$432.33	15	0.93	$0.22
Cooling	Central AC	Ductless Minisplit	223.76	$1,451.38	15	0.67	$0.60
Cooling	Central AC	SEER 21	317.58	$1,399.91	15	0.71	$0.41
Cooling	Room AC	EER 9.8	-	$0.00	10	1.00	$0.00
Cooling	Room AC	EER 10.8 (ESTAR)	37.14	$135.89	10	0.90	$0.45
Cooling	Room AC	EER 11.0	43.78	$173.64	10	0.88	$0.49
Cooling	Room AC	EER 11.5	59.32	$211.39	10	0.86	$0.44
Cooling	Room AC	EER 12.0	73.56	$890.84	10	0.52	$1.50
Cooling	Air Source HP	SEER 13, HSPF 7.7	-	$0.00	16	1.00	$0.00
Cooling	Air Source HP	SEER 14, HSPF 8.0	48.23	$141.26	16	0.96	$0.26
Cooling	Air Source HP	SEER 15, HSPF 8.2	67.92	$220.72	16	0.93	$0.29
Cooling	Air Source HP	SEER 16, HSPF 8.5	84.36	$370.80	16	0.87	$0.39
Cooling	Air Source HP	Ductless Minisplit	98.47	$1,112.41	16	0.63	$1.00
Cooling	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.00
Cooling	Geo Heat Pump	EER 16, COP 3.5	40.67	$133.11	16	0.98	$0.29
Cooling	Geo Heat Pump	EER 18, COP 3.8	106.61	$354.97	16	0.95	$0.29
Cooling	Geo Heat Pump	EER 30, COP 5.0	317.61	$798.68	16	0.93	$0.22
Heating	Elec. Resistance	Standard	-	$0.00	20	1.00	$0.00
Heating	Furnace	Standard	-	$0.00	15	1.00	$0.00
Heating	Air Source HP	SEER 13, HSPF 7.7	-	$0.00	16	1.00	$0.00
Heating	Air Source HP	SEER 14, HSPF 8.0	98.87	$109.69	16	0.97	$0.10
Heating	Air Source HP	SEER 15, HSPF 8.2	174.66	$171.38	16	0.97	$0.09
Heating	Air Source HP	SEER 16, HSPF 8.5	233.51	$287.92	16	0.93	$0.11
Heating	Air Source HP	Ductless Minisplit	278.60	$863.77	16	0.72	$0.27
Heating	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.00
Heating	Geo Heat Pump	EER 16, COP 3.5	38.59	$219.69	16	0.97	$0.50
Heating	Geo Heat Pump	EER 18, COP 3.8	185.81	$585.83	16	0.93	$0.28
Heating	Geo Heat Pump	EER 30, COP 5.0	598.03	$1,318.12	16	0.87	$0.20
Water Heating	W. Htr <= 55 gal	EF 0.9	-	$0.00	15	1.00	$0.00
Water Heating	W. Htr <= 55 gal	EF 0.95	98.18	$67.00	15	1.00	$0.06
Water Heating	W. Htr <= 55 gal	EF 2.3 (HP)	1,135.23	$1,614.00	15	0.69	$0.13
Water Heating	W. Htr > 55 gal	EF 0.9	-	$0.00	15	1.00	$0.00

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Water Heating	W. Htr > 55 gal	EF 0.95	104.66	$67.00	15	1.00	$0.06
Water Heating	W. Htr > 55 gal	EF 2.3 (HP)	1,210.09	$1,614.00	15	0.71	$0.12
Int Lighting	Screw-in	Incandescent	-	$0.00	3	1.00	$0.00
Int Lighting	Screw-in	Inf. Halogen	216.63	$101.70	4	-	$0.13
Int Lighting	Screw-in	Inf. Halogen (2020)	666.31	$101.70	4	-	$0.04
Int Lighting	Screw-in	CFL	780.62	$43.10	6	2.39	$0.01
Int Lighting	Screw-in	LED	830.30	$1,217.42	15	0.48	$0.14
Int Lighting	Screw-in	LED (2020)	879.99	$390.43	15	-	$0.04
Int Lighting	Lin. Fluor.	T12	-	$0.00	10	-	$0.00
Int Lighting	Lin. Fluor.	T8	11.18	-$3.70	10	1.00	-$0.04
Int Lighting	Lin. Fluor.	Super T8	33.48	$29.57	10	0.80	$0.11
Int Lighting	Lin. Fluor.	LED (2011)	33.27	$168.63	20	0.47	$0.39
Int Lighting	Lin. Fluor.	T5	33.96	$50.72	10	0.63	$0.19
Int Lighting	Lin. Fluor.	LED (2020)	130.39	$439.58	20	-	$0.26
Int Lighting	Specialty	Incandescent	-	$0.00	3	1.00	$0.00
Int Lighting	Specialty	Inf. Halogen	87.83	$127.97	4	-	$0.39
Int Lighting	Specialty	Inf. Halogen (2020)	270.15	$127.97	4	-	$0.13
Int Lighting	Specialty	CFL	316.50	$54.23	6	1.38	$0.03
Int Lighting	Specialty	LED	336.64	$1,531.91	15	0.19	$0.42
Int Lighting	Specialty	LED (2020)	356.78	$491.29	15	-	$0.13
Ext Lighting	Screw-in	Incandescent	-	$0.00	3	1.00	$0.00
Ext Lighting	Screw-in	Inf. Halogen	14.88	$14.50	4	-	$0.26
Ext Lighting	Screw-in	Inf. Halogen (2020)	92.07	$14.50	4	-	$0.04
Ext Lighting	Screw-in	CFL	106.28	$7.48	6	2.13	$0.01
Ext Lighting	Screw-in	LED	118.24	$158.52	15	0.51	$0.12
Ext Lighting	Screw-in	LED (2020)	129.76	$50.98	15	-	$0.04
Appliances	Clothes Washer	Standard (1.26)	-	$0.00	10	1.00	$0.00
Appliances	Clothes Washer	ESTAR (1.72)	-	$75.00	10	-	$0.00
Appliances	Clothes Washer	AHAM (MEF 1.72)	-	$75.00	10	-	$0.00
Appliances	Clothes Washer	ESTAR (MEF 2.0)	-	$115.00	10	0.84	$0.00
Appliances	Clothes Washer	AHAM (MEF 2.0)	-	$115.00	10	-	$0.00
Appliances	Clothes Washer	Compact (MEF 2.79)	-	$225.00	10	0.73	$0.00
Appliances	Clothes Dryer	Baseline	-	$0.00	13	1.00	$0.00
Appliances	Clothes Dryer	High Eff.	16.67	$100.00	13	0.87	$0.61
Appliances	Clothes Dryer	Baseline (2015+)	17.51	$75.00	13	-	$0.44
Appliances	Clothes Dryer	High Eff. (2015+)	39.20	$175.00	13	-	$0.46
Appliances	Clothes Dryer	HP (EF 4.52)	120.18	$458.00	13	0.60	$0.39
Appliances	Dishwasher	Standard (EF 0.63)	-	$0.00	9	-	$0.00
Appliances	Dishwasher	ESTAR (EF 0.69)	17.39	$5.00	9	-	$0.04
Appliances	Dishwasher	ESTAR (EF 0.73)	27.39	$80.00	9	-	$0.39
Appliances	Dishwasher	AHAM (EF 0.73)	27.39	$80.00	9	1.00	$0.39
Appliances	Dishwasher	Ultra Eff. (EF 1.1)	92.33	$255.00	9	0.84	$0.37
Appliances	Refrigerator	Standard	-	$0.00	13	1.00	$0.00
Appliances	Refrigerator	ESTAR	49.07	$25.00	13	1.00	$0.05
Appliances	Refrigerator	High Eff.	69.41	$425.00	13	0.72	$0.62
Appliances	Refrigerator	AHAM (2014)	104.12	$218.00	13	-	$0.21
Appliances	Refrigerator	High Eff. (2014)	134.03	$695.00	13	-	$0.53
Appliances	Freezer	Standard	-	$0.00	11	1.00	$0.00
Appliances	Freezer	ESTAR	46.99	$50.00	11	0.96	$0.12
Appliances	Freezer	High Eff.	98.26	$198.00	11	0.81	$0.23
Appliances	Freezer	AHAM (2014)	99.33	$198.00	11	-	$0.23
Appliances	Freezer	High Eff. (2014)	123.89	$352.00	11	-	$0.33
Appliances	2nd Fridge	Standard	-	$0.00	13	1.00	$0.00
Appliances	2nd Fridge	ESTAR	34.99	$25.00	13	1.00	$0.07
Appliances	2nd Fridge	High Eff.	49.50	$425.00	13	0.69	$0.88
Appliances	2nd Fridge	AHAM (2014)	74.24	$218.00	13	-	$0.30
Appliances	2nd Fridge	High Eff. (2014)	95.58	$695.00	13	-	$0.74
Appliances	Stove	Baseline	-	$0.00	13	1.00	$0.00
Appliances	Stove	Convection	1.31	$121.00	13	0.91	$9.44
Appliances	Stove	Halogen Burner	4.31	$580.00	13	0.68	$13.71
Appliances	Stove	Induction	24.23	$898.00	13	0.58	$3.78
Appliances	Microwave	Standard	-	$0.00	9	1.00	$0.00

End Use	Technology	Eff. Definition	Savings (kWh/HH/yr)	Incremental Cost ($/HH)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Electronics	PCs	Standard	-	$0.00	5	1.00	$0.00
Electronics	PCs	ESTAR	99.63	$0.01	5	1.03	$0.00
Electronics	Monitor	Standard	-	$0.00	5	1.00	$0.00
Electronics	Monitor	ESTAR	13.16	$0.01	5	1.02	$0.00
Electronics	Laptops	Standard	-	$0.00	4	1.00	$0.00
Electronics	Laptops	ESTAR	51.20	$0.01	4	1.02	$0.00
Electronics	TVs	Standard	-	$0.00	11	1.00	$0.00
Electronics	TVs	ESTAR (4.1)	127.82	$0.02	11	-	$0.00
Electronics	TVs	ESTAR (5.1)	143.93	$0.03	11	1.12	$0.00
Electronics	Print/Fax/Copy	Standard	-	$0.00	5	1.00	$0.00
Electronics	Print/Fax/Copy	ESTAR	12.56	$0.01	5	1.02	$0.00
Electronics	Set-top Box/DVR	Standard	-	$0.00	5	1.00	$0.00
Electronics	Set-top Box/DVR	ESTAR (2009)	50.90	$0.01	5	-	$0.00
Electronics	Set-top Box/DVR	ESTAR (2011)	67.87	$0.02	5	1.05	$0.00
Electronics	Devices/Gadget	Standard	-	$0.00	5	1.00	$0.00
Miscellaneous	Pool Pump	Standard	-	$0.00	15	1.00	$0.00
Miscellaneous	Pool Pump	High Eff.	154.64	$85.00	15	1.02	$0.05
Miscellaneous	Pool Pump	Two-Speed	618.56	$579.00	15	0.91	$0.09
Miscellaneous	Pool Heater	Electric Resistance	-	$0.00	15	1.00	$0.00
Miscellaneous	Pool Heater	Heat Pump (COP 5.0)	4,213.81	$2,550.00	15	1.08	$0.06
Miscellaneous	Hot Tub / Spa	Standard	-	$0.00	15	1.00	$0.00
Miscellaneous	Hot Tub / Spa	Efficient Pumps	146.15	$300.00	15	0.94	$0.19
Miscellaneous	Hot Tub / Spa	Imp. Controls/Pumps	194.87	$350.00	15	0.94	$0.17
Miscellaneous	Well Pump	Baseline (40% EF)	-	$0.00	10	1.00	$0.00
Miscellaneous	Well Pump	High Eff. (60% EF)	198.57	$110.00	10	0.97	$0.07
Miscellaneous	Furnace Fan	Standard	-	$0.00	18	1.00	$0.00
Miscellaneous	Furnace Fan	ECM	47.85	$769.00	18	0.33	$1.32
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.00

Table B-7 Energy Efficiency Non-Equipment Data, Electric—Single Family, Existing Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Cost ($/HH)	Savings (kWh)	BC Ratio	Levelized Cost ($/kWh)
Insulation - Ceiling	16.0%	37.5%	20	$363.46	360.71	1.44	$0.08
Insulation - Ducting	15.0%	75.0%	20	$95.00	79.09	2.12	$0.09
Insulation - Foundation	20.0%	45.0%	20	$583.04	3,241.09	7.58	$0.01
Insulation - Infiltration Control	46.0%	90.0%	15	$327.96	793.77	2.28	$0.04
Insulation - Radiant Barrier	5.0%	90.0%	20	$82.85	335.50	5.85	$0.02
Insulation - Wall Cavity	13.0%	45.0%	20	$6,048.35	662.41	0.14	$0.70
Insulation - Wall Sheathing	20.0%	45.0%	20	$4,435.45	-	-	$-
Ducting - Repair and Sealing	11.8%	50.0%	18	$497.62	1,176.17	3.24	$0.03
Windows - High Efficiency/ENERGY STAR	24.0%	90.0%	20	$7,132.86	1,117.45	0.43	$0.49
Windows - Install Reflective Film	5.0%	45.0%	10	$1,028.72	1,098.09	1.46	$0.12
Doors - Storm and Thermal	38.0%	75.0%	25	$133.00	187.58	2.63	$0.05
Roofs - High Reflectivity	5.0%	10.0%	20	$85.52	185.80	6.16	$0.04
Attic Fan - Installation	12.0%	22.5%	20	$120.48	10.00	0.24	$0.93
Attic Fan - Photovoltaic - Installation	13.0%	45.0%	20	$461.52	10.00	0.06	$3.56
Whole-House Fan - Installation	4.0%	18.8%	20	$546.60	338.03	1.75	$0.12
Ceiling Fan - Installation	56.0%	75.0%	10	$135.00	327.27	3.32	$0.05
Thermostat - Clock/Programmable	46.0%	56.3%	5	$30.00	856.44	8.69	$0.01
Home Energy Management System	2.0%	37.5%	15	$1,747.00	1,058.48	0.63	$0.15
Air Filter Alarm			1	$3	41	>1.0	$0.07
Central AC - Early Replacement	37.0%	100.0%	15	$3,373.96	396.27	0.25	$0.79
Central AC - Maintenance and Tune-Up	15.0%	100.0%	2	$175.00	334.17	0.52	$0.27
Central Heat Pump - Maintenance	15.0%	90.0%	2	$175.00	612.09	0.29	$0.15
Room AC - Removal of Second Unit	0.0%	37.5%	4	$120.00	1,291.50	6.58	$0.02
Water Heater - Drainwater Heat Recovery	1.0%	45.0%	40	$529.00	503.20	2.89	$0.06
Water Heater - Faucet Aerators	12.0%	90.0%	9	$16.00	107.82	3.23	$0.02
Water Heater - Low-Flow Showerheads	27.0%	75.0%	10	$24.00	490.93	11.00	$0.01

Water Heater - Pipe Insulation	42.0%	38.1%	15	$512.22	159.81	0.27	$0.30
Water Heater - Timer	17.0%	40.0%	5	$115.00	86.40	0.19	$0.29
Water Heater - Desuperheater	0.0%	75.0%	0	$-	-	2.00	$-
Water Heater - Solar System	0.0%	75.0%	20	$5,400.00	2,515.99	0.56	$0.17
Interior Lighting - Occupancy Sensors	3.6%	5.0%	10	$547.62	612.33	0.48	$0.11
Exterior Lighting - Photosensor Control	10.0%	45.0%	8	$130.00	136.66	0.30	$0.14
Exterior Lighting - Photovoltaic Installation	26.0%	45.0%	12	$2,973.50	27.33	0.00	$11.75
Exterior Lighting - Timeclock Installation	10.0%	45.0%	5	$115.00	27.33	0.04	$0.93
Refrigerator - Early Replacement	37.0%	100.0%	9	$876.00	249.51	0.12	$0.47
Refrigerator - Maintenance	37.0%	100.0%	4	$50.00	90.02	-	$0.12
Refrigerator - Remove Second Unit	0.0%	100.0%	5	$120.00	968.78	1.76	$0.03
Freezer - Remove Second Unit	0.0%	37.5%	5	$120.00	933	>1.0	$0.03
Freezer - Early Replacement	37.0%	100.0%	6	$403.00	198.77	0.13	$0.38
Freezer - Maintenance	0.0%	100.0%	4	$50.00	33.13	-	$0.41
Electronics - Smart Power Strips	5.0%	90.0%	4	$26.00	103.00	0.85	$0.07
Pool Pump - Timer	25.0%	90.0%	5	$115.00	129.03	0.30	$0.20
Pool Heater - Solar System	0.0%	75.0%	10	$3,500.00	3,735.75	-	$0.12
ENERGY STAR Home Design	0.0%	0.0%	25	$-	3,704.66	3.00	$-

Table B-8 Energy Efficiency Non-Equipment Data, Electric—Single Family, New Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Cost ($/HH)	Savings (kWh)	BC Ratio	Levelized Cost ($/kWh)
Insulation - Ceiling	4.0%	8.0%	12	$300.00	256.07	3.87	$0.13
Insulation - Ducting	5.0%	90.0%	5	$12.00	309.14	4.59	$0.01
Insulation - Foundation	16.0%	47.5%	20	$575.75	2,563.88	0.68	$0.02
Insulation - Infiltration Control	50.0%	75.0%	20	$95.00	535.76	4.86	$0.01
Insulation - Radiant Barrier	20.0%	90.0%	20	$760.32	88.52	4.97	$0.66
Insulation - Wall Cavity	46.0%	90.0%	15	$427.68	398.40	1.26	$0.10
Insulation - Wall Sheathing	25.0%	90.0%	20	$94.61	1,165.01	1.42	$0.01
Ducting - Repair and Sealing	13.0%	90.0%	20	$4,367.34	605.07	0.12	$0.56
Windows - High Efficiency/ENERGY STAR	20.0%	90.0%	20	$757.78	959.09	2.16	$0.06
Windows - Install Reflective Film	11.8%	50.0%	18	$497.62	951.30	1.74	$0.04
Doors - Storm and Thermal	24.0%	90.0%	20	$6,852.83	44.66	0.42	$11.83
Roofs - High Reflectivity	2.0%	45.0%	10	$656.80	124.10	2.16	$0.66
Attic Fan - Installation	13.0%	75.0%	25	$133.00	10.65	0.64	$0.85
Attic Fan - Photovoltaic - Installation	5.0%	90.0%	20	$97.66	10.65	3.99	$0.71
Whole-House Fan - Installation	4.0%	22.5%	20	$120.48	326.98	0.28	$0.03
Ceiling Fan - Installation	4.0%	11.3%	20	$461.52	300.83	0.07	$0.12
Thermostat - Clock/Programmable	4.0%	18.8%	20	$712.80	505.02	1.44	$0.11
Home Energy Management System	57.0%	75.0%	10	$135.00	813.68	3.33	$0.02
Central AC - Early Replacement	57.0%	75.0%	5	$30.00	300.22	5.47	$0.02
Central AC - Maintenance and Tune-Up	0.0%	67.5%	15	$1,747.00	254.64	0.50	$0.63
Central Heat Pump - Maintenance	24.0%	100.0%	15	$966.35	154.48	0.71	$0.58
Room AC - Removal of Second Unit	15.0%	100.0%	2	$175.00	1,109.24	0.41	$0.08
Water Heater - Drainwater Heat Recovery	15.0%	90.0%	2	$175.00	460.54	0.09	$0.19
Water Heater - Faucet Aerators	0.0%	37.5%	4	$120.00	98.61	5.83	$0.33
Water Heater - Low-Flow Showerheads	1.0%	90.0%	40	$529.00	449.41	2.60	$0.07
Water Heater - Pipe Insulation	3.0%	90.0%	9	$16.00	146.30	2.86	$0.01
Water Heater - Timer	12.0%	75.0%	10	$24.00	86.40	9.74	$0.03
Water Heater - Desuperheater	42.0%	41.3%	15	$584.93	-	0.21	$-
Water Heater - Solar System	5.0%	40.0%	5	$115.00	2,302.83	0.19	$0.01
Interior Lighting - Occupancy Sensors	0.0%	75.0%	0	$-	726.95	2.00	$-
Exterior Lighting - Photosensor Control	0.0%	75.0%	20	$5,400.00	143.87	0.50	$2.89
Exterior Lighting - Photovoltaic Installation	2.8%	9.0%	10	$547.62	28.77	0.53	$2.36
Exterior Lighting - Timeclock Installation	10.0%	45.0%	8	$130.00	28.77	0.38	$0.67
Refrigerator - Early Replacement	19.0%	45.0%	12	$2,973.50	173.69	0.00	$1.85
Refrigerator - Maintenance	16.0%	45.0%	4	$115.00	60.64	0.05	$0.42
Refrigerator - Remove Second Unit	24.0%	100.0%	9	$876.00	633.81	0.10	$0.19
Freezer - Remove Second Unit	24.0%	100.0%	5	$120	933	>1.0	$0.03
Freezer - Early Replacement	0.0%	100.0%	5	$120.00	137.93	1.37	$0.19
Freezer - Maintenance	0.0%	37.5%	4	$120.00	22.99	0.76	$1.40

Electronics - Smart Power Strips	24.0%	100.0%	6	$403.00	103.00	0.10	$0.74
Pool Pump - Timer	0.0%	100.0%	0	$50.00	108.25	-	$-
Pool Heater - Solar System	5.0%	90.0%	4	$26.00	3,437.04	0.80	$0.00
ENERGY STAR Home Design	25.0%	90.0%	5	$115.00	2,937.94	0.25	$0.01

Table B-9 Energy Efficiency Non-Equipment Data, Electric—Multi Family, Existing Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Cost ($/HH)	Savings (kWh)	BC Ratio	Levelized Cost ($/kWh)
Insulation - Ceiling	0.0%	75.0%	0	$3,500.00	291.25	-	$-
Insulation - Ducting	14.0%	75.0%	25	$8,544.00	24.00	0.68	$24.32
Insulation - Foundation	3.0%	3.0%	12	$300.00	-	3.21	$-
Insulation - Infiltration Control	5.0%	90.0%	5	$12.00	562.07	4.56	$0.00
Insulation - Radiant Barrier	11.0%	18.8%	20	$574.60	273.38	0.75	$0.16
Insulation - Wall Cavity	13.0%	75.0%	20	$95.00	347.09	0.53	$0.02
Insulation - Wall Sheathing	0.0%	0.0%	20	$-	-	2.00	$-
Ducting - Repair and Sealing	19.0%	90.0%	15	$152.10	271.12	3.40	$0.05
Windows - High Efficiency/ENERGY STAR	5.0%	90.0%	20	$130.98	238.51	3.10	$0.04
Windows - Install Reflective Film	17.0%	45.0%	20	$703.35	220.17	0.65	$0.25
Doors - Storm and Thermal	4.0%	45.0%	20	$515.79	50.71	-	$0.78
Roofs - High Reflectivity	11.8%	50.0%	18	$497.62	73.14	0.75	$0.56
Attic Fan - Installation	13.0%	90.0%	20	$1,578.78	-	0.39	$-
Attic Fan - Photovoltaic - Installation	5.0%	45.0%	10	$227.70	-	1.26	$-
Whole-House Fan - Installation	17.0%	75.0%	25	$133.00	-	0.73	$-
Ceiling Fan - Installation	3.0%	10.0%	20	$135.20	239.02	1.46	$0.04
Thermostat - Clock/Programmable	1.0%	22.5%	20	$120.48	115.65	-	$0.08
Home Energy Management System	2.0%	11.3%	20	$461.52	990.22	-	$0.04
Central AC - Early Replacement	4.0%	18.8%	20	$253.50	114.19	-	$0.17
Central AC - Maintenance and Tune-Up	56.0%	75.0%	10	$135.00	45.49	2.30	$0.37
Central Heat Pump - Maintenance	27.0%	67.5%	5	$30.00	43.41	1.21	$0.15
Room AC - Removal of Second Unit	2.0%	12.5%	15	$1,747.00	397.97	0.61	$0.41
Water Heater - Drainwater Heat Recovery	27.0%	100.0%	15	$3,430.28	322.88	0.07	$0.98
Water Heater - Faucet Aerators	15.0%	100.0%	2	$175.00	96.75	0.07	$0.93
Water Heater - Low-Flow Showerheads	15.0%	90.0%	2	$175.00	441.42	0.02	$0.20
Water Heater - Pipe Insulation	0.0%	37.5%	4	$120.00	102.49	1.69	$0.31
Water Heater - Timer	1.0%	45.0%	40	$529.00	86.40	1.87	$0.34
Water Heater - Desuperheater	8.0%	90.0%	9	$16.00	-	2.89	$-
Water Heater - Solar System	17.0%	75.0%	10	$24.00	1,614.38	9.86	$0.00
Interior Lighting - Occupancy Sensors	42.0%	38.1%	15	$348.83	390.68	0.25	$0.08
Exterior Lighting - Photosensor Control	5.0%	40.0%	5	$115.00	56.62	0.19	$0.45
Exterior Lighting - Photovoltaic Installation	0.0%	75.0%	0	$-	11.32	2.00	$-
Exterior Lighting - Timeclock Installation	0.0%	75.0%	20	$5,400.00	11.32	0.36	$36.76
Refrigerator - Early Replacement	1.0%	5.0%	10	$273.81	226.75	0.59	$0.15
Refrigerator - Maintenance	10.0%	45.0%	4	$130.00	81.81	0.17	$0.24
Refrigerator - Remove Second Unit	11.0%	45.0%	12	$2,973.50	880.39	0.00	$0.36
Freezer - Remove Second Unit	6.0%	45.0%	5	$120	933	>1.0	$0.03
Freezer - Early Replacement	27.0%	100.0%	9	$876.00	180.62	0.11	$0.65
Freezer - Maintenance	27.0%	100.0%	0	$50.00	30.10	-	$-
Electronics - Smart Power Strips	0.0%	100.0%	5	$120.00	103.00	1.47	$0.26
Pool Pump - Timer	0.0%	37.5%	4	$120.00	129.03	0.88	$0.25
Pool Heater - Solar System	27.0%	100.0%	6	$403.00	3,735.73	0.12	$0.02
ENERGY STAR Home Design	0.0%	100.0%	0	$50.00	1,134.01	-	$-

Table B-10 Energy Efficiency Non-Equipment Data, Electric—Multi Family, New Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Cost ($/HH)	Savings (kWh)	BC Ratio	Levelized Cost ($/kWh)
Insulation - Ceiling	5.0%	90.0%	4	$26.00	175.09	0.84	$0.04
Insulation - Ducting	25.0%	90.0%	5	$115.00	75.59	0.30	$0.34
Insulation - Foundation	0.0%	75.0%	0	$3,500.00	-	-	$-
Insulation - Infiltration Control	0.0%	0.0%	25	$-	306.65	3.00	$-
Insulation - Radiant Barrier	2.0%	3.0%	12	$300.00	61.69	1.05	$0.53
Insulation - Wall Cavity	5.0%	90.0%	5	$12.00	197.51	4.59	$0.01
Insulation - Wall Sheathing	13.0%	47.5%	20	$741.42	572.56	0.36	$0.10
Ducting - Repair and Sealing	50.0%	75.0%	20	$95.00	146.56	1.16	$0.05
Windows - High Efficiency/ENERGY STAR	0.0%	0.0%	20	$-	230.23	2.00	$-
Windows - Install Reflective Film	19.0%	90.0%	15	$141.48	218.72	2.03	$0.06
Doors - Storm and Thermal	5.0%	90.0%	20	$121.83	12.30	0.76	$0.76
Roofs - High Reflectivity	17.0%	90.0%	20	$392.77	32.60	0.66	$0.93
Attic Fan - Installation	4.0%	90.0%	20	$68.15	-	11.45	$-
Attic Fan - Photovoltaic - Installation	11.8%	50.0%	18	$497.62	-	0.41	$-
Whole-House Fan - Installation	13.0%	90.0%	20	$1,708.83	-	0.39	$-
Ceiling Fan - Installation	2.0%	45.0%	10	$163.78	164.85	1.89	$0.12
Thermostat - Clock/Programmable	19.0%	75.0%	25	$133.00	289.28	0.18	$0.03
Home Energy Management System	0.0%	90.0%	20	$125.76	762.27	0.77	$0.01
Central AC - Early Replacement	15.0%	22.5%	20	$120.48	85.55	-	$0.11
Central AC - Maintenance and Tune-Up	5.0%	11.3%	20	$461.52	72.46	-	$0.49
Central Heat Pump - Maintenance	4.0%	18.8%	20	$235.80	11.43	-	$1.59
Room AC - Removal of Second Unit	33.0%	75.0%	10	$135.00	339.85	1.73	$0.05
Water Heater - Drainwater Heat Recovery	19.0%	25.0%	5	$30.00	295.87	2.51	$0.02
Water Heater - Faucet Aerators	0.0%	67.5%	15	$1,747.00	88.64	0.48	$1.82
Water Heater - Low-Flow Showerheads	9.0%	100.0%	15	$999.22	404.48	0.19	$0.23
Water Heater - Pipe Insulation	15.0%	100.0%	2	$175.00	93.92	0.11	$0.95
Water Heater - Timer	15.0%	90.0%	2	$175.00	86.40	0.01	$1.04
Water Heater - Desuperheater	0.0%	37.5%	4	$120.00	-	1.49	$-
Water Heater - Solar System	1.0%	90.0%	40	$529.00	1,479.35	1.71	$0.02
Interior Lighting - Occupancy Sensors	4.0%	90.0%	9	$16.00	459.66	2.61	$0.00
Exterior Lighting - Photosensor Control	19.0%	75.0%	10	$24.00	59.85	8.91	$0.05
Exterior Lighting - Photovoltaic Installation	42.0%	41.3%	15	$336.43	11.97	0.24	$2.60
Exterior Lighting - Timeclock Installation	5.0%	40.0%	5	$115.00	11.97	0.19	$2.12
Refrigerator - Early Replacement	0.0%	75.0%	0	$-	157.84	2.00	$-
Refrigerator - Maintenance	0.0%	75.0%	4	$5,400.00	-	0.33	$-
Refrigerator - Remove Second Unit	1.4%	9.0%	10	$273.81	-	0.76	$-
Freezer - Remove Second Unit	10.0%	45.0%	5	$120.00	933	>1.0	$0.03
Freezer - Early Replacement	0.0%	45.0%	12	$2,973.50	-	0.00	$-
Freezer - Maintenance	11.0%	45.0%	5	$115.00	-	0.03	$-
Electronics - Smart Power Strips	9.0%	100.0%	9	$876.00	-	0.09	$-
Pool Pump - Timer	9.0%	100.0%	0	$50.00	-	-	$-
Pool Heater - Solar System	0.0%	100.0%	5	$120.00	-	1.20	$-
ENERGY STAR Home Design	0.0%	37.5%	4	$120.00	-	0.69	$-

COMMERCIAL ENERGY EFFICIENCY EQUIPMENT AND MEASURE DATA

This appendix presents detailed information for all commercial energy-efficiency measures (*equipment* and *non-equipment* measures per the LoadMAP taxonomy) that were evaluated in this study.

Table C-1 and Table C-2 provide brief narrative descriptions for all equipment and non-equipment measures that were assessed for potential.

Table C-3 through Table C-24 list the detailed unit-level data (including economic screen results) for commercial equipment measures in existing and new buildings. The column headings and units are the same as described for the corresponding residential sector tables above.

Table C-27 through Table C-48 list the detailed unit-level data (including economic screen results) for commercial non-equipment measures in existing and new construction. The column headings and units are the same as described for the corresponding residential sector tables above.

Table C-1 Commercial Energy Efficiency Equipment Measure Descriptions

End Use	Technology	Measure Description
Cooling	Air-Cooled Chiller	A central chiller plant creates chilled water for distribution throughout the facility. Because of the wide variety of system types and sizes, savings and cost values for efficiency improvements represent an average over screw, reciprocating, and centrifugal technologies. Under this simplified approach, each central system is characterized by an aggregate efficiency value (inclusive of chiller, pumps, and motors), in kW/ton with a further efficiency upgrade through the application of variable refrigerant flow technology.
Cooling	Water-Cooled Chiller	A central chiller plant creates chilled water for distribution throughout the facility. Water source chillers include heat rejection via a condenser loop and cooling tower. Because of the wide variety of system types and sizes, savings and cost values for efficiency improvements represent an average over screw, reciprocating, and centrifugal technologies. Under this simplified approach, each central system is characterized by an aggregate efficiency value (inclusive of chiller, pumps, motors, and condenser loop equipment), in kW/ton with a further efficiency upgrade through the application of variable refrigerant flow technology.
Cooling	Roof Top AC	Packaged cooling systems, such as rooftop units (RTUs), are simple to install and maintain, and are commonly used in small and medium-sized commercial buildings. Applications range from a single supply system with air intake filters, supply fan, and cooling coil, or can become more complex with the addition of a return air duct, return air fan, and various controls to optimize performance. For packaged RTUs, varying Energy Efficiency Ratios (EER) are modeled, as well as a ductless mini-split system.
Cooling	Other Cooling	This measure includes efficiency upgrades to other small cooling systems in commercial buildings including room AC units, packaged terminal air conditioning (PTAC) units, and packaged terminal heat pumps (PTHP).
Cooling / Heating	Air-Source Heat Pump	For heat pumps, units with increasing EER and COP levels are evaluated, as well as a ductless mini-split system.
Cooling / Heating	Geothermal Heat Pump	For heat pumps, units with increasing EER and COP levels are evaluated.
Heating	Electric Furnace	Resistive heating elements are used to convert electricity directly to heat. The heat is then delivered by a supply fan and duct system to the regions that require heating.
Heating	Electric Room Heat	Resistive heating elements are used to convert electricity directly to heat. Conductive fins surrounding the element or another mechanism is used to deliver the heat directly to the surrounding room or area. These are typically either baseboard or wall-mounted units.
Ventilation	Ventilation	A variable air volume ventilation system modulates the air flow rate as needed based on the interior conditions of the building to reduce fan load, improve dehumidification, and reduce energy usage.
Water Heating	Water Heater	Efficient electric water heaters are characterized by a high recovery or thermal efficiency (percentage of delivered electric energy which is transferred to the water) and low standby losses (the ratio of heat lost per hour to the content of the stored water). Included in the savings associated with high-efficiency electric water heaters are timers that allow temperature setpoints to change with hot water demand patterns. For example, the heating element could be shut off throughout the night, increasing the overall energy factor of the unit. In addition, tank and pipe insulation reduces standby losses and therefore reduces the demands on the water heater. This analysis considers conventional electric water heaters and heat pump water heaters. For natural gas hot water heating, the most common type is a storage heater, which incorporates a burner, storage tank, outer jacket, insulation, and controls in a single unit. Efficient units are characterized by a high recovery or thermal efficiency and low standby losses (the ratio of heat lost per hour to the content of the stored water). A further efficiency gain is available in condensing

End Use	Technology	Measure Description
		units, which condense the water vapor produced in the combustion process and also use the heat from this condensation.
Interior Lighting	Screw-in	This measure evaluates higher-efficiency alternatives for screw-in interior lamps including halogen, CFL, and LED.
Interior Lighting	High-Bay Fixtures	With the exception of screw-in lighting, commercial lighting efficiency changes typically require more than the simple purchase and installation of an alternative lamp Restrictions regarding ballasts, fixtures, and circuitry limit the potential for direct substitution of one lamp type for another. Also, during the buildout for a leased office space, management could decide to replace all lamps, ballasts, and fixtures with different configurations. This type of decision-making is modeled on a stock turnover basis because of the time between opportunities for upgrades. For High-Bay fixtures, alternatives include mercury vapor, metal halides, T5 fluorescent high output, and high-pressure sodium.
Interior Lighting	Linear Fluorescent	With the exception of screw-in lighting, commercial lighting efficiency changes typically require more than the simple purchase and installation of an alternative lamp Restrictions regarding ballasts, fixtures, and circuitry limit the potential for direct substitution of one lamp type for another. Also, during the buildout for a leased office space, management could decide to replace all lamps, ballasts, and fixtures with different configurations. This type of decision-making is modeled on a stock turnover basis because of the time between opportunities for upgrades. For linear fluorescent fixtures, alternatives include T12, T8, Super T8, T5, and LED.
Exterior Lighting	Screw-in	This measure evaluates higher-efficiency alternatives for screw-in interior lamps including halogen, CFL, and LED.
Exterior Lighting	HID	Alternatives modeled include metal halides, T8 and T5 high output, high pressure sodium, and LEDs
Exterior Lighting	Linear Fluorescent	For linear fluorescent fixtures, alternatives include T12, T8, Super T8, T5, and LED.
Refrigeration	Walk-in Refrigerator	These refrigerators can be designed to perform at higher efficiency through a combination of compressor equipment upgrades, default temperature settings, and defrost patterns. Standard refrigeration compressors typically operate at approximately 65% efficiency. High-efficiency models are available that can improve compressor efficiency by 15%. Analysis assumes unit with: 140 square feet, Cooling capacity of 26,230 BTU/hr.
Refrigeration	Reach-in Refrigerator	A significant amount of energy in the commercial sector can be attributed to "reach-in" units. These stand-alone appliances can range from a residential-style refrigerator/freezer unit in an office kitchen or the breakroom of a retail store, to the larger reach-in units in foodservice applications. As in the case of residential units, these refrigerators can be designed to perform at higher efficiency through a combination of compressor equipment upgrades, default temperature settings, and defrost patterns. Analysis assumes unit with: 48 cubic feet, Cooling capacity of 3000 BTU/hr.
Refrigeration	Glass Door Display, Open Display Case	These refrigerators can be designed to perform at higher efficiency through a combination of compressor equipment upgrades, default temperature settings, and defrost patterns. Standard refrigeration compressors typically operate at approximately 65% efficiency. High-efficiency models are available that can improve compressor efficiency by 15%. Analysis assumes unit with: Cooling capacity of 20,000 BTU/hr
Refrigeration	Icemaker	By optimizing the timing of ice production and the type of output to the specific application, icemakers are assumed to deliver electricity savings.
Refrigeration	Vending Machine	High-efficiency vending machines incorporate more efficient compressors and lighting.
Food Preparation	Ovens,Fryers, Hot Food Containers, Dishwashers	This set of measures includes high-efficiency fryers, ovens, dishwashers, and hot food containers. Less common equipment, such as broilers and steamers, and assumed to be modeled with the other more common equipment types.

End Use	Technology	Measure Description
Office Equipment	Desktop Computer, Laptop, Monitors	ENERGY STAR labeled computers automatically power down to 15 watts or less when not in use and may actually last longer than conventional products because they spend a large portion of time in a low-power sleep mode. ENERGY STAR labeled computers also generate less heat than conventional models.
Office Equipment	Server	In addition to the "sleep" mode a reductions, servers have additional energy-saving opportunities through "virtualization" and other architecture solutions that involve optimal matching of computation tasks to hardware requirements
Office Equipment	Printer/Copier/Fax	ENERGY STAR labeled office equipment saves energy by powering down and "going to sleep" when not in use. ENERGY STAR labeled copiers are equipped with a feature that allows them to automatically turn off after a period of inactivity.
Office Equipment	POS Terminal	Point-of-sale terminals in retail and supermarket facilities are always on. Efficient models incorporate a high-efficiency power supply to reduce energy use.
Miscellaneous	Non-HVAC Motors	Includes motors for a variety of non-HVAC uses including vertical transportation. Premium efficiency motors can provide savings of 0.5% to 3% over standard motors. The savings results from the fact that energy efficient motors run cooler than their standard counterparts, resulting in an increase in the life of the motor insulation and bearing. In general, an efficient motor is a more reliable motor because there are fewer winding failures, longer periods between needed maintenance, and fewer forced outages. For example, using copper instead of aluminum in the windings, and increasing conductor cross-sectional area, lowers a motor's I2R losses.
Miscellaneous	Pool Pump	High-efficiency motors and two-speed pumps provide improved energy efficiency for this load.
Miscellaneous	Pool Heater	Efficient pool heaters can make use of heat pump technology to achieve significantly higher coefficients of performance in the COP=5.0 range. Gas pool heaters have a burner to heat water in a loop. Efficiency improvements can include: exhaust fan controls, electronic ignition (no pilot light), compact size and lighter weight to reduce cycling losses, and sealed combustion. Very high efficiency units, or condensing units, condense the water vapor produced in the combustion process and also use the heat from this condensation.
Miscellaneous	Miscellaneous	Improvement of miscellaneous electricity uses
Exterior Lighting	LED Traffic Signals	This measure installs an LED traffic signal that is not only more efficient, but lasts multiples longer than conventional technology lifetimes, thereby avoiding significant operational and maintenance costs.
Exterior Lighting	LED Crosswalk Lights	This measure installs an LED pedestrian signals that is not only more efficient, but lasts multiples longer than conventional technology lifetimes, thereby avoiding significant operational and maintenance costs.

Table C-2 Commercial Energy Efficiency Non-Equipment Measure Descriptions

End Use	Measure	Description
HVAC (All)	Insulation - Ceiling	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation can conserve energy by reducing the heat loss or gain of a building. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose; loose-fill (blown) fiberglass; and rigid polystyrene.
HVAC (All)	Insulation - Ducting	Air distribution ducts can be insulated to reduce heating or cooling losses. Best results can be achieved by covering the entire surface area with insulation. Insulation material inhibits the transfer of heat through the air-supply duct. Several types of ducts and duct insulation are available, including flexible duct, pre-insulated duct, duct board, duct wrap, tacked, or glued rigid insulation, and waterproof hard shell materials for exterior ducts.
HVAC (All)	Insulation - Radiant Barrier	Radiant barriers are materials installed to reduce the heat gain in buildings. Radiant barriers are made from materials that are highly reflective and have low emissivity like aluminum. The closer the emissivity is to 0 the better they will perform. Radiant barriers can be placed above the insulation or on the roof rafters.
HVAC (All)	Insulation - Wall Cavity	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation can conserve energy by reducing the heat loss or gain of a building. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose; loose-fill (blown) fiberglass; and rigid polystyrene.
HVAC (All)	HVAC - Duct Repair and Sealing	Leakage in unsealed ducts varies considerably because of the differences in fabricating machinery used, the methods for assembly, installation workmanship, and age of the ductwork. Air leaks from the system to the outdoors result in a direct loss proportional to the amount of leakage and the difference in enthalpy between the outdoor air and the conditioned air. To seal ducts, a wide variety of sealing methods and products exist. Each has a relatively short shelf life, and no documented research has identified the aging characteristics of sealant applications.
HVAC (All)	Doors - High Efficiency	Like other components of the shell, doors are subject to several types of heat loss: conduction, infiltration, and radiant losses. High efficiency doors have exceptional thermal insulation properties and tight-fitting, weather-stripping on the doorframe to reduce air leakage.
HVAC (All)	Windows - High Efficiency	High-efficiency windows, such as those labeled under the ENERGY STAR Program, are designed to reduce a building's energy bill while increasing comfort for the occupants at the same time. High-efficiency windows have reducing properties that reduce the amount of heat transfer through the glazing surface. For example, some windows have a low-E coating, which is a thin film of metallic oxide coating on the glass surface that allows passage of short-wave solar energy through glass and prevents long-wave energy from escaping. Another example is double-pane glass that reduces conductive and convective heat transfer. There are also double-pane glasses that are gas-filled (usually argon) to further increase the insulating properties of the window.
HVAC (All)	Roof - High Reflectivity	The color and material of a building structure surface will determine the amount of solar radiation absorbed by that surface and subsequently transferred into a building. This is called solar absorptance. By using a living roof or a roofing material with a light color (and a lower solar absorptance), the roof will absorb less solar radiation and consequently reduce the cooling load. Living roofs also reduce stormwater runoff.
Cooling	Air-Cooled Chiller - Condenser Water Temperature Reset	Resetting the condenser water temperature to the lowest possible setting allows the cooling tower to generate cooler water whenever possible and decreases the temperature lift between the condenser and the evaporator. This will generally increase chiller part-load efficiency, though it may require

End Use	Measure	Description
		increased tower fan energy use.
Cooling	Air-Cooled Chiller - Economizer	Economizers allow outside air (when it is cool and dry enough) to be brought into the building space to meet cooling loads instead of using mechanically cooled interior air. A dual enthalpy economizer consists of indoor and outdoor temperature and humidity sensors, dampers, motors, and motor controls. Economizers are most applicable to temperate climates and savings will be smaller in extremely hot or humid areas.
Cooling	Air-Cooled Chiller - Thermal Energy Storage	This measure uses energy at off-peak times to create a chilled media, typically cool water or ice, then stores it in an insulated chamber until peak hours. During peak hours, it uses the cooling energy stored in the media by running the chiller loop through a heat exchanger in the thermal storage chamber, thereby reducing energy and peak demand from the grid.
Cooling	Air-Cooled Chiller - VSD on Fans	Variable speed drives, which reduce chiller energy use under part load, are modeled for both air-cooled and water-cooled chillers.
Cooling	Air-Cooled Chiller - Chilled Water Reset	Chilled water reset controls save energy by improving chiller performance through increasing the supply chilled water temperature, which allows increased suction pressure during low load periods. Raising the chilled water temperature also reduces chilled water piping losses. However, the primary savings from the chilled water reset measure results from chiller efficiency improvement. This is due partly to the smaller temperature difference between chilled water and ambient air, and partly due to the sensitivity of chiller performance to suction temperature.
Cooling	Air-Cooled Chiller - Chilled Water Variable-Flow System	The part-load efficiency of chilled water loops can be improved substantially by varying the flow speed of the delivered water with the building demand for cooling.
Cooling	Air-Cooled Chiller - High Efficiency Cooling Tower Fans	High-efficiency cooling fans utilize efficient components and variable frequency drives that improve fan performance by adjusting fan speed and rotation as conditions change.
Cooling	Air-Cooled Chiller - Maintenance	Filters, coils, and fins require regular cleaning and maintenance for the heat pump or roof top unit to function effectively and efficiently throughout its years of service. Neglecting necessary maintenance leads to a steady decline in performance while energy use increases.
Water-Cooled Chiller	Water Cooled Chiller Condenser Water Temperature Reset	Resetting the condenser water temperature to the lowest possible setting allows the cooling tower to generate cooler water whenever possible and decreases the temperature lift between the condenser and the evaporator. This will generally increase chiller part-load efficiency, though it may require increased tower fan energy use.
Water-Cooled Chiller	Water Cooled Chiller Economizer	Economizers allow outside air (when it is cool and dry enough) to be brought into the building space to meet cooling loads instead of using mechanically cooled interior air. A dual enthalpy economizer consists of indoor and outdoor temperature and humidity sensors, dampers, motors, and motor controls. Economizers are most applicable to temperate climates and savings will be smaller in extremely hot or humid areas.
Water-Cooled Chiller	Water Cooled Chiller-Thermal Energy Storage	This measure uses energy at off-peak times to create a chilled media, typically cool water or ice, then stores it in an insulated chamber until peak hours. During peak hours, it uses the cooling energy stored in the media by running the chiller loop through a heat exchanger in the thermal storage chamber, thereby reducing energy and peak demand from the grid.
Water-Cooled Chiller	Water-Cooled Chiller VSD on Fans	Variable speed drives, which reduce chiller energy use under part load, are modeled for both air-cooled and water-cooled chillers.
Water-Cooled Chiller	Water-Cooled Chiller-Chiller Water reset	Chilled water reset controls save energy by improving chiller performance through increasing the supply chilled water temperature, which allows increased suction pressure during low load periods. Raising the chilled water temperature also reduces chilled water piping losses. However, the primary savings from the chilled water reset measure results from chiller efficiency

End Use	Measure	Description
		improvement. This is due partly to the smaller temperature difference between chilled water and ambient air, and partly due to the sensitivity of chiller performance to suction temperature.
Water-Cooled Chiller	Water- Cooled Chiller Variable Flow System	The part-load efficiency of chilled water loops can be improved substantially by varying the flow speed of the delivered water with the building demand for cooling.
Water-Cooled Chiller Water Cooled Chiller	Water-Cooled Chiller High Efficiency Cooling Tower Fans	High-efficiency cooling fans utilize efficient components and variable frequency drives that improve fan performance by adjusting fan speed and rotation as conditions change.
Water-Cooled Chiller	Water-Cooled Chiller Maintenance	Filters, coils, and fins require regular cleaning and maintenance for the heat pump or roof top unit to function effectively and efficiently throughout its years of service. Neglecting necessary maintenance leads to a steady decline in performance while energy use increases.
Water-Cooled Chiller	Water-Cooled Chiller Heat Recovery	Capturing the waste heat from the cooling tower of a chiller by means of a heat exchanger in order to meet water heating loads.
Water Heating	Air-Cooled Chiller - Chiller Heat Recovery	Capturing the waste heat from the cooling tower of a chiller by means of a heat exchanger in order to meet water heating loads.
Water Heating	Pre-rinse Sprayer	Low-flow pre-rinse sprayer are attachments in a kitchen or wash area that aerate and optimize the efficiency of water flow and the associated water heating energy. They are effective at rinsing and cleaning while using less hot water.
Cooling	RTU - Evaporative Precooler	Evaporative precooling can improve the performance of air conditioning systems, most commonly RTUs. These systems typically use indirect evaporative cooling as a first stage to pre-cool outside air. If the evaporative system cannot meet the full cooling load, the air steam is further cooled with conventional refrigerative air conditioning technology.
Cooling	RTU - Maintenance	Regular cleaning and maintenance enables a roof top unit to function effectively and efficiently throughout its years of service. Neglecting necessary maintenance leads to a steady decline in performance while energy use increases. Maintenance can increase the efficiency of poorly performing equipment by as much as 10%.
Heating	Space Heating - Heat Recovery Ventilator	Heat recovery ventilation uses a counter-flow, air-to-air heat exchanger between inbound and outbound air flow to selectively transfer heat and reduce space heating loads.
Cooling / Heating	Heat Pump - Maintenance	Regular cleaning and maintenance enables a heat pump to function effectively and efficiently throughout its years of service. Neglecting necessary maintenance leads to a steady decline in performance while energy use increases. Maintenance can increase the efficiency of poorly performing equipment by as much as 10%.
Ventilation	Ventilation - ECM on VAV Boxes	ECM motors are well suited to the variable flow rates of VAV boxes. ECMs are a higher efficiency option for the air blowers and maintain efficiency better over a wide range of loads.
Ventilation	Ventilation - Variable Speed Control	Variable speed controls adjust ventilation fans for part-load conditions to reduce energy use.
Water Heating	Water Heater - Drainwater Heat Recovery	Drainwater Heat Recovery is a system in which drain water is used to preheat cold water entering the water heater. While these systems themselves are relatively inexpensive, upgrading an existing system could be unreasonable because of demolition costs. Thus they are modeled for new vintage only.
Water Heating	Water Heater - Faucet Aerators/Low Flow Nozzles	A faucet aerator or low flow nozzle spreads the stream from a faucet helping to reduce water usage. The amount of water passing through the aerator is measured in gallons per minute (GPM) and the lower the GPM the more water the aerator conserves.
Water	Water Heater - High	A high efficiency circulation pump uses an electronically commutated motor

End Use	Measure	Description
Heating	Efficiency Circulation Pump	(ECM) to improve motor efficiency over a larger range of partial loads. In addition, an ECM allows for improved low RPM performance with greater torque and smaller pump dimensions.
Water Heating	Water Heater - Desuperheater	A desuperheater can be added to an existing geothermal heat pump system (typically installed with the primary function of space heating and cooling) in order to draw off a portion of the geothermal heat for water heating purposes. The system can either supplement the building's water heater, or be a full-demand water heater that meets all of the building's hot water needs.
Water Heating	Water Heater - Solar System	Solar water heating systems can be used in residential buildings that have an appropriate near-south-facing roof or nearby unshaded grounds for installing a collector. Although system types vary, in general these systems use a solar absorber surface within a solar collector or an actual storage tank. Either a heat-transfer fluid or the actual potable water flows through tubes attached to the absorber and transfers heat from it. (Systems with a separate heat-transfer-fluid loop include a heat exchanger that then heats the potable water.) The heated water is stored in a separate preheat tank or a conventional water heater tank. If additional heat is needed, it is provided by a conventional water-heating system.
Water Heating	Water Heater - Install Timer	These measures use either a programmable thermostat or a timer to adjust the water heater setpoint at times of low usage, typically when a home is unoccupied.
Water Heating	Water Heater - Pipe Insulation	Insulating hot water pipes decreases the amount of energy lost during distribution of hot water throughout the building. Insulating pipes will result in quicker delivery of hot water and allows lowering the water heating set point. There are several different types of insulation, the most common being polyethylene and neoprene.
Water Heating	Water Heater - Tank Blanket/Insulation	Insulation levels on hot water heaters can be increased by installing a fiberglass blanket on the outside of the tank. This increase in insulation reduces standby losses and thus saves energy. Water heater insulation is available either by the blanket or by square foot of fiberglass insulation with R-values ranging from 5 to 14.
Interior Lighting	Interior Lighting - Daylighting Controls	Daylighting controls use a photosensor to detect ambient light and adjust or turn off electric lights accordingly.
Interior Lighting	Interior Lighting - LED Exit Lighting	The lamps inside exit signs represent a significant energy end-use, since they usually operate 24 hours per day. Many old exit signs use incandescent lamps, which consume approximately 40 watts per sign. The incandescent lamps can be replaced with LED lamps that are specially designed for this specific purpose. In comparison, the LED lamps consume approximately 2-5 watts.
Interior Lighting	Interior Lighting - Occupancy Sensors	The installation of occupancy sensors allows lights to be turned off during periods when a space is unoccupied, virtually eliminating the wasted energy due to lights being left on. There are several types of occupancy sensors in the market.
Interior Lighting	Interior Lighting - Timeclocks and Timers	In many cases lighting remains on at night and during weekends. A simple timer can set a schedule for turning lights off to reduce operating hours.
Interior Lighting	Interior Lighting - Task Lighting	Individual work areas can use task lighting instead of brightly lighting the entire area. Significant energy savings can be realized by focusing light directly where it is needed and lowering the general lighting level. An example of task lighting is the common desk lamp. A 25W desk lamp can be installed in place of a typical lamp in a fixture.
Interior Lighting	Interior Fluorescent - Bi-Level Fixture	Bi-level fixtures have the ability to reduce light output to a lower level, given a control strategy that is based on a timer, occupancy sensor, motion sensor, or manual switch.
Interior Lighting	Interior Fluorescent - Delamp and Install Reflectors	While sometimes included in lighting retrofit projects, delamping is often performed as a separate energy efficiency measure in which a lighting engineer analyzes the lighting provided by current systems compared to the

End Use	Measure	Description
		requirements of building occupants. This often leads to the removal of unnecessary lamps corresponding to an overall reduction in energy usage. In addition, installing a reflector in each fixture can improve light distribution from the remaining lamps.
Exterior Lighting	Exterior Lighting - Bi-Level Fixture	Bi-level fixtures have the ability to reduce light output to a lower level, given a control strategy that is based on a timer, occupancy sensor, motion sensor, or manual switch.
Exterior Lighting	Exterior Lighting - Daylighting Controls	Daylighting controls use a photosensor to detect ambient light and adjust or turn off electric lights accordingly.
Exterior Lighting	Exterior Lighting - Photovoltaic Installation	Solar photovoltaic generation may be used to power exterior lighting and thus eliminate all or part of the electrical energy use.
Refrigeration	Refrigerator - Anti-Sweat Heater	Anti-sweat heaters are used in virtually all low-temperature display cases and many medium-temperature cases to control humidity and prevent the condensation of water vapor on the sides and doors and on the products contained in the cases. Typically, these heaters stay on all the time, even though they only need to be on about half the time. Anti-sweat heater controls can come in the form of humidity sensors or time clocks.
Refrigeration	Refrigerator - Decommissioning	Early retirement, removal, and recycling or older, little used refrigerators and freezers removes the energy use of these inefficient, aging units.
Refrigeration	Refrigerator - Demand Defrost	Units can be designed to perform at higher efficiency with a sensing and control system that runs defrost cycles based on demand/only when necessary.
Refrigeration	Refrigerator - Door Gasket Replacement	This measure involves replacing aging door gaskets that no longer adequately seal reach-in refrigerators or glass door display cases.
Refrigeration	Refrigerator - Evaporator Fan Controls	Evaporator fan motor controls allow for part load use or demand scheduling based on variable refrigeration load requirements, reducing energy consumption.
Refrigeration	Refrigerator - Floating Head Pressure	Floating head pressure control allows the pressure in the condenser to "float" with ambient temperatures. This method reduces refrigeration compression ratios, improves system efficiency and extends the compressor life. The greatest savings with a floating head pressure approach occurs when the ambient temperatures are low, such as in the winter season. Floating head pressure control is most practical for new installations. However, retrofits installation can be completed with some existing refrigeration systems. Installing floating head pressure control increases the capacity of the compressor when temperatures are low, which may lead to short cycling.
Refrigeration	Refrigerator - Strip Curtain	Strip curtains at the entrances to large walk-in coolers or freezers, such as those used in supermarkets, reduce air transfer between the refrigerated space and the surrounding space.
Refrigeration	Refrigerator - High Efficiency Compressor	Standard compressors typically operate at approximately 65% efficiency. High-efficiency models are available that can improve compressor efficiency by 15%.
Refrigeration	Refrigerator - Variable Speed Compressor	The part-load efficiency of drive systems can be improved by varying the speed of the motor drive. An additional benefit of variable-speed controls is the ability to start and stop the motor and process gradually, thus extending the life of the motor and associated machinery.
Refrigeration	Refrigerator - eCube	The eCube consists of a solid, waxy food simulant that is fitted around a thermostat sensor that would otherwise measure air temperature. The refrigeration controls therefore attempt to regulate the temperature of food, which changes more slowly and gradually than air, thereby reducing the frequency of refrigeration cycles.
Refrigeration	Vending Machine - Controller	Cold beverage vending machines usually operate 24 hours a day regardless of whether the surrounding area is occupied or not. The result is that the vending machine consumes energy unnecessarily, because it will operate all night to keep the beverage cold even when there would be no customers until the next

End Use	Measure	Description
		morning. A vending machine controller can reduce energy consumption without compromising the temperature of the vended product. The controller uses an infrared sensor to monitor the surrounding area's occupancy and will power down the vending machine when the area is unoccupied. It will also monitor the room's temperature and will re-power the machine at one to three hour intervals independent of occupancy to ensure that the product stays cold.
Office Equipment	Office Equipment - ENERGY STAR Power Supplies	Power supplies with an efficient ac-dc or ac-ac conversion process can obtain the ENERGY STAR label. These devices can be used to power computers, phones, and other office equipment.
Office Equipment	Office Equipment - Plug Load Occupancy Sensors	Occupancy sensors can control power strips and thus turn off energy used by plug loads, such as task lights, when an office is unoccupied.
Miscellaneous	Pool Heater - Solar	This measure replaces a conventional pool heater with a solar system.
Miscellaneous	Pool Pump - Timer	A pool pump timer allows the pump to turn off automatically, eliminating the wasted energy associated with unnecessary pumping.
Ventilation	Ventilation - CO2 Controlled	Also known as Demand Controlled Ventilation, this measure uses carbon dioxide (CO2) levels to indicate the level of occupancy in a space. Sensors monitor CO2 levels so that air handling controls can adjust the amount of outside air the system needs to intake. Ventilation rates are thereby controlled based on occupancy, rather than a fixed rate, thus saving HVAC energy use.
Miscellaneous	Non-HVAC Motors - Variable Speed Control	The part-load efficiency of motors can be improved by varying the speed of the motor drive. There are two major types of variable speed controls: mechanical and electronic. An additional benefit of variable-speed controls is the ability to start and stop the motor gradually, thus extending the life of the motor and associated machinery. This analysis assumes that electronic variable speed controls are installed.
HVAC (All)	Energy Management System	An energy management system (EMS) allows managers/owners to monitor and control the major energy-consuming systems within a commercial building. At the minimum, the EMS can be used to monitor and record energy consumption of the different end-uses in a building, and can control operation schedules of the HVAC and lighting systems. The monitoring function helps building managers/owners to identify systems that are operating inefficiently so that actions can be taken to correct the problem. The EMS can also provide preventive maintenance scheduling that will reduce the cost of operations and maintenance in the long run. The control functionality of the EMS allows the building manager/owner to operate building systems from one central location. The operation schedules set via the EMS help to prevent building systems from operating during unwanted or unoccupied periods. This analysis assumes that this measure is limited to buildings with a central HVAC system.
HVAC (All)	Thermostat - Clock/Programmable	A programmable thermostat can be added to most heating/cooling systems. They are typically used during winter to lower temperatures at night and in summer to increase temperatures during the afternoon. There are two-setting models, and well as models that allow separate programming for each day of the week. The energy savings from this type of thermostat are identical to those of a "setback" strategy with standard thermostats, but the convenience of a programmable thermostat makes it a much more attractive option. In this analysis, the baseline is assumed to have no thermostat setback.
HVAC, Lighting	HVAC - Occupancy Sensors	Occupancy sensors turn off or adjust HVAC settings when a space is unoccupied.
HVAC, Lighting	Commissioning - HVAC, Lighting	For new construction and major renovations, commissioning ensures that building systems are properly designed, specified, and installed to meet the design intent and provide high-efficiency performance. Commissioning begins during the design process.
HVAC, Lighting	Retrocommissioning - HVAC, Lighting	In existing buildings, the retrocommissioning process identifies low-cost or no cost measures, including controls adjustments, to improve building performance and reduce operating costs. Retrocommissioning addresses

End Use	Measure	Description
		HVAC, lighting, DHW, and other major building systems.
HVAC (All)	Advanced New Construction Designs	Advanced new construction designs use an integrated approach to the design of new buildings to account for the interaction of building systems. Designs may specify the building orientation, building shell, proper sizing of equipment and systems, and controls strategies with the goal of optimizing building energy efficiency and comfort. Options that may be evaluated and incorporated include passive solar strategies, increased thermal mass, natural ventilation, energy recovery ventilation, daylighting strategies, and shading strategies. This measure is modeled for new vintage only.
HVAC, Lighting	Custom Measures	Custom measures may be included in the analysis to serve as a "catch all" for measures for which costs and savings are not easily quantified and that could be part of a custom program. Typical costs and energy savings are assumed such that the measures pass the economic screen.
Office Equipment	PC Power Management Software	This measure employs software and policies designed to minimize monitor and peripheral run times, and maximize the use of sleep and hibernation modes.

Table C-3 Energy Efficiency Equipment Data, Electric—Small Office, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	1.10	$0.32	20	1.16	$0.022
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	1.24	$0.41	20	1.18	$0.026
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	1.46	$0.51	20	1.22	$0.027
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	1.75	$0.60	20	1.27	$0.026
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	1.68	$0.18	20	1.19	$0.008
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	1.90	$0.36	20	1.21	$0.015
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	2.23	$0.43	20	1.26	$0.015
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	2.68	$0.68	20	1.30	$0.019
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	2.79	$0.75	20	1.32	$0.021
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	3.02	$0.82	20	1.35	$0.021
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	0.55	$0.33	16	-	$0.053
Cooling	Roof top AC	EER 11.2	1.10	$0.63	16	1.00	$0.051
Cooling	Roof top AC	EER 12.0	1.44	$1.21	16	0.98	$0.075
Cooling	Roof top AC	Ductless Minisplit	1.80	$3.98	16	0.79	$0.195
Cooling	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air Source Heat Pump	EER 10.3, COP 3.2	0.60	$0.41	16	-	$0.060
Cooling	Air Source Heat Pump	EER 11.0, COP 3.3	0.96	$0.59	16	1.00	$0.055
Cooling	Air Source Heat Pump	EER 11.7, COP 3.4	1.27	$1.51	16	0.95	$0.105
Cooling	Air Source Heat Pump	EER 12.0, COP 3.4	1.39	$1.97	16	0.92	$0.125
Cooling	Air Source Heat Pump	Ductless Minisplit	1.76	$3.78	16	0.82	$0.190
Cooling	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geo Heat Pump	EER 16, COP 3.5	0.37	$0.99	16	0.96	$0.234
Cooling	Geo Heat Pump	EER 18, COP 3.8	0.68	$1.97	16	0.91	$0.257
Cooling	Geo Heat Pump	EER 30, COP 5.0	1.66	$2.60	16	0.97	$0.138
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	0.07	$0.02	14	1.02	$0.027
Cooling	Other Cooling	EER 10.8	0.14	$0.23	14	0.99	$0.156
Cooling	Other Cooling	EER 11	0.21	$0.25	14	1.00	$0.112
Cooling	Other Cooling	EER 11.5	0.28	$0.28	14	1.01	$0.097
Heating	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air Source Heat Pump	EER 10.3, COP 3.2	0.04	$0.15	16	-	$0.361
Heating	Air Source Heat Pump	EER 11.0, COP 3.3	0.07	$0.21	16	1.00	$0.274
Heating	Air Source Heat Pump	EER 11.7, COP 3.4	0.10	$0.54	16	0.94	$0.500
Heating	Air Source Heat Pump	EER 12.0, COP 3.4	0.10	$0.71	16	0.91	$0.652
Heating	Air Source Heat Pump	Ductless Minisplit	0.12	$1.35	16	0.81	$0.992
Heating	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geo Heat Pump	EER 16, COP 3.5	0.39	$0.33	16	0.99	$0.075
Heating	Geo Heat Pump	EER 18, COP 3.8	0.70	$0.65	16	0.96	$0.082
Heating	Geo Heat Pump	EER 30, COP 5.0	0.11	$0.86	16	0.85	$0.685
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	1.76	-$0.10	10	1.29	-$0.007
Water Heating	Water Heating	EF .97	-	$0.00	15	1.00	$0.000
Water Heating	Water Heating	EF .98	0.01	$0.00	15	1.01	$0.000
Water Heating	Water Heating	EF 2.0	0.41	$0.00	15	2.06	$0.000
Water Heating	Water Heating	EF 2.3	0.46	$0.00	15	2.37	$0.000
Water Heating	Water Heating	EF 2.4	0.47	$0.00	15	2.47	$0.000
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	1.04	$0.05	3	-	$0.017
Int. Lighting	Screw-in	70W HIR PAR-38	1.59	$0.07	3	-	$0.015
Int. Lighting	Screw-in	CFL	2.98	$0.04	6	3.46	$0.003
Int. Lighting	Screw-in	LED (2010)	3.23	$1.07	20	1.95	$0.026
Int. Lighting	Screw-in	LED (2020)	3.71	$0.30	20	-	$0.006
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	0.13	$0.24	15	0.68	$0.166

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Int. Lighting	High-Bay Fixtures	T8	0.14	-$0.01	10	1.81	-$0.006
Int. Lighting	High-Bay Fixtures	HP Sodium	0.15	$0.00	6	1.76	$0.001
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	0.17	$0.00	15	1.95	$0.002
Int. Lighting	High-Bay Fixtures	T5	0.17	$0.00	10	2.21	-$0.003
Int. Lighting	High-Bay Fixtures	LED (2020)	0.26	$0.06	15	-	$0.022
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	0.82	$3.73	15	0.48	$0.421
Int. Lighting	Linear Fluorescent	T8	0.85	$0.00	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	1.18	$0.02	10	1.51	$0.003
Int. Lighting	Linear Fluorescent	T5	1.37	$0.04	10	1.63	$0.004
Int. Lighting	Linear Fluorescent	LED (2020)	2.50	$1.03	15	-	$0.038
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	0.08	$0.00	3	-	$0.017
Ext. Lighting	Screw-in	70W HIR PAR-38	0.12	$0.01	3	-	$0.015
Ext. Lighting	Screw-in	CFL	0.23	$0.00	6	3.21	$0.003
Ext. Lighting	Screw-in	LED (2010)	0.25	$0.08	20	1.50	$0.026
Ext. Lighting	Screw-in	LED (2020)	0.29	$0.02	20	-	$0.006
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	0.45	$0.66	15	0.61	$0.137
Ext. Lighting	HID	T8	0.45	-$0.02	10	1.76	-$0.005
Ext. Lighting	HID	HP Sodium	0.48	$0.00	6	1.73	$0.001
Ext. Lighting	HID	Light Emitting Plasma	0.56	$0.01	15	1.84	$0.002
Ext. Lighting	HID	T5	0.58	-$0.01	10	2.15	-$0.002
Ext. Lighting	HID	LED (2020)	0.85	$0.17	15	-	$0.018
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.02	$0.09	15	0.39	$0.421
Ext. Lighting	Linear Fluorescent	T8	0.02	$0.00	10	1.34	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.03	$0.00	10	1.50	$0.003
Ext. Lighting	Linear Fluorescent	T5	0.03	$0.00	10	1.61	$0.004
Ext. Lighting	Linear Fluorescent	LED (2020)	0.06	$0.03	15	-	$0.038
Refrigeration	Walk-in Refrigerator	14600 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	10800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	10000 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	9000 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	3800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	3100 kWh/yr	0.04	$0.00	12	1.20	$0.003
Refrigeration	Reach-in Refrigerator	2500 kWh/yr	0.07	$0.00	12	1.45	$0.003
Refrigeration	Reach-in Refrigerator	2400 kWh/yr	0.07	$0.00	12	1.50	$0.003
Refrigeration	Reach-in Refrigerator	1500 kWh/yr	0.12	$0.00	12	2.28	$0.002
Refrigeration	Glass Door Display	14480 kWh/yr	-	$0.00	12	-	$0.000
Refrigeration	Glass Door Display	11700 kWh/yr	-	$0.00	12	-	$0.000
Refrigeration	Glass Door Display	8400 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Glass Door Display	6800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Open Display Case	6500 kWh/yr	-	$0.00	18	-	$0.000
Refrigeration	Open Display Case	5350 kWh/yr	-	$0.00	18	1.00	$0.000
Refrigeration	Open Display Case	5300 kWh/yr	-	$0.00	18	-	$0.000
Refrigeration	Open Display Case	4330 kWh/yr	-	$0.00	18	1.00	$0.000
Refrigeration	Icemaker	7.0 kWh/100 lbs	-	$0.00	10	1.00	$0.000
Refrigeration	Icemaker	6.3 kWh/100 lbs	0.02	$0.01	10	1.01	$0.054
Refrigeration	Icemaker	6.0 kWh/100 lbs	0.03	$0.01	10	1.00	$0.057
Refrigeration	Icemaker	5.5 kWh/100 lbs	0.05	$0.05	10	0.88	$0.142
Refrigeration	Vending Machine	3400 kWh/year	-	$0.00	10	1.00	$0.000
Refrigeration	Vending Machine	3000 kWh/year	0.02	$0.00	10	1.05	$0.012
Refrigeration	Vending Machine	2400 kWh/year	0.05	$0.01	10	1.14	$0.012
Refrigeration	Vending Machine	1700 kWh/year	0.09	$0.02	10	1.20	$0.022
Food Prep.	Oven	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Oven	Energy Star	0.05	$0.00	12	1.14	$0.000
Food Prep.	Fryer	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Fryer	Energy Star	-	$0.00	12	1.00	$0.000
Food Prep.	Dishwasher	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Dishwasher	Energy Star	0.24	$0.01	12	1.36	$0.005
Food Prep.	Hot Food Container	Standard	-	$0.00	12	1.00	$0.000

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Food Prep.	Hot Food Container	Energy Star	-	$0.00	12	1.00	$0.000
Office Equip.	Desktop Computer	Standard	-	$0.00	5	1.00	$0.000
Office Equip.	Desktop Computer	Energy Star	0.39	$0.00	5	1.05	$0.000
Office Equip.	Laptop	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Laptop	Energy Star	0.06	$0.00	4	1.02	$0.000
Office Equip.	Server	Standard	-	$0.00	3	1.00	$0.000
Office Equip.	Server	Energy Star	0.18	$0.00	3	1.04	$0.000
Office Equip.	Monitor	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Monitor	Energy Star	0.04	$0.00	4	1.02	$0.000
Office Equip.	Printer/Copier/Fax	Standard	-	$0.00	6	1.00	$0.000
Office Equip.	Printer/Copier/Fax	Energy Star	0.13	$0.00	6	1.10	$0.000
Office Equip.	POS Terminal	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	POS Terminal	Energy Star	0.05	$0.03	4	0.95	$0.152
Miscellaneous	Non-HVAC Motors	Standard (EPAct)	-	$0.00	15	1.00	$0.000
Miscellaneous	Non-HVAC Motors	Standard (EPAct 2015)	0.00	$0.00	15	-	$0.000
Miscellaneous	Non-HVAC Motors	High Eff.	0.01	$0.00	15	1.01	$0.010
Miscellaneous	Non-HVAC Motors	High Eff. (2015)	0.01	$0.00	15	-	$0.007
Miscellaneous	Non-HVAC Motors	Premium (NEMA)	0.02	$0.00	15	1.02	$0.010
Miscellaneous	Non-HVAC Motors	Premium (NEMA 2015)	0.02	$0.00	15	-	$0.008
Miscellaneous	Pool Pump	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff.	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff. Multi-Speed	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Heat Pump	-	$0.00	15	1.00	$0.000
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table C-4 Energy Efficiency Equipment Data, Electric—Small Office, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	0.90	$0.33	20	1.14	$0.028
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	1.02	$0.43	20	1.16	$0.032
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	1.20	$0.53	20	1.19	$0.034
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	1.44	$0.63	20	1.23	$0.033
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	1.56	$0.21	20	1.18	$0.011
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	1.77	$0.43	20	1.19	$0.019
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	2.08	$0.51	20	1.23	$0.019
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	2.50	$0.80	20	1.27	$0.025
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	2.60	$0.88	20	1.28	$0.026
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	2.81	$0.97	20	1.31	$0.027
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	0.51	$0.32	16	-	$0.056
Cooling	Roof top AC	EER 11.2	1.03	$0.62	16	1.00	$0.053
Cooling	Roof top AC	EER 12.0	1.34	$1.18	16	0.98	$0.078
Cooling	Roof top AC	Ductless Minisplit	1.68	$3.89	16	0.78	$0.204
Cooling	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air Source Heat Pump	EER 10.3, COP 3.2	0.52	$0.37	16	-	$0.063
Cooling	Air Source Heat Pump	EER 11.0, COP 3.3	0.83	$0.53	16	1.00	$0.057
Cooling	Air Source Heat Pump	EER 11.7, COP 3.4	1.10	$1.37	16	0.95	$0.111
Cooling	Air Source Heat Pump	EER 12.0, COP 3.4	1.20	$1.79	16	0.92	$0.131
Cooling	Air Source Heat Pump	Ductless Minisplit	1.52	$3.43	16	0.81	$0.199
Cooling	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geo Heat Pump	EER 16, COP 3.5	0.35	$0.96	16	0.96	$0.245
Cooling	Geo Heat Pump	EER 18, COP 3.8	0.63	$1.93	16	0.91	$0.269
Cooling	Geo Heat Pump	EER 30, COP 5.0	1.55	$2.54	16	0.96	$0.145
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Other Cooling	EER 10.2	0.07	$0.02	14	1.02	$0.027
Cooling	Other Cooling	EER 10.8	0.14	$0.23	14	0.99	$0.155
Cooling	Other Cooling	EER 11	0.21	$0.24	14	1.00	$0.111
Cooling	Other Cooling	EER 11.5	0.27	$0.27	14	1.01	$0.097
Heating	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air Source Heat Pump	EER 10.3, COP 3.2	0.09	$0.19	16	-	$0.195
Heating	Air Source Heat Pump	EER 11.0, COP 3.3	0.17	$0.27	16	1.00	$0.139
Heating	Air Source Heat Pump	EER 11.7, COP 3.4	0.26	$0.70	16	0.93	$0.238
Heating	Air Source Heat Pump	EER 12.0, COP 3.4	0.26	$0.91	16	0.89	$0.311
Heating	Air Source Heat Pump	Ductless Minisplit	0.35	$1.75	16	0.78	$0.445
Heating	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geo Heat Pump	EER 16, COP 3.5	0.36	$0.39	16	0.97	$0.098
Heating	Geo Heat Pump	EER 18, COP 3.8	0.65	$0.78	16	0.93	$0.107
Heating	Geo Heat Pump	EER 30, COP 5.0	0.89	$1.04	16	0.92	$0.102
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	1.99	-$0.12	10	1.26	-$0.008
Water Heating	Water Heating	EF .97	-	$0.00	15	1.00	$0.000
Water Heating	Water Heating	EF .98	0.01	$0.00	15	1.01	$0.000
Water Heating	Water Heating	EF 2.0	0.41	$0.00	15	2.06	$0.000
Water Heating	Water Heating	EF 2.3	0.46	$0.00	15	2.37	$0.000
Water Heating	Water Heating	EF 2.4	0.47	$0.00	15	2.47	$0.000
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	1.04	$0.05	3	-	$0.017
Int. Lighting	Screw-in	70W HIR PAR-38	1.59	$0.07	3	-	$0.015
Int. Lighting	Screw-in	CFL	2.98	$0.04	6	3.46	$0.003
Int. Lighting	Screw-in	LED (2010)	3.23	$1.07	20	1.95	$0.026
Int. Lighting	Screw-in	LED (2020)	3.71	$0.30	20	-	$0.006
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	0.13	$0.24	15	0.68	$0.166
Int. Lighting	High-Bay Fixtures	T8	0.14	-$0.01	10	1.81	-$0.006
Int. Lighting	High-Bay Fixtures	HP Sodium	0.15	$0.00	6	1.76	$0.001
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	0.17	$0.00	15	1.95	$0.002
Int. Lighting	High-Bay Fixtures	T5	0.17	$0.00	10	2.21	-$0.003
Int. Lighting	High-Bay Fixtures	LED (2020)	0.26	$0.06	15	-	$0.022
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	0.82	$3.73	15	0.48	$0.421
Int. Lighting	Linear Fluorescent	T8	0.85	$0.00	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	1.18	$0.02	10	1.51	$0.003
Int. Lighting	Linear Fluorescent	T5	1.37	$0.04	10	1.63	$0.004
Int. Lighting	Linear Fluorescent	LED (2020)	2.50	$1.03	15	-	$0.038
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	0.08	$0.00	3	-	$0.017
Ext. Lighting	Screw-in	70W HIR PAR-38	0.12	$0.01	3	-	$0.015
Ext. Lighting	Screw-in	CFL	0.23	$0.00	6	3.21	$0.003
Ext. Lighting	Screw-in	LED (2010)	0.25	$0.08	20	1.50	$0.026
Ext. Lighting	Screw-in	LED (2020)	0.29	$0.02	20	-	$0.006
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	0.45	$0.66	15	0.61	$0.137
Ext. Lighting	HID	T8	0.45	-$0.02	10	1.76	-$0.005
Ext. Lighting	HID	HP Sodium	0.48	$0.00	6	1.73	$0.001
Ext. Lighting	HID	Light Emitting Plasma	0.56	$0.01	15	1.84	$0.002
Ext. Lighting	HID	T5	0.58	-$0.01	10	2.15	-$0.002
Ext. Lighting	HID	LED (2020)	0.85	$0.17	15	-	$0.018
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.02	$0.09	15	0.39	$0.421
Ext. Lighting	Linear Fluorescent	T8	0.02	$0.00	10	1.34	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.03	$0.00	10	1.50	$0.003
Ext. Lighting	Linear Fluorescent	T5	0.03	$0.00	10	1.61	$0.004
Ext. Lighting	Linear Fluorescent	LED (2020)	0.06	$0.03	15	-	$0.038
Refrigeration	Walk-in Refrigerator	14600 kWh/yr	-	$0.00	12	1.00	$0.000

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Refrigeration	Walk-in Refrigerator	10800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	10000 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	9000 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	3800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	3100 kWh/yr	0.04	$0.00	12	1.19	$0.005
Refrigeration	Reach-in Refrigerator	2500 kWh/yr	0.07	$0.00	12	1.43	$0.005
Refrigeration	Reach-in Refrigerator	2400 kWh/yr	0.07	$0.00	12	1.47	$0.005
Refrigeration	Reach-in Refrigerator	1500 kWh/yr	0.12	$0.00	12	2.19	$0.003
Refrigeration	Glass Door Display	14480 kWh/yr	-	$0.00	12	-	$0.000
Refrigeration	Glass Door Display	11700 kWh/yr	-	$0.00	12	-	$0.000
Refrigeration	Glass Door Display	8400 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Glass Door Display	6800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Open Display Case	6500 kWh/yr	-	$0.00	18	-	$0.000
Refrigeration	Open Display Case	5350 kWh/yr	-	$0.00	18	1.00	$0.000
Refrigeration	Open Display Case	5300 kWh/yr	-	$0.00	18	-	$0.000
Refrigeration	Open Display Case	4330 kWh/yr	-	$0.00	18	1.00	$0.000
Refrigeration	Icemaker	7.0 kWh/100 lbs	-	$0.00	10	1.00	$0.000
Refrigeration	Icemaker	6.3 kWh/100 lbs	0.02	$0.01	10	1.01	$0.054
Refrigeration	Icemaker	6.0 kWh/100 lbs	0.03	$0.01	10	1.00	$0.057
Refrigeration	Icemaker	5.5 kWh/100 lbs	0.05	$0.05	10	0.88	$0.142
Refrigeration	Vending Machine	3400 kWh/year	-	$0.00	10	1.00	$0.000
Refrigeration	Vending Machine	3000 kWh/year	0.02	$0.00	10	1.05	$0.012
Refrigeration	Vending Machine	2400 kWh/year	0.05	$0.01	10	1.14	$0.012
Refrigeration	Vending Machine	1700 kWh/year	0.09	$0.02	10	1.20	$0.022
Food Prep.	Oven	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Oven	Energy Star	0.05	$0.00	12	1.14	$0.000
Food Prep.	Fryer	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Fryer	Energy Star	-	$0.00	12	1.00	$0.000
Food Prep.	Dishwasher	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Dishwasher	Energy Star	0.24	$0.01	12	1.36	$0.005
Food Prep.	Hot Food Container	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Hot Food Container	Energy Star	-	$0.00	12	1.00	$0.000
Office Equip.	Desktop Computer	Standard	-	$0.00	5	1.00	$0.000
Office Equip.	Desktop Computer	Energy Star	0.39	$0.00	5	1.05	$0.000
Office Equip.	Laptop	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Laptop	Energy Star	0.06	$0.00	4	1.02	$0.000
Office Equip.	Server	Standard	-	$0.00	3	1.00	$0.000
Office Equip.	Server	Energy Star	0.18	$0.00	3	1.04	$0.000
Office Equip.	Monitor	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Monitor	Energy Star	0.04	$0.00	4	1.02	$0.000
Office Equip.	Printer/Copier/Fax	Standard	-	$0.00	6	1.00	$0.000
Office Equip.	Printer/Copier/Fax	Energy Star	0.13	$0.00	6	1.10	$0.000
Office Equip.	POS Terminal	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	POS Terminal	Energy Star	0.05	$0.03	4	0.95	$0.152
Miscellaneous	Non-HVAC Motors	Standard (EPAct)	-	$0.00	15	1.00	$0.000
Miscellaneous	Non-HVAC Motors	Standard (EPAct 2015)	0.00	$0.00	15	-	$0.000
Miscellaneous	Non-HVAC Motors	High Eff.	0.01	$0.00	15	1.01	$0.010
Miscellaneous	Non-HVAC Motors	High Eff. (2015)	0.01	$0.00	15	-	$0.007
Miscellaneous	Non-HVAC Motors	Premium (NEMA)	0.02	$0.00	15	1.02	$0.010
Miscellaneous	Non-HVAC Motors	Premium (NEMA 2015)	0.02	$0.00	15	-	$0.008
Miscellaneous	Pool Pump	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff.	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff. Multi-Speed	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Heat Pump	-	$0.00	15	1.00	$0.000
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table C-5 Energy Efficiency Equipment Data, Large Office, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	0.88	$0.23	20	1.14	$0.020
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	1.00	$0.30	20	1.15	$0.023
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	1.18	$0.37	20	1.18	$0.024
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	1.41	$0.44	20	1.23	$0.024
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	1.11	$0.11	20	1.18	$0.008
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	1.26	$0.22	20	1.19	$0.013
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	1.48	$0.26	20	1.23	$0.014
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	1.78	$0.41	20	1.27	$0.018
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	1.85	$0.46	20	1.28	$0.019
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	2.00	$0.50	20	1.30	$0.019
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	0.54	$0.31	16	-	$0.051
Cooling	Roof top AC	EER 11.2	1.08	$0.60	16	1.00	$0.049
Cooling	Roof top AC	EER 12.0	1.41	$1.15	16	0.96	$0.072
Cooling	Roof top AC	Ductless Minisplit	1.77	$3.76	16	0.73	$0.188
Cooling	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air Source Heat Pump	EER 10.3, COP 3.2	0.59	$0.39	16	-	$0.058
Cooling	Air Source Heat Pump	EER 11.0, COP 3.3	0.94	$0.56	16	1.00	$0.053
Cooling	Air Source Heat Pump	EER 11.7, COP 3.4	1.24	$1.43	16	0.93	$0.101
Cooling	Air Source Heat Pump	EER 12.0, COP 3.4	1.36	$1.86	16	0.89	$0.121
Cooling	Air Source Heat Pump	Ductless Minisplit	1.73	$3.57	16	0.77	$0.183
Cooling	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geo Heat Pump	EER 16, COP 3.5	0.37	$0.93	16	0.94	$0.225
Cooling	Geo Heat Pump	EER 18, COP 3.8	0.67	$1.86	16	0.88	$0.247
Cooling	Geo Heat Pump	EER 30, COP 5.0	1.63	$2.45	16	0.91	$0.133
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	0.07	$0.02	14	1.01	$0.027
Cooling	Other Cooling	EER 10.8	0.14	$0.23	14	0.96	$0.156
Cooling	Other Cooling	EER 11	0.21	$0.24	14	0.98	$0.112
Cooling	Other Cooling	EER 11.5	0.27	$0.27	14	0.98	$0.097
Heating	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air Source Heat Pump	EER 10.3, COP 3.2	0.02	$0.17	16	-	$0.725
Heating	Air Source Heat Pump	EER 11.0, COP 3.3	0.04	$0.25	16	1.00	$0.566
Heating	Air Source Heat Pump	EER 11.7, COP 3.4	0.05	$0.65	16	0.92	$1.050
Heating	Air Source Heat Pump	EER 12.0, COP 3.4	0.05	$0.84	16	0.89	$1.370
Heating	Air Source Heat Pump	Ductless Minisplit	0.07	$1.61	16	0.77	$2.143
Heating	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geo Heat Pump	EER 16, COP 3.5	0.34	$0.38	16	0.97	$0.100
Heating	Geo Heat Pump	EER 18, COP 3.8	0.62	$0.77	16	0.93	$0.109
Heating	Geo Heat Pump	EER 30, COP 5.0	0.03	$1.01	16	0.82	$2.894
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	1.77	-$0.11	10	1.22	-$0.007
Water Heating	Water Heating	EF .97	-	$0.00	15	1.00	$0.000
Water Heating	Water Heating	EF .98	0.01	$0.00	15	1.01	$0.024
Water Heating	Water Heating	EF 2.0	0.46	$0.00	15	2.01	$0.001
Water Heating	Water Heating	EF 2.3	0.52	$0.01	15	2.28	$0.001
Water Heating	Water Heating	EF 2.4	0.53	$0.01	15	2.37	$0.001
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	0.80	$0.03	3	-	$0.014
Int. Lighting	Screw-in	70W HIR PAR-38	1.23	$0.04	3	-	$0.012
Int. Lighting	Screw-in	CFL	2.30	$0.02	6	3.47	$0.002
Int. Lighting	Screw-in	LED (2010)	2.49	$0.66	20	2.05	$0.020
Int. Lighting	Screw-in	LED (2020)	2.86	$0.19	20	-	$0.005
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	0.05	$0.07	15	0.72	$0.132

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Int. Lighting	High-Bay Fixtures	T8	0.05	$0.00	10	1.76	-$0.005
Int. Lighting	High-Bay Fixtures	HP Sodium	0.05	$0.00	6	1.76	$0.001
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	0.06	$0.00	15	1.91	$0.002
Int. Lighting	High-Bay Fixtures	T5	0.07	$0.00	10	2.17	-$0.002
Int. Lighting	High-Bay Fixtures	LED (2020)	0.10	$0.02	15	-	$0.018
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	1.08	$3.92	15	0.52	$0.335
Int. Lighting	Linear Fluorescent	T8	1.12	$0.00	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	1.56	$0.03	10	1.52	$0.002
Int. Lighting	Linear Fluorescent	T5	1.81	$0.04	10	1.64	$0.003
Int. Lighting	Linear Fluorescent	LED (2020)	3.30	$1.09	15	-	$0.030
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	0.06	$0.00	3	-	$0.014
Ext. Lighting	Screw-in	70W HIR PAR-38	0.09	$0.00	3	-	$0.012
Ext. Lighting	Screw-in	CFL	0.17	$0.00	6	3.31	$0.002
Ext. Lighting	Screw-in	LED (2010)	0.19	$0.05	20	1.72	$0.020
Ext. Lighting	Screw-in	LED (2020)	0.22	$0.01	20	-	$0.005
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	0.25	$0.29	15	0.68	$0.109
Ext. Lighting	HID	T8	0.25	-$0.01	10	1.72	-$0.004
Ext. Lighting	HID	HP Sodium	0.27	$0.00	6	1.73	$0.001
Ext. Lighting	HID	Light Emitting Plasma	0.31	$0.00	15	1.82	$0.001
Ext. Lighting	HID	T5	0.32	$0.00	10	2.11	-$0.002
Ext. Lighting	HID	LED (2020)	0.47	$0.07	15	-	$0.015
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.01	$0.03	15	0.45	$0.335
Ext. Lighting	Linear Fluorescent	T8	0.01	$0.00	10	1.34	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.01	$0.00	10	1.51	$0.002
Ext. Lighting	Linear Fluorescent	T5	0.01	$0.00	10	1.63	$0.003
Ext. Lighting	Linear Fluorescent	LED (2020)	0.02	$0.01	15	-	$0.030
Refrigeration	Walk-in Refrigerator	14600 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	10800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	10000 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	9000 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	3800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	3100 kWh/yr	0.01	$0.00	12	1.08	$0.029
Refrigeration	Reach-in Refrigerator	2500 kWh/yr	0.02	$0.00	12	1.15	$0.030
Refrigeration	Reach-in Refrigerator	2400 kWh/yr	0.02	$0.01	12	1.17	$0.030
Refrigeration	Reach-in Refrigerator	1500 kWh/yr	0.03	$0.01	12	1.44	$0.019
Refrigeration	Glass Door Display	14480 kWh/yr	-	$0.00	12	-	$0.000
Refrigeration	Glass Door Display	11700 kWh/yr	0.04	$0.02	12	-	$0.072
Refrigeration	Glass Door Display	8400 kWh/yr	0.08	$0.00	12	1.00	$0.000
Refrigeration	Glass Door Display	6800 kWh/yr	0.10	$0.02	12	0.91	$0.026
Refrigeration	Open Display Case	6500 kWh/yr	-	$0.00	18	-	$0.000
Refrigeration	Open Display Case	5350 kWh/yr	0.02	$0.00	18	1.00	$0.000
Refrigeration	Open Display Case	5300 kWh/yr	0.02	$0.01	18	-	$0.056
Refrigeration	Open Display Case	4330 kWh/yr	0.03	$0.01	18	1.00	$0.032
Refrigeration	Icemaker	7.0 kWh/100 lbs	-	$0.00	10	1.00	$0.000
Refrigeration	Icemaker	6.3 kWh/100 lbs	0.01	$0.00	10	1.01	$0.054
Refrigeration	Icemaker	6.0 kWh/100 lbs	0.01	$0.00	10	1.00	$0.057
Refrigeration	Icemaker	5.5 kWh/100 lbs	0.01	$0.01	10	0.88	$0.142
Refrigeration	Vending Machine	3400 kWh/year	-	$0.00	10	1.00	$0.000
Refrigeration	Vending Machine	3000 kWh/year	0.01	$0.00	10	1.05	$0.012
Refrigeration	Vending Machine	2400 kWh/year	0.03	$0.00	10	1.14	$0.012
Refrigeration	Vending Machine	1700 kWh/year	0.04	$0.01	10	1.20	$0.022
Food Prep.	Oven	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Oven	Energy Star	0.02	$0.00	12	1.13	$0.000
Food Prep.	Fryer	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Fryer	Energy Star	0.01	$0.00	12	1.04	$0.024
Food Prep.	Dishwasher	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Dishwasher	Energy Star	0.09	$0.00	12	1.36	$0.005
Food Prep.	Hot Food Container	Standard	-	$0.00	12	1.00	$0.000

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Food Prep.	Hot Food Container	Energy Star	0.06	$0.01	12	1.35	$0.024
Office Equip.	Desktop Computer	Standard	-	$0.00	5	1.00	$0.000
Office Equip.	Desktop Computer	Energy Star	0.95	$0.00	5	1.05	$0.000
Office Equip.	Laptop	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Laptop	Energy Star	0.15	$0.00	4	1.02	$0.000
Office Equip.	Server	Standard	-	$0.00	3	1.00	$0.000
Office Equip.	Server	Energy Star	0.07	$0.00	3	1.03	$0.000
Office Equip.	Monitor	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Monitor	Energy Star	0.11	$0.00	4	1.02	$0.000
Office Equip.	Printer/Copier/Fax	Standard	-	$0.00	6	1.00	$0.000
Office Equip.	Printer/Copier/Fax	Energy Star	0.11	$0.00	6	1.09	$0.000
Office Equip.	POS Terminal	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	POS Terminal	Energy Star	0.01	$0.00	4	0.95	$0.152
Miscellaneous	Non-HVAC Motors	Standard (EPAct)	-	$0.00	15	1.00	$0.000
Miscellaneous	Non-HVAC Motors	Standard (EPAct 2015)	0.00	$0.00	15	-	$0.000
Miscellaneous	Non-HVAC Motors	High Eff.	0.00	$0.00	15	1.01	$0.010
Miscellaneous	Non-HVAC Motors	High Eff. (2015)	0.01	$0.00	15	-	$0.007
Miscellaneous	Non-HVAC Motors	Premium (NEMA)	0.01	$0.00	15	1.02	$0.010
Miscellaneous	Non-HVAC Motors	Premium (NEMA 2015)	0.01	$0.00	15	-	$0.008
Miscellaneous	Pool Pump	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff.	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff. Multi-Speed	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Heat Pump	-	$0.00	15	1.00	$0.000
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table C-6 Energy Efficiency Equipment Data, Electric—Large Office, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	0.70	$0.24	20	1.12	$0.027
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	0.79	$0.32	20	1.13	$0.031
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	0.93	$0.39	20	1.15	$0.032
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	1.12	$0.46	20	1.18	$0.032
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	1.02	$0.13	20	1.16	$0.010
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	1.16	$0.27	20	1.17	$0.018
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	1.36	$0.32	20	1.20	$0.018
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	1.63	$0.50	20	1.23	$0.023
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	1.70	$0.55	20	1.23	$0.025
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	1.84	$0.60	20	1.25	$0.025
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	0.49	$0.32	16	-	$0.058
Cooling	Roof top AC	EER 11.2	0.99	$0.62	16	1.00	$0.055
Cooling	Roof top AC	EER 12.0	1.29	$1.19	16	0.96	$0.081
Cooling	Roof top AC	Ductless Minisplit	1.62	$3.89	16	0.71	$0.213
Cooling	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air Source Heat Pump	EER 10.3, COP 3.2	0.52	$0.39	16	-	$0.066
Cooling	Air Source Heat Pump	EER 11.0, COP 3.3	0.82	$0.55	16	1.00	$0.060
Cooling	Air Source Heat Pump	EER 11.7, COP 3.4	1.09	$1.42	16	0.92	$0.115
Cooling	Air Source Heat Pump	EER 12.0, COP 3.4	1.20	$1.86	16	0.88	$0.137
Cooling	Air Source Heat Pump	Ductless Minisplit	1.52	$3.56	16	0.75	$0.207
Cooling	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geo Heat Pump	EER 16, COP 3.5	0.34	$0.99	16	0.93	$0.255
Cooling	Geo Heat Pump	EER 18, COP 3.8	0.62	$1.97	16	0.87	$0.280
Cooling	Geo Heat Pump	EER 30, COP 5.0	1.53	$2.60	16	0.89	$0.151
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	0.07	$0.02	14	1.01	$0.027

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Other Cooling	EER 10.8	0.14	$0.22	14	0.96	$0.155
Cooling	Other Cooling	EER 11	0.20	$0.24	14	0.98	$0.111
Cooling	Other Cooling	EER 11.5	0.27	$0.27	14	0.98	$0.097
Heating	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air Source Heat Pump	EER 10.3, COP 3.2	0.07	$0.19	16	-	$0.259
Heating	Air Source Heat Pump	EER 11.0, COP 3.3	0.13	$0.28	16	1.00	$0.184
Heating	Air Source Heat Pump	EER 11.7, COP 3.4	0.20	$0.71	16	0.92	$0.314
Heating	Air Source Heat Pump	EER 12.0, COP 3.4	0.20	$0.92	16	0.88	$0.410
Heating	Air Source Heat Pump	Ductless Minisplit	0.27	$1.77	16	0.75	$0.585
Heating	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geo Heat Pump	EER 16, COP 3.5	0.31	$0.40	16	0.96	$0.116
Heating	Geo Heat Pump	EER 18, COP 3.8	0.56	$0.81	16	0.91	$0.127
Heating	Geo Heat Pump	EER 30, COP 5.0	0.78	$1.06	16	0.89	$0.121
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	1.79	-$0.14	10	1.19	-$0.010
Water Heating	Water Heating	EF .97	-	$0.00	15	1.00	$0.000
Water Heating	Water Heating	EF .98	0.01	$0.00	15	1.01	$0.022
Water Heating	Water Heating	EF 2.0	0.45	$0.00	15	2.01	$0.001
Water Heating	Water Heating	EF 2.3	0.50	$0.01	15	2.29	$0.001
Water Heating	Water Heating	EF 2.4	0.52	$0.01	15	2.38	$0.001
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	0.80	$0.03	3	-	$0.014
Int. Lighting	Screw-in	70W HIR PAR-38	1.23	$0.04	3	-	$0.012
Int. Lighting	Screw-in	CFL	2.30	$0.02	6	3.47	$0.002
Int. Lighting	Screw-in	LED (2010)	2.49	$0.66	20	2.05	$0.020
Int. Lighting	Screw-in	LED (2020)	2.86	$0.19	20	-	$0.005
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	0.05	$0.07	15	0.72	$0.132
Int. Lighting	High-Bay Fixtures	T8	0.05	$0.00	10	1.76	-$0.005
Int. Lighting	High-Bay Fixtures	HP Sodium	0.05	$0.00	6	1.76	$0.001
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	0.06	$0.00	15	1.91	$0.002
Int. Lighting	High-Bay Fixtures	T5	0.07	$0.00	10	2.17	-$0.002
Int. Lighting	High-Bay Fixtures	LED (2020)	0.10	$0.02	15	-	$0.018
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	1.08	$3.92	15	0.52	$0.335
Int. Lighting	Linear Fluorescent	T8	1.12	$0.00	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	1.56	$0.03	10	1.52	$0.002
Int. Lighting	Linear Fluorescent	T5	1.81	$0.04	10	1.64	$0.003
Int. Lighting	Linear Fluorescent	LED (2020)	3.30	$1.09	15	-	$0.030
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	0.06	$0.00	3	-	$0.014
Ext. Lighting	Screw-in	70W HIR PAR-38	0.09	$0.00	3	-	$0.012
Ext. Lighting	Screw-in	CFL	0.17	$0.00	6	3.31	$0.002
Ext. Lighting	Screw-in	LED (2010)	0.19	$0.05	20	1.72	$0.020
Ext. Lighting	Screw-in	LED (2020)	0.22	$0.01	20	-	$0.005
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	0.25	$0.29	15	0.68	$0.109
Ext. Lighting	HID	T8	0.25	-$0.01	10	1.72	-$0.004
Ext. Lighting	HID	HP Sodium	0.27	$0.00	6	1.73	$0.001
Ext. Lighting	HID	Light Emitting Plasma	0.31	$0.00	15	1.82	$0.001
Ext. Lighting	HID	T5	0.32	$0.00	10	2.11	-$0.002
Ext. Lighting	HID	LED (2020)	0.47	$0.07	15	-	$0.015
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.01	$0.03	15	0.45	$0.335
Ext. Lighting	Linear Fluorescent	T8	0.01	$0.00	10	1.34	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.01	$0.00	10	1.51	$0.002
Ext. Lighting	Linear Fluorescent	T5	0.01	$0.00	10	1.63	$0.003
Ext. Lighting	Linear Fluorescent	LED (2020)	0.02	$0.01	15	-	$0.030
Refrigeration	Walk-in Refrigerator	14600 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	10800 kWh/yr	-	$0.00	12	1.00	$0.000

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Refrigeration	Walk-in Refrigerator	10000 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	9000 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	3800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	3100 kWh/yr	0.01	$0.00	12	1.05	$0.040
Refrigeration	Reach-in Refrigerator	2500 kWh/yr	0.02	$0.01	12	1.08	$0.043
Refrigeration	Reach-in Refrigerator	2400 kWh/yr	0.02	$0.01	12	1.09	$0.042
Refrigeration	Reach-in Refrigerator	1500 kWh/yr	0.03	$0.01	12	1.30	$0.027
Refrigeration	Glass Door Display	14480 kWh/yr	-	$0.00	12	-	$0.000
Refrigeration	Glass Door Display	11700 kWh/yr	0.04	$0.02	12	-	$0.072
Refrigeration	Glass Door Display	8400 kWh/yr	0.08	$0.00	12	1.00	$0.000
Refrigeration	Glass Door Display	6800 kWh/yr	0.10	$0.02	12	0.91	$0.026
Refrigeration	Open Display Case	6500 kWh/yr	-	$0.00	18	-	$0.000
Refrigeration	Open Display Case	5350 kWh/yr	0.02	$0.00	18	1.00	$0.000
Refrigeration	Open Display Case	5300 kWh/yr	0.02	$0.01	18	-	$0.056
Refrigeration	Open Display Case	4330 kWh/yr	0.03	$0.01	18	1.00	$0.032
Refrigeration	Icemaker	7.0 kWh/100 lbs	-	$0.00	10	1.00	$0.000
Refrigeration	Icemaker	6.3 kWh/100 lbs	0.01	$0.00	10	1.01	$0.054
Refrigeration	Icemaker	6.0 kWh/100 lbs	0.01	$0.00	10	1.00	$0.057
Refrigeration	Icemaker	5.5 kWh/100 lbs	0.01	$0.01	10	0.88	$0.142
Refrigeration	Vending Machine	3400 kWh/year	-	$0.00	10	1.00	$0.000
Refrigeration	Vending Machine	3000 kWh/year	0.01	$0.00	10	1.05	$0.012
Refrigeration	Vending Machine	2400 kWh/year	0.03	$0.00	10	1.14	$0.012
Refrigeration	Vending Machine	1700 kWh/year	0.04	$0.01	10	1.20	$0.022
Food Prep.	Oven	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Oven	Energy Star	0.02	$0.00	12	1.13	$0.000
Food Prep.	Fryer	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Fryer	Energy Star	0.01	$0.00	12	1.04	$0.024
Food Prep.	Dishwasher	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Dishwasher	Energy Star	0.09	$0.00	12	1.36	$0.005
Food Prep.	Hot Food Container	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Hot Food Container	Energy Star	0.06	$0.01	12	1.35	$0.024
Office Equip.	Desktop Computer	Standard	-	$0.00	5	1.00	$0.000
Office Equip.	Desktop Computer	Energy Star	0.95	$0.00	5	1.05	$0.000
Office Equip.	Laptop	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Laptop	Energy Star	0.15	$0.00	4	1.02	$0.000
Office Equip.	Server	Standard	-	$0.00	3	1.00	$0.000
Office Equip.	Server	Energy Star	0.07	$0.00	3	1.03	$0.000
Office Equip.	Monitor	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Monitor	Energy Star	0.11	$0.00	4	1.02	$0.000
Office Equip.	Printer/Copier/Fax	Standard	-	$0.00	6	1.00	$0.000
Office Equip.	Printer/Copier/Fax	Energy Star	0.11	$0.00	6	1.09	$0.000
Office Equip.	POS Terminal	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	POS Terminal	Energy Star	0.01	$0.00	4	0.95	$0.152
Miscellaneous	Non-HVAC Motors	Standard (EPAct)	-	$0.00	15	1.00	$0.000
Miscellaneous	Non-HVAC Motors	Standard (EPAct 2015)	0.00	$0.00	15	-	$0.000
Miscellaneous	Non-HVAC Motors	High Eff.	0.00	$0.00	15	1.01	$0.010
Miscellaneous	Non-HVAC Motors	High Eff. (2015)	0.01	$0.00	15	-	$0.007
Miscellaneous	Non-HVAC Motors	Premium (NEMA)	0.01	$0.00	15	1.02	$0.010
Miscellaneous	Non-HVAC Motors	Premium (NEMA 2015)	0.01	$0.00	15	-	$0.008
Miscellaneous	Pool Pump	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff.	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff. Multi-Speed	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Heat Pump	-	$0.00	15	1.00	$0.000
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table C-7 Energy Efficiency Equipment Data, Electric—Restaurant, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	1.39	$0.27	20	1.18	$0.015
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	1.58	$0.35	20	1.20	$0.017
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	1.86	$0.43	20	1.24	$0.018
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	2.23	$0.51	20	1.31	$0.018
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	2.00	$0.14	20	1.20	$0.006
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	2.26	$0.29	20	1.22	$0.010
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	2.66	$0.35	20	1.27	$0.010
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	3.20	$0.54	20	1.33	$0.013
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	3.33	$0.60	20	1.35	$0.014
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	3.60	$0.65	20	1.39	$0.014
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	0.79	$0.27	16	-	$0.030
Cooling	Roof top AC	EER 11.2	1.58	$0.51	16	1.00	$0.029
Cooling	Roof top AC	EER 12.0	2.07	$0.98	16	1.01	$0.042
Cooling	Roof top AC	Ductless Minisplit	2.59	$3.22	16	0.86	$0.110
Cooling	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air Source Heat Pump	EER 10.3, COP 3.2	0.86	$0.33	16	-	$0.034
Cooling	Air Source Heat Pump	EER 11.0, COP 3.3	1.37	$0.47	16	1.00	$0.031
Cooling	Air Source Heat Pump	EER 11.7, COP 3.4	1.82	$1.22	16	0.98	$0.059
Cooling	Air Source Heat Pump	EER 12.0, COP 3.4	1.99	$1.59	16	0.96	$0.071
Cooling	Air Source Heat Pump	Ductless Minisplit	2.52	$3.04	16	0.89	$0.107
Cooling	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geo Heat Pump	EER 16, COP 3.5	0.80	$1.19	16	0.98	$0.132
Cooling	Geo Heat Pump	EER 18, COP 3.8	1.46	$2.38	16	0.96	$0.144
Cooling	Geo Heat Pump	EER 30, COP 5.0	3.57	$3.13	16	1.07	$0.078
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	0.11	$0.03	14	1.01	$0.027
Cooling	Other Cooling	EER 10.8	0.21	$0.34	14	0.98	$0.156
Cooling	Other Cooling	EER 11	0.31	$0.36	14	0.99	$0.112
Cooling	Other Cooling	EER 11.5	0.41	$0.41	14	1.00	$0.097
Heating	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air Source Heat Pump	EER 10.3, COP 3.2	0.06	$0.29	16	-	$0.411
Heating	Air Source Heat Pump	EER 11.0, COP 3.3	0.12	$0.42	16	1.00	$0.307
Heating	Air Source Heat Pump	EER 11.7, COP 3.4	0.18	$1.08	16	0.89	$0.545
Heating	Air Source Heat Pump	EER 12.0, COP 3.4	0.18	$1.41	16	0.85	$0.711
Heating	Air Source Heat Pump	Ductless Minisplit	0.22	$2.70	16	0.70	$1.062
Heating	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geo Heat Pump	EER 16, COP 3.5	0.33	$0.76	16	0.93	$0.202
Heating	Geo Heat Pump	EER 18, COP 3.8	0.61	$1.53	16	0.87	$0.222
Heating	Geo Heat Pump	EER 30, COP 5.0	0.39	$2.02	16	0.80	$0.456
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	2.04	-$0.69	10	1.08	-$0.042
Water Heating	Water Heating	EF .97	-	$0.00	15	1.00	$0.000
Water Heating	Water Heating	EF .98	0.09	$0.01	15	1.01	$0.013
Water Heating	Water Heating	EF 2.0	4.45	$0.03	15	2.03	$0.001
Water Heating	Water Heating	EF 2.3	5.00	$0.04	15	2.32	$0.001
Water Heating	Water Heating	EF 2.4	5.15	$0.04	15	2.41	$0.001
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	2.17	$0.07	3	-	$0.011
Int. Lighting	Screw-in	70W HIR PAR-38	3.33	$0.09	3	-	$0.010
Int. Lighting	Screw-in	CFL	6.23	$0.05	6	3.52	$0.002
Int. Lighting	Screw-in	LED (2010)	6.75	$1.46	20	2.22	$0.017
Int. Lighting	Screw-in	LED (2020)	7.75	$0.41	20	-	$0.004
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	0.08	$0.09	15	0.77	$0.108

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Int. Lighting	High-Bay Fixtures	T8	0.08	$0.00	10	1.73	-$0.004
Int. Lighting	High-Bay Fixtures	HP Sodium	0.08	$0.00	6	1.76	$0.001
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	0.10	$0.00	15	1.88	$0.001
Int. Lighting	High-Bay Fixtures	T5	0.10	$0.00	10	2.13	-$0.002
Int. Lighting	High-Bay Fixtures	LED (2020)	0.14	$0.02	15	-	$0.015
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	0.40	$1.19	15	0.57	$0.273
Int. Lighting	Linear Fluorescent	T8	0.42	$0.00	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	0.58	$0.01	10	1.52	$0.002
Int. Lighting	Linear Fluorescent	T5	0.67	$0.01	10	1.65	$0.002
Int. Lighting	Linear Fluorescent	LED (2020)	1.22	$0.33	15	-	$0.025
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	0.11	$0.00	3	-	$0.011
Ext. Lighting	Screw-in	70W HIR PAR-38	0.17	$0.00	3	-	$0.010
Ext. Lighting	Screw-in	CFL	0.33	$0.00	6	3.39	$0.002
Ext. Lighting	Screw-in	LED (2010)	0.35	$0.08	20	1.93	$0.017
Ext. Lighting	Screw-in	LED (2020)	0.41	$0.02	20	-	$0.004
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	1.14	$1.09	15	0.74	$0.089
Ext. Lighting	HID	T8	1.16	-$0.03	10	1.68	-$0.003
Ext. Lighting	HID	HP Sodium	1.23	$0.01	6	1.73	$0.001
Ext. Lighting	HID	Light Emitting Plasma	1.44	$0.02	15	1.81	$0.001
Ext. Lighting	HID	T5	1.48	-$0.02	10	2.08	-$0.001
Ext. Lighting	HID	LED (2020)	2.17	$0.28	15	-	$0.012
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.00	$0.01	15	0.51	$0.273
Ext. Lighting	Linear Fluorescent	T8	0.00	$0.00	10	1.34	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.00	$0.00	10	1.52	$0.002
Ext. Lighting	Linear Fluorescent	T5	0.00	$0.00	10	1.64	$0.002
Ext. Lighting	Linear Fluorescent	LED (2020)	0.01	$0.00	15	-	$0.025
Refrigeration	Walk-in Refrigerator	14600 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	10800 kWh/yr	0.63	$0.24	12	1.03	$0.041
Refrigeration	Walk-in Refrigerator	10000 kWh/yr	0.76	$0.31	12	1.03	$0.043
Refrigeration	Walk-in Refrigerator	9000 kWh/yr	0.93	$0.55	12	1.00	$0.064
Refrigeration	Reach-in Refrigerator	3800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	3100 kWh/yr	0.13	$0.07	12	1.00	$0.062
Refrigeration	Reach-in Refrigerator	2500 kWh/yr	0.24	$0.14	12	0.99	$0.066
Refrigeration	Reach-in Refrigerator	2400 kWh/yr	0.26	$0.15	12	0.99	$0.065
Refrigeration	Reach-in Refrigerator	1500 kWh/yr	0.42	$0.16	12	1.13	$0.042
Refrigeration	Glass Door Display	14480 kWh/yr	-	$0.00	12	-	$0.000
Refrigeration	Glass Door Display	11700 kWh/yr	0.51	$0.34	12	-	$0.072
Refrigeration	Glass Door Display	8400 kWh/yr	1.11	$0.00	12	1.00	$0.000
Refrigeration	Glass Door Display	6800 kWh/yr	1.40	$0.34	12	0.91	$0.026
Refrigeration	Open Display Case	6500 kWh/yr	-	$0.00	18	-	$0.000
Refrigeration	Open Display Case	5350 kWh/yr	0.22	$0.00	18	1.00	$0.000
Refrigeration	Open Display Case	5300 kWh/yr	0.23	$0.15	18	-	$0.056
Refrigeration	Open Display Case	4330 kWh/yr	0.40	$0.15	18	1.00	$0.032
Refrigeration	Icemaker	7.0 kWh/100 lbs	-	$0.00	10	1.00	$0.000
Refrigeration	Icemaker	6.3 kWh/100 lbs	0.08	$0.03	10	1.01	$0.054
Refrigeration	Icemaker	6.0 kWh/100 lbs	0.11	$0.05	10	1.00	$0.057
Refrigeration	Icemaker	5.5 kWh/100 lbs	0.16	$0.18	10	0.88	$0.142
Refrigeration	Vending Machine	3400 kWh/year	-	$0.00	10	1.00	$0.000
Refrigeration	Vending Machine	3000 kWh/year	0.07	$0.01	10	1.05	$0.012
Refrigeration	Vending Machine	2400 kWh/year	0.18	$0.02	10	1.14	$0.012
Refrigeration	Vending Machine	1700 kWh/year	0.31	$0.05	10	1.20	$0.022
Food Prep.	Oven	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Oven	Energy Star	0.80	$0.00	12	1.13	$0.000
Food Prep.	Fryer	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Fryer	Energy Star	0.50	$0.11	12	1.03	$0.024
Food Prep.	Dishwasher	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Dishwasher	Energy Star	2.00	$0.09	12	1.35	$0.005
Food Prep.	Hot Food Container	Standard	-	$0.00	12	1.00	$0.000

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Food Prep.	Hot Food Container	Energy Star	1.35	$0.30	12	1.30	$0.024
Office Equip.	Desktop Computer	Standard	-	$0.00	5	1.00	$0.000
Office Equip.	Desktop Computer	Energy Star	0.09	$0.00	5	1.05	$0.000
Office Equip.	Laptop	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Laptop	Energy Star	0.01	$0.00	4	1.01	$0.000
Office Equip.	Server	Standard	-	$0.00	3	1.00	$0.000
Office Equip.	Server	Energy Star	0.08	$0.00	3	1.03	$0.000
Office Equip.	Monitor	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Monitor	Energy Star	0.01	$0.00	4	1.02	$0.000
Office Equip.	Printer/Copier/Fax	Standard	-	$0.00	6	1.00	$0.000
Office Equip.	Printer/Copier/Fax	Energy Star	0.02	$0.00	6	1.09	$0.000
Office Equip.	POS Terminal	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	POS Terminal	Energy Star	0.05	$0.03	4	0.95	$0.152
Miscellaneous	Non-HVAC Motors	Standard (EPAct)	-	$0.00	15	1.00	$0.000
Miscellaneous	Non-HVAC Motors	Standard (EPAct 2015)	0.00	$0.00	15	-	$0.000
Miscellaneous	Non-HVAC Motors	High Eff.	0.00	$0.00	15	1.01	$0.010
Miscellaneous	Non-HVAC Motors	High Eff. (2015)	0.00	$0.00	15	-	$0.007
Miscellaneous	Non-HVAC Motors	Premium (NEMA)	0.01	$0.00	15	1.02	$0.010
Miscellaneous	Non-HVAC Motors	Premium (NEMA 2015)	0.01	$0.00	15	-	$0.008
Miscellaneous	Pool Pump	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff.	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff. Multi-Speed	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Heat Pump	-	$0.00	15	1.00	$0.000
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table C-8 Energy Efficiency Equipment Data, Electric— Restaurant, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	1.18	$0.36	20	1.15	$0.024
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	1.33	$0.47	20	1.16	$0.027
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	1.57	$0.57	20	1.19	$0.028
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	1.88	$0.68	20	1.24	$0.028
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	1.84	$0.21	20	1.18	$0.009
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	2.09	$0.42	20	1.19	$0.016
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	2.46	$0.51	20	1.24	$0.016
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	2.95	$0.79	20	1.28	$0.021
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	3.08	$0.87	20	1.29	$0.022
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	3.33	$0.96	20	1.31	$0.022
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	0.74	$0.38	16	-	$0.045
Cooling	Roof top AC	EER 11.2	1.48	$0.73	16	1.00	$0.043
Cooling	Roof top AC	EER 12.0	1.94	$1.39	16	0.98	$0.064
Cooling	Roof top AC	Ductless Minisplit	2.43	$4.57	16	0.79	$0.167
Cooling	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air Source Heat Pump	EER 10.3, COP 3.2	0.78	$0.46	16	-	$0.052
Cooling	Air Source Heat Pump	EER 11.0, COP 3.3	1.25	$0.66	16	1.00	$0.047
Cooling	Air Source Heat Pump	EER 11.7, COP 3.4	1.66	$1.68	16	0.95	$0.090
Cooling	Air Source Heat Pump	EER 12.0, COP 3.4	1.82	$2.20	16	0.92	$0.107
Cooling	Air Source Heat Pump	Ductless Minisplit	2.30	$4.21	16	0.82	$0.162
Cooling	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geo Heat Pump	EER 16, COP 3.5	0.76	$1.71	16	0.96	$0.200
Cooling	Geo Heat Pump	EER 18, COP 3.8	1.38	$3.41	16	0.91	$0.219
Cooling	Geo Heat Pump	EER 30, COP 5.0	3.37	$4.50	16	0.97	$0.118
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	0.11	$0.03	14	1.01	$0.027

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Other Cooling	EER 10.8	0.21	$0.33	14	0.98	$0.155
Cooling	Other Cooling	EER 11	0.31	$0.35	14	0.99	$0.111
Cooling	Other Cooling	EER 11.5	0.40	$0.40	14	1.00	$0.097
Heating	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air Source Heat Pump	EER 10.3, COP 3.2	0.06	$0.33	16	-	$0.483
Heating	Air Source Heat Pump	EER 11.0, COP 3.3	0.12	$0.48	16	1.00	$0.361
Heating	Air Source Heat Pump	EER 11.7, COP 3.4	0.17	$1.23	16	0.88	$0.641
Heating	Air Source Heat Pump	EER 12.0, COP 3.4	0.17	$1.60	16	0.83	$0.837
Heating	Air Source Heat Pump	Ductless Minisplit	0.22	$3.06	16	0.68	$1.249
Heating	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geo Heat Pump	EER 16, COP 3.5	0.32	$0.89	16	0.92	$0.244
Heating	Geo Heat Pump	EER 18, COP 3.8	0.59	$1.78	16	0.85	$0.267
Heating	Geo Heat Pump	EER 30, COP 5.0	0.41	$2.35	16	0.80	$0.505
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	1.44	-$0.75	10	1.06	-$0.064
Water Heating	Water Heating	EF .97	-	$0.00	15	1.00	$0.000
Water Heating	Water Heating	EF .98	0.09	$0.01	15	1.01	$0.014
Water Heating	Water Heating	EF 2.0	4.32	$0.03	15	2.03	$0.001
Water Heating	Water Heating	EF 2.3	4.85	$0.04	15	2.32	$0.001
Water Heating	Water Heating	EF 2.4	4.99	$0.04	15	2.41	$0.001
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	2.17	$0.07	3	-	$0.011
Int. Lighting	Screw-in	70W HIR PAR-38	3.33	$0.09	3	-	$0.010
Int. Lighting	Screw-in	CFL	6.23	$0.05	6	3.52	$0.002
Int. Lighting	Screw-in	LED (2010)	6.75	$1.46	20	2.22	$0.017
Int. Lighting	Screw-in	LED (2020)	7.75	$0.41	20	-	$0.004
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	0.08	$0.09	15	0.77	$0.108
Int. Lighting	High-Bay Fixtures	T8	0.08	$0.00	10	1.73	-$0.004
Int. Lighting	High-Bay Fixtures	HP Sodium	0.08	$0.00	6	1.76	$0.001
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	0.10	$0.00	15	1.88	$0.001
Int. Lighting	High-Bay Fixtures	T5	0.10	$0.00	10	2.13	-$0.002
Int. Lighting	High-Bay Fixtures	LED (2020)	0.14	$0.02	15	-	$0.015
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	0.40	$1.19	15	0.57	$0.273
Int. Lighting	Linear Fluorescent	T8	0.42	$0.00	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	0.58	$0.01	10	1.52	$0.002
Int. Lighting	Linear Fluorescent	T5	0.67	$0.01	10	1.65	$0.002
Int. Lighting	Linear Fluorescent	LED (2020)	1.22	$0.33	15	-	$0.025
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	0.11	$0.00	3	-	$0.011
Ext. Lighting	Screw-in	70W HIR PAR-38	0.17	$0.00	3	-	$0.010
Ext. Lighting	Screw-in	CFL	0.33	$0.00	6	3.39	$0.002
Ext. Lighting	Screw-in	LED (2010)	0.35	$0.08	20	1.93	$0.017
Ext. Lighting	Screw-in	LED (2020)	0.41	$0.02	20	-	$0.004
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	1.14	$1.09	15	0.74	$0.089
Ext. Lighting	HID	T8	1.16	-$0.03	10	1.68	-$0.003
Ext. Lighting	HID	HP Sodium	1.23	$0.01	6	1.73	$0.001
Ext. Lighting	HID	Light Emitting Plasma	1.44	$0.02	15	1.81	$0.001
Ext. Lighting	HID	T5	1.48	-$0.02	10	2.08	-$0.001
Ext. Lighting	HID	LED (2020)	2.17	$0.28	15	-	$0.012
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.00	$0.01	15	0.51	$0.273
Ext. Lighting	Linear Fluorescent	T8	0.00	$0.00	10	1.34	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.00	$0.00	10	1.52	$0.002
Ext. Lighting	Linear Fluorescent	T5	0.00	$0.00	10	1.64	$0.002
Ext. Lighting	Linear Fluorescent	LED (2020)	0.01	$0.00	15	-	$0.025
Refrigeration	Walk-in Refrigerator	14600 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	10800 kWh/yr	0.63	$0.34	12	1.01	$0.058

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Refrigeration	Walk-in Refrigerator	10000 kWh/yr	0.76	$0.43	12	1.00	$0.061
Refrigeration	Walk-in Refrigerator	9000 kWh/yr	0.93	$0.77	12	0.96	$0.089
Refrigeration	Reach-in Refrigerator	3800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	3100 kWh/yr	0.13	$0.10	12	0.97	$0.087
Refrigeration	Reach-in Refrigerator	2500 kWh/yr	0.24	$0.20	12	0.93	$0.092
Refrigeration	Reach-in Refrigerator	2400 kWh/yr	0.26	$0.22	12	0.93	$0.091
Refrigeration	Reach-in Refrigerator	1500 kWh/yr	0.42	$0.23	12	1.02	$0.059
Refrigeration	Glass Door Display	14480 kWh/yr	-	$0.00	12	-	$0.000
Refrigeration	Glass Door Display	11700 kWh/yr	0.51	$0.34	12	-	$0.072
Refrigeration	Glass Door Display	8400 kWh/yr	1.11	$0.00	12	1.00	$0.000
Refrigeration	Glass Door Display	6800 kWh/yr	1.40	$0.34	12	0.91	$0.026
Refrigeration	Open Display Case	6500 kWh/yr	-	$0.00	18	-	$0.000
Refrigeration	Open Display Case	5350 kWh/yr	0.22	$0.00	18	1.00	$0.000
Refrigeration	Open Display Case	5300 kWh/yr	0.23	$0.15	18	-	$0.056
Refrigeration	Open Display Case	4330 kWh/yr	0.40	$0.15	18	1.00	$0.032
Refrigeration	Icemaker	7.0 kWh/100 lbs	-	$0.00	10	1.00	$0.000
Refrigeration	Icemaker	6.3 kWh/100 lbs	0.08	$0.03	10	1.01	$0.054
Refrigeration	Icemaker	6.0 kWh/100 lbs	0.11	$0.05	10	1.00	$0.057
Refrigeration	Icemaker	5.5 kWh/100 lbs	0.16	$0.18	10	0.88	$0.142
Refrigeration	Vending Machine	3400 kWh/year	-	$0.00	10	1.00	$0.000
Refrigeration	Vending Machine	3000 kWh/year	0.07	$0.01	10	1.05	$0.012
Refrigeration	Vending Machine	2400 kWh/year	0.18	$0.02	10	1.14	$0.012
Refrigeration	Vending Machine	1700 kWh/year	0.31	$0.05	10	1.20	$0.022
Food Prep.	Oven	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Oven	Energy Star	0.80	$0.00	12	1.13	$0.000
Food Prep.	Fryer	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Fryer	Energy Star	0.50	$0.11	12	1.03	$0.024
Food Prep.	Dishwasher	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Dishwasher	Energy Star	2.00	$0.09	12	1.35	$0.005
Food Prep.	Hot Food Container	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Hot Food Container	Energy Star	1.35	$0.30	12	1.30	$0.024
Office Equip.	Desktop Computer	Standard	-	$0.00	5	1.00	$0.000
Office Equip.	Desktop Computer	Energy Star	0.09	$0.00	5	1.05	$0.000
Office Equip.	Laptop	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Laptop	Energy Star	0.01	$0.00	4	1.01	$0.000
Office Equip.	Server	Standard	-	$0.00	3	1.00	$0.000
Office Equip.	Server	Energy Star	0.08	$0.00	3	1.03	$0.000
Office Equip.	Monitor	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Monitor	Energy Star	0.01	$0.00	4	1.02	$0.000
Office Equip.	Printer/Copier/Fax	Standard	-	$0.00	6	1.00	$0.000
Office Equip.	Printer/Copier/Fax	Energy Star	0.02	$0.00	6	1.09	$0.000
Office Equip.	POS Terminal	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	POS Terminal	Energy Star	0.05	$0.03	4	0.95	$0.152
Miscellaneous	Non-HVAC Motors	Standard (EPAct)	-	$0.00	15	1.00	$0.000
Miscellaneous	Non-HVAC Motors	Standard (EPAct 2015)	0.00	$0.00	15	-	$0.000
Miscellaneous	Non-HVAC Motors	High Eff.	0.00	$0.00	15	1.01	$0.010
Miscellaneous	Non-HVAC Motors	High Eff. (2015)	0.00	$0.00	15	-	$0.007
Miscellaneous	Non-HVAC Motors	Premium (NEMA)	0.01	$0.00	15	1.02	$0.010
Miscellaneous	Non-HVAC Motors	Premium (NEMA 2015)	0.01	$0.00	15	-	$0.008
Miscellaneous	Pool Pump	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff.	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff. Multi-Speed	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Heat Pump	-	$0.00	15	1.00	$0.000
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table C-9 Energy Efficiency Equipment Data, Electric—Retail, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	0.56	$0.11	20	1.18	$0.015
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	0.63	$0.14	20	1.21	$0.017
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	0.75	$0.18	20	1.25	$0.018
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	0.90	$0.21	20	1.32	$0.018
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	0.76	$0.06	20	1.21	$0.006
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	0.86	$0.11	20	1.23	$0.010
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	1.02	$0.14	20	1.28	$0.010
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	1.22	$0.21	20	1.35	$0.013
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	1.27	$0.23	20	1.36	$0.014
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	1.37	$0.26	20	1.40	$0.014
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	0.50	$0.23	16	-	$0.041
Cooling	Roof top AC	EER 11.2	0.99	$0.44	16	1.00	$0.039
Cooling	Roof top AC	EER 12.0	1.30	$0.85	16	1.00	$0.058
Cooling	Roof top AC	Ductless Minisplit	1.63	$2.79	16	0.83	$0.152
Cooling	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air Source Heat Pump	EER 10.3, COP 3.2	0.54	$0.29	16	-	$0.047
Cooling	Air Source Heat Pump	EER 11.0, COP 3.3	0.86	$0.41	16	1.00	$0.042
Cooling	Air Source Heat Pump	EER 11.7, COP 3.4	1.14	$1.05	16	0.97	$0.082
Cooling	Air Source Heat Pump	EER 12.0, COP 3.4	1.25	$1.38	16	0.95	$0.097
Cooling	Air Source Heat Pump	Ductless Minisplit	1.58	$2.64	16	0.86	$0.148
Cooling	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geo Heat Pump	EER 16, COP 3.5	0.33	$0.69	16	0.97	$0.182
Cooling	Geo Heat Pump	EER 18, COP 3.8	0.61	$1.37	16	0.94	$0.199
Cooling	Geo Heat Pump	EER 30, COP 5.0	1.49	$1.81	16	1.02	$0.107
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	0.07	$0.02	14	1.02	$0.027
Cooling	Other Cooling	EER 10.8	0.13	$0.21	14	0.99	$0.156
Cooling	Other Cooling	EER 11	0.19	$0.22	14	1.00	$0.112
Cooling	Other Cooling	EER 11.5	0.25	$0.25	14	1.01	$0.097
Heating	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air Source Heat Pump	EER 10.3, COP 3.2	0.04	$0.25	16	-	$0.558
Heating	Air Source Heat Pump	EER 11.0, COP 3.3	0.07	$0.36	16	1.00	$0.429
Heating	Air Source Heat Pump	EER 11.7, COP 3.4	0.10	$0.92	16	0.91	$0.789
Heating	Air Source Heat Pump	EER 12.0, COP 3.4	0.10	$1.20	16	0.87	$1.029
Heating	Air Source Heat Pump	Ductless Minisplit	0.13	$2.30	16	0.75	$1.586
Heating	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geo Heat Pump	EER 16, COP 3.5	0.39	$0.64	16	0.95	$0.143
Heating	Geo Heat Pump	EER 18, COP 3.8	0.72	$1.27	16	0.89	$0.156
Heating	Geo Heat Pump	EER 30, COP 5.0	0.09	$1.68	16	0.80	$1.710
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	0.76	-$0.07	10	1.17	-$0.012
Water Heating	Water Heating	EF .97	-	$0.00	15	1.00	$0.000
Water Heating	Water Heating	EF .98	0.01	$0.00	15	1.01	$0.016
Water Heating	Water Heating	EF 2.0	0.46	$0.00	15	2.03	$0.001
Water Heating	Water Heating	EF 2.3	0.51	$0.00	15	2.31	$0.001
Water Heating	Water Heating	EF 2.4	0.53	$0.00	15	2.40	$0.001
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	1.33	$0.06	3	-	$0.015
Int. Lighting	Screw-in	70W HIR PAR-38	2.04	$0.08	3	-	$0.013
Int. Lighting	Screw-in	CFL	3.82	$0.05	6	3.42	$0.002
Int. Lighting	Screw-in	LED (2010)	4.14	$1.21	20	1.89	$0.023
Int. Lighting	Screw-in	LED (2020)	4.76	$0.34	20	-	$0.006
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	0.19	$0.30	15	0.67	$0.146

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Int. Lighting	High-Bay Fixtures	T8	0.19	-$0.01	10	1.78	-$0.005
Int. Lighting	High-Bay Fixtures	HP Sodium	0.21	$0.00	6	1.75	$0.001
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	0.24	$0.00	15	1.91	$0.002
Int. Lighting	High-Bay Fixtures	T5	0.25	$0.00	10	2.18	-$0.002
Int. Lighting	High-Bay Fixtures	LED (2020)	0.36	$0.08	15	-	$0.020
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	0.76	$3.05	15	0.48	$0.370
Int. Lighting	Linear Fluorescent	T8	0.79	$0.00	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	1.10	$0.02	10	1.51	$0.002
Int. Lighting	Linear Fluorescent	T5	1.27	$0.03	10	1.63	$0.003
Int. Lighting	Linear Fluorescent	LED (2020)	2.32	$0.85	15	-	$0.034
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	0.62	$0.03	3	-	$0.015
Ext. Lighting	Screw-in	70W HIR PAR-38	0.95	$0.04	3	-	$0.013
Ext. Lighting	Screw-in	CFL	1.79	$0.02	6	3.27	$0.002
Ext. Lighting	Screw-in	LED (2010)	1.93	$0.57	20	1.62	$0.023
Ext. Lighting	Screw-in	LED (2020)	2.22	$0.16	20	-	$0.006
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	0.18	$0.24	15	0.65	$0.120
Ext. Lighting	HID	T8	0.19	-$0.01	10	1.74	-$0.004
Ext. Lighting	HID	HP Sodium	0.20	$0.00	6	1.73	$0.001
Ext. Lighting	HID	Light Emitting Plasma	0.23	$0.00	15	1.83	$0.001
Ext. Lighting	HID	T5	0.24	$0.00	10	2.12	-$0.002
Ext. Lighting	HID	LED (2020)	0.35	$0.06	15	-	$0.016
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.00	$0.01	15	0.42	$0.370
Ext. Lighting	Linear Fluorescent	T8	0.00	$0.00	10	1.34	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.00	$0.00	10	1.50	$0.002
Ext. Lighting	Linear Fluorescent	T5	0.00	$0.00	10	1.62	$0.003
Ext. Lighting	Linear Fluorescent	LED (2020)	0.01	$0.00	15	-	$0.034
Refrigeration	Walk-in Refrigerator	14600 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	10800 kWh/yr	0.07	$0.02	12	1.09	$0.022
Refrigeration	Walk-in Refrigerator	10000 kWh/yr	0.09	$0.02	12	1.11	$0.023
Refrigeration	Walk-in Refrigerator	9000 kWh/yr	0.11	$0.03	12	1.09	$0.034
Refrigeration	Reach-in Refrigerator	3800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	3100 kWh/yr	0.02	$0.00	12	1.06	$0.034
Refrigeration	Reach-in Refrigerator	2500 kWh/yr	0.03	$0.01	12	1.12	$0.035
Refrigeration	Reach-in Refrigerator	2400 kWh/yr	0.03	$0.01	12	1.13	$0.035
Refrigeration	Reach-in Refrigerator	1500 kWh/yr	0.05	$0.01	12	1.37	$0.023
Refrigeration	Glass Door Display	14480 kWh/yr	-	$0.00	12	-	$0.000
Refrigeration	Glass Door Display	11700 kWh/yr	0.06	$0.04	12	-	$0.072
Refrigeration	Glass Door Display	8400 kWh/yr	0.13	$0.00	12	1.00	$0.000
Refrigeration	Glass Door Display	6800 kWh/yr	0.17	$0.04	12	0.91	$0.026
Refrigeration	Open Display Case	6500 kWh/yr	-	$0.00	18	-	$0.000
Refrigeration	Open Display Case	5350 kWh/yr	0.03	$0.00	18	1.00	$0.000
Refrigeration	Open Display Case	5300 kWh/yr	0.03	$0.02	18	-	$0.056
Refrigeration	Open Display Case	4330 kWh/yr	0.05	$0.02	18	1.00	$0.032
Refrigeration	Icemaker	7.0 kWh/100 lbs	-	$0.00	10	1.00	$0.000
Refrigeration	Icemaker	6.3 kWh/100 lbs	0.02	$0.01	10	1.01	$0.054
Refrigeration	Icemaker	6.0 kWh/100 lbs	0.03	$0.01	10	1.00	$0.057
Refrigeration	Icemaker	5.5 kWh/100 lbs	0.04	$0.04	10	0.88	$0.142
Refrigeration	Vending Machine	3400 kWh/year	-	$0.00	10	1.00	$0.000
Refrigeration	Vending Machine	3000 kWh/year	0.02	$0.00	10	1.05	$0.012
Refrigeration	Vending Machine	2400 kWh/year	0.04	$0.00	10	1.14	$0.012
Refrigeration	Vending Machine	1700 kWh/year	0.07	$0.01	10	1.20	$0.022
Food Prep.	Oven	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Oven	Energy Star	0.03	$0.00	12	1.13	$0.000
Food Prep.	Fryer	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Fryer	Energy Star	0.02	$0.00	12	1.03	$0.024
Food Prep.	Dishwasher	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Dishwasher	Energy Star	0.16	$0.01	12	1.35	$0.005
Food Prep.	Hot Food Container	Standard	-	$0.00	12	1.00	$0.000

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Food Prep.	Hot Food Container	Energy Star	0.11	$0.02	12	1.31	$0.024
Office Equip.	Desktop Computer	Standard	-	$0.00	5	1.00	$0.000
Office Equip.	Desktop Computer	Energy Star	0.06	$0.00	5	1.05	$0.000
Office Equip.	Laptop	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Laptop	Energy Star	0.01	$0.00	4	1.01	$0.000
Office Equip.	Server	Standard	-	$0.00	3	1.00	$0.000
Office Equip.	Server	Energy Star	0.06	$0.00	3	1.03	$0.000
Office Equip.	Monitor	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Monitor	Energy Star	0.01	$0.00	4	1.02	$0.000
Office Equip.	Printer/Copier/Fax	Standard	-	$0.00	6	1.00	$0.000
Office Equip.	Printer/Copier/Fax	Energy Star	0.01	$0.00	6	1.09	$0.000
Office Equip.	POS Terminal	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	POS Terminal	Energy Star	0.03	$0.02	4	0.95	$0.152
Miscellaneous	Non-HVAC Motors	Standard (EPAct)	-	$0.00	15	1.00	$0.000
Miscellaneous	Non-HVAC Motors	Standard (EPAct 2015)	0.00	$0.00	15	-	$0.000
Miscellaneous	Non-HVAC Motors	High Eff.	0.00	$0.00	15	1.01	$0.010
Miscellaneous	Non-HVAC Motors	High Eff. (2015)	0.01	$0.00	15	-	$0.007
Miscellaneous	Non-HVAC Motors	Premium (NEMA)	0.01	$0.00	15	1.02	$0.010
Miscellaneous	Non-HVAC Motors	Premium (NEMA 2015)	0.01	$0.00	15	-	$0.008
Miscellaneous	Pool Pump	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff.	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff. Multi-Speed	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Heat Pump	-	$0.00	15	1.00	$0.000
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table C-10 Energy Efficiency Equipment Data, Electric— Retail, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	0.47	$0.14	20	1.16	$0.023
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	0.53	$0.18	20	1.18	$0.026
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	0.62	$0.22	20	1.21	$0.028
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	0.75	$0.26	20	1.26	$0.027
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	0.72	$0.08	20	1.19	$0.009
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	0.81	$0.16	20	1.21	$0.015
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	0.95	$0.19	20	1.25	$0.016
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	1.15	$0.30	20	1.30	$0.020
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	1.19	$0.33	20	1.31	$0.021
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	1.29	$0.36	20	1.34	$0.022
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	0.47	$0.18	16	-	$0.034
Cooling	Roof top AC	EER 11.2	0.93	$0.34	16	1.00	$0.033
Cooling	Roof top AC	EER 12.0	1.22	$0.66	16	1.01	$0.048
Cooling	Roof top AC	Ductless Minisplit	1.53	$2.17	16	0.86	$0.126
Cooling	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air Source Heat Pump	EER 10.3, COP 3.2	0.46	$0.20	16	-	$0.039
Cooling	Air Source Heat Pump	EER 11.0, COP 3.3	0.73	$0.29	16	1.00	$0.035
Cooling	Air Source Heat Pump	EER 11.7, COP 3.4	0.97	$0.74	16	0.98	$0.068
Cooling	Air Source Heat Pump	EER 12.0, COP 3.4	1.07	$0.97	16	0.97	$0.081
Cooling	Air Source Heat Pump	Ductless Minisplit	1.35	$1.86	16	0.90	$0.122
Cooling	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geo Heat Pump	EER 16, COP 3.5	0.32	$0.54	16	0.98	$0.151
Cooling	Geo Heat Pump	EER 18, COP 3.8	0.58	$1.08	16	0.96	$0.165
Cooling	Geo Heat Pump	EER 30, COP 5.0	1.42	$1.43	16	1.07	$0.089
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	0.06	$0.02	14	1.02	$0.027

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Other Cooling	EER 10.8	0.13	$0.20	14	0.99	$0.155
Cooling	Other Cooling	EER 11	0.19	$0.22	14	1.00	$0.111
Cooling	Other Cooling	EER 11.5	0.25	$0.25	14	1.01	$0.097
Heating	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air Source Heat Pump	EER 10.3, COP 3.2	0.05	$0.10	16	-	$0.166
Heating	Air Source Heat Pump	EER 11.0, COP 3.3	0.11	$0.15	16	1.00	$0.118
Heating	Air Source Heat Pump	EER 11.7, COP 3.4	0.16	$0.37	16	0.95	$0.202
Heating	Air Source Heat Pump	EER 12.0, COP 3.4	0.16	$0.49	16	0.93	$0.263
Heating	Air Source Heat Pump	Ductless Minisplit	0.22	$0.94	16	0.85	$0.376
Heating	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geo Heat Pump	EER 16, COP 3.5	0.41	$0.23	16	1.01	$0.049
Heating	Geo Heat Pump	EER 18, COP 3.8	0.75	$0.46	16	1.01	$0.054
Heating	Geo Heat Pump	EER 30, COP 5.0	0.91	$0.60	16	1.00	$0.059
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	0.69	-$0.08	10	1.14	-$0.015
Water Heating	Water Heating	EF .97	-	$0.00	15	1.00	$0.000
Water Heating	Water Heating	EF .98	0.01	$0.00	15	1.01	$0.023
Water Heating	Water Heating	EF 2.0	0.45	$0.00	15	2.01	$0.001
Water Heating	Water Heating	EF 2.3	0.51	$0.01	15	2.28	$0.001
Water Heating	Water Heating	EF 2.4	0.52	$0.01	15	2.37	$0.001
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	1.33	$0.06	3	-	$0.015
Int. Lighting	Screw-in	70W HIR PAR-38	2.04	$0.08	3	-	$0.013
Int. Lighting	Screw-in	CFL	3.82	$0.05	6	3.42	$0.002
Int. Lighting	Screw-in	LED (2010)	4.14	$1.21	20	1.89	$0.023
Int. Lighting	Screw-in	LED (2020)	4.76	$0.34	20	-	$0.006
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	0.19	$0.30	15	0.67	$0.146
Int. Lighting	High-Bay Fixtures	T8	0.19	-$0.01	10	1.78	-$0.005
Int. Lighting	High-Bay Fixtures	HP Sodium	0.21	$0.00	6	1.75	$0.001
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	0.24	$0.00	15	1.91	$0.002
Int. Lighting	High-Bay Fixtures	T5	0.25	$0.00	10	2.18	-$0.002
Int. Lighting	High-Bay Fixtures	LED (2020)	0.36	$0.08	15	-	$0.020
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	0.76	$3.05	15	0.48	$0.370
Int. Lighting	Linear Fluorescent	T8	0.79	$0.00	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	1.10	$0.02	10	1.51	$0.002
Int. Lighting	Linear Fluorescent	T5	1.27	$0.03	10	1.63	$0.003
Int. Lighting	Linear Fluorescent	LED (2020)	2.32	$0.85	15	-	$0.034
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	0.62	$0.03	3	-	$0.015
Ext. Lighting	Screw-in	70W HIR PAR-38	0.95	$0.04	3	-	$0.013
Ext. Lighting	Screw-in	CFL	1.79	$0.02	6	3.27	$0.002
Ext. Lighting	Screw-in	LED (2010)	1.93	$0.57	20	1.62	$0.023
Ext. Lighting	Screw-in	LED (2020)	2.22	$0.16	20	-	$0.006
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	0.18	$0.24	15	0.65	$0.120
Ext. Lighting	HID	T8	0.19	-$0.01	10	1.74	-$0.004
Ext. Lighting	HID	HP Sodium	0.20	$0.00	6	1.73	$0.001
Ext. Lighting	HID	Light Emitting Plasma	0.23	$0.00	15	1.83	$0.001
Ext. Lighting	HID	T5	0.24	$0.00	10	2.12	-$0.002
Ext. Lighting	HID	LED (2020)	0.35	$0.06	15	-	$0.016
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.00	$0.01	15	0.42	$0.370
Ext. Lighting	Linear Fluorescent	T8	0.00	$0.00	10	1.34	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.00	$0.00	10	1.50	$0.002
Ext. Lighting	Linear Fluorescent	T5	0.00	$0.00	10	1.62	$0.003
Ext. Lighting	Linear Fluorescent	LED (2020)	0.01	$0.00	15	-	$0.034
Refrigeration	Walk-in Refrigerator	14600 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	10800 kWh/yr	0.07	$0.02	12	1.08	$0.025

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Refrigeration	Walk-in Refrigerator	10000 kWh/yr	0.09	$0.02	12	1.09	$0.026
Refrigeration	Walk-in Refrigerator	9000 kWh/yr	0.11	$0.04	12	1.08	$0.038
Refrigeration	Reach-in Refrigerator	3800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	3100 kWh/yr	0.02	$0.01	12	1.05	$0.037
Refrigeration	Reach-in Refrigerator	2500 kWh/yr	0.03	$0.01	12	1.10	$0.039
Refrigeration	Reach-in Refrigerator	2400 kWh/yr	0.03	$0.01	12	1.11	$0.038
Refrigeration	Reach-in Refrigerator	1500 kWh/yr	0.05	$0.01	12	1.33	$0.025
Refrigeration	Glass Door Display	14480 kWh/yr	-	$0.00	12	-	$0.000
Refrigeration	Glass Door Display	11700 kWh/yr	0.06	$0.04	12	-	$0.072
Refrigeration	Glass Door Display	8400 kWh/yr	0.13	$0.00	12	1.00	$0.000
Refrigeration	Glass Door Display	6800 kWh/yr	0.17	$0.04	12	0.91	$0.026
Refrigeration	Open Display Case	6500 kWh/yr	-	$0.00	18	-	$0.000
Refrigeration	Open Display Case	5350 kWh/yr	0.03	$0.00	18	1.00	$0.000
Refrigeration	Open Display Case	5300 kWh/yr	0.03	$0.02	18	-	$0.056
Refrigeration	Open Display Case	4330 kWh/yr	0.05	$0.02	18	1.00	$0.032
Refrigeration	Icemaker	7.0 kWh/100 lbs	-	$0.00	10	1.00	$0.000
Refrigeration	Icemaker	6.3 kWh/100 lbs	0.02	$0.01	10	1.01	$0.054
Refrigeration	Icemaker	6.0 kWh/100 lbs	0.03	$0.01	10	1.00	$0.057
Refrigeration	Icemaker	5.5 kWh/100 lbs	0.04	$0.04	10	0.88	$0.142
Refrigeration	Vending Machine	3400 kWh/year	-	$0.00	10	1.00	$0.000
Refrigeration	Vending Machine	3000 kWh/year	0.02	$0.00	10	1.05	$0.012
Refrigeration	Vending Machine	2400 kWh/year	0.04	$0.00	10	1.14	$0.012
Refrigeration	Vending Machine	1700 kWh/year	0.07	$0.01	10	1.20	$0.022
Food Prep.	Oven	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Oven	Energy Star	0.03	$0.00	12	1.13	$0.000
Food Prep.	Fryer	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Fryer	Energy Star	0.02	$0.00	12	1.03	$0.024
Food Prep.	Dishwasher	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Dishwasher	Energy Star	0.16	$0.01	12	1.35	$0.005
Food Prep.	Hot Food Container	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Hot Food Container	Energy Star	0.11	$0.02	12	1.31	$0.024
Office Equip.	Desktop Computer	Standard	-	$0.00	5	1.00	$0.000
Office Equip.	Desktop Computer	Energy Star	0.06	$0.00	5	1.05	$0.000
Office Equip.	Laptop	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Laptop	Energy Star	0.01	$0.00	4	1.01	$0.000
Office Equip.	Server	Standard	-	$0.00	3	1.00	$0.000
Office Equip.	Server	Energy Star	0.06	$0.00	3	1.03	$0.000
Office Equip.	Monitor	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Monitor	Energy Star	0.01	$0.00	4	1.02	$0.000
Office Equip.	Printer/Copier/Fax	Standard	-	$0.00	6	1.00	$0.000
Office Equip.	Printer/Copier/Fax	Energy Star	0.01	$0.00	6	1.09	$0.000
Office Equip.	POS Terminal	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	POS Terminal	Energy Star	0.03	$0.02	4	0.95	$0.152
Miscellaneous	Non-HVAC Motors	Standard (EPAct)	-	$0.00	15	1.00	$0.000
Miscellaneous	Non-HVAC Motors	Standard (EPAct 2015)	0.00	$0.00	15	-	$0.000
Miscellaneous	Non-HVAC Motors	High Eff.	0.00	$0.00	15	1.01	$0.010
Miscellaneous	Non-HVAC Motors	High Eff. (2015)	0.01	$0.00	15	-	$0.007
Miscellaneous	Non-HVAC Motors	Premium (NEMA)	0.01	$0.00	15	1.02	$0.010
Miscellaneous	Non-HVAC Motors	Premium (NEMA 2015)	0.01	$0.00	15	-	$0.008
Miscellaneous	Pool Pump	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff.	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff. Multi-Speed	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Heat Pump	-	$0.00	15	1.00	$0.000
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table C-11 Energy Efficiency Equipment Data, Electric—Grocery, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	1.06	$0.21	20	1.21	$0.015
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	1.20	$0.27	20	1.24	$0.017
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	1.41	$0.34	20	1.30	$0.018
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	1.70	$0.40	20	1.38	$0.018
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	1.37	$0.10	20	1.22	$0.006
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	1.55	$0.20	20	1.26	$0.010
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	1.83	$0.24	20	1.32	$0.010
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	2.20	$0.38	20	1.40	$0.013
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	2.29	$0.42	20	1.42	$0.014
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	2.47	$0.46	20	1.47	$0.014
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	0.87	$1.38	16	-	$0.141
Cooling	Roof top AC	EER 11.2	1.74	$2.66	16	1.00	$0.135
Cooling	Roof top AC	EER 12.0	2.28	$5.11	16	0.97	$0.199
Cooling	Roof top AC	Ductless Minisplit	2.85	$16.77	16	0.74	$0.520
Cooling	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air Source Heat Pump	EER 10.3, COP 3.2	0.92	$1.67	16	-	$0.160
Cooling	Air Source Heat Pump	EER 11.0, COP 3.3	1.47	$2.41	16	1.00	$0.145
Cooling	Air Source Heat Pump	EER 11.7, COP 3.4	1.95	$6.17	16	0.93	$0.280
Cooling	Air Source Heat Pump	EER 12.0, COP 3.4	2.14	$8.05	16	0.89	$0.333
Cooling	Air Source Heat Pump	Ductless Minisplit	2.71	$15.43	16	0.77	$0.504
Cooling	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geo Heat Pump	EER 16, COP 3.5	0.55	$3.86	16	0.94	$0.625
Cooling	Geo Heat Pump	EER 18, COP 3.8	1.00	$7.72	16	0.88	$0.685
Cooling	Geo Heat Pump	EER 30, COP 5.0	2.44	$10.18	16	0.91	$0.369
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	0.12	$0.03	14	1.02	$0.027
Cooling	Other Cooling	EER 10.8	0.23	$0.38	14	1.01	$0.156
Cooling	Other Cooling	EER 11	0.34	$0.40	14	1.03	$0.112
Cooling	Other Cooling	EER 11.5	0.45	$0.45	14	1.05	$0.097
Heating	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air Source Heat Pump	EER 10.3, COP 3.2	0.06	$0.34	16	-	$0.508
Heating	Air Source Heat Pump	EER 11.0, COP 3.3	0.11	$0.49	16	1.00	$0.381
Heating	Air Source Heat Pump	EER 11.7, COP 3.4	0.15	$1.26	16	0.90	$0.762
Heating	Air Source Heat Pump	EER 12.0, COP 3.4	0.15	$1.64	16	0.86	$0.995
Heating	Air Source Heat Pump	Ductless Minisplit	0.17	$3.14	16	0.72	$1.602
Heating	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geo Heat Pump	EER 16, COP 3.5	0.46	$0.77	16	0.95	$0.148
Heating	Geo Heat Pump	EER 18, COP 3.8	0.84	$1.54	16	0.89	$0.162
Heating	Geo Heat Pump	EER 30, COP 5.0	0.27	$2.03	16	0.81	$0.658
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	1.03	-$0.48	10	1.06	-$0.057
Water Heating	Water Heating	EF .97	-	$0.00	15	1.00	$0.000
Water Heating	Water Heating	EF .98	0.02	$0.00	15	1.01	$0.018
Water Heating	Water Heating	EF 2.0	1.22	$0.01	15	2.02	$0.001
Water Heating	Water Heating	EF 2.3	1.37	$0.01	15	2.30	$0.001
Water Heating	Water Heating	EF 2.4	1.41	$0.02	15	2.39	$0.001
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	1.38	$0.04	3	-	$0.010
Int. Lighting	Screw-in	70W HIR PAR-38	2.12	$0.05	3	-	$0.009
Int. Lighting	Screw-in	CFL	3.97	$0.03	6	3.60	$0.001
Int. Lighting	Screw-in	LED (2010)	4.30	$0.84	20	2.48	$0.015
Int. Lighting	Screw-in	LED (2020)	4.94	$0.24	20	-	$0.004
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	0.14	$0.14	15	0.84	$0.097

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Int. Lighting	High-Bay Fixtures	T8	0.14	$0.00	10	1.72	-$0.003
Int. Lighting	High-Bay Fixtures	HP Sodium	0.15	$0.00	6	1.77	$0.001
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	0.18	$0.00	15	1.91	$0.001
Int. Lighting	High-Bay Fixtures	T5	0.18	$0.00	10	2.14	-$0.002
Int. Lighting	High-Bay Fixtures	LED (2020)	0.26	$0.04	15	-	$0.013
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	2.05	$5.47	15	0.63	$0.246
Int. Lighting	Linear Fluorescent	T8	2.13	$0.00	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	2.96	$0.04	10	1.53	$0.002
Int. Lighting	Linear Fluorescent	T5	3.43	$0.06	10	1.66	$0.002
Int. Lighting	Linear Fluorescent	LED (2020)	6.26	$1.52	15	-	$0.022
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	0.14	$0.00	3	-	$0.010
Ext. Lighting	Screw-in	70W HIR PAR-38	0.21	$0.01	3	-	$0.009
Ext. Lighting	Screw-in	CFL	0.39	$0.00	6	3.42	$0.001
Ext. Lighting	Screw-in	LED (2010)	0.43	$0.08	20	2.03	$0.015
Ext. Lighting	Screw-in	LED (2020)	0.49	$0.02	20	-	$0.004
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	0.54	$0.47	15	0.78	$0.080
Ext. Lighting	HID	T8	0.55	-$0.01	10	1.67	-$0.003
Ext. Lighting	HID	HP Sodium	0.59	$0.00	6	1.73	$0.001
Ext. Lighting	HID	Light Emitting Plasma	0.69	$0.01	15	1.80	$0.001
Ext. Lighting	HID	T5	0.70	-$0.01	10	2.06	-$0.001
Ext. Lighting	HID	LED (2020)	1.03	$0.12	15	-	$0.011
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.01	$0.03	15	0.54	$0.246
Ext. Lighting	Linear Fluorescent	T8	0.01	$0.00	10	1.34	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.02	$0.00	10	1.52	$0.002
Ext. Lighting	Linear Fluorescent	T5	0.02	$0.00	10	1.65	$0.002
Ext. Lighting	Linear Fluorescent	LED (2020)	0.04	$0.01	15	-	$0.022
Refrigeration	Walk-in Refrigerator	14600 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	10800 kWh/yr	1.06	$0.41	12	1.03	$0.042
Refrigeration	Walk-in Refrigerator	10000 kWh/yr	1.28	$0.52	12	1.03	$0.044
Refrigeration	Walk-in Refrigerator	9000 kWh/yr	1.56	$0.94	12	1.00	$0.065
Refrigeration	Reach-in Refrigerator	3800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	3100 kWh/yr	0.06	$0.04	12	1.00	$0.063
Refrigeration	Reach-in Refrigerator	2500 kWh/yr	0.11	$0.07	12	0.99	$0.067
Refrigeration	Reach-in Refrigerator	2400 kWh/yr	0.12	$0.07	12	0.99	$0.066
Refrigeration	Reach-in Refrigerator	1500 kWh/yr	0.20	$0.08	12	1.13	$0.042
Refrigeration	Glass Door Display	14480 kWh/yr	-	$0.00	12	-	$0.000
Refrigeration	Glass Door Display	11700 kWh/yr	2.44	$1.62	12	-	$0.072
Refrigeration	Glass Door Display	8400 kWh/yr	5.33	$0.00	12	1.00	$0.000
Refrigeration	Glass Door Display	6800 kWh/yr	6.73	$1.62	12	0.91	$0.026
Refrigeration	Open Display Case	6500 kWh/yr	-	$0.00	18	-	$0.000
Refrigeration	Open Display Case	5350 kWh/yr	1.04	$0.00	18	1.00	$0.000
Refrigeration	Open Display Case	5300 kWh/yr	1.08	$0.74	18	-	$0.056
Refrigeration	Open Display Case	4330 kWh/yr	1.92	$0.74	18	1.00	$0.032
Refrigeration	Icemaker	7.0 kWh/100 lbs	-	$0.00	10	1.00	$0.000
Refrigeration	Icemaker	6.3 kWh/100 lbs	0.02	$0.01	10	1.01	$0.054
Refrigeration	Icemaker	6.0 kWh/100 lbs	0.03	$0.01	10	1.01	$0.057
Refrigeration	Icemaker	5.5 kWh/100 lbs	0.04	$0.04	10	0.88	$0.142
Refrigeration	Vending Machine	3400 kWh/year	-	$0.00	10	1.00	$0.000
Refrigeration	Vending Machine	3000 kWh/year	0.04	$0.00	10	1.05	$0.012
Refrigeration	Vending Machine	2400 kWh/year	0.09	$0.01	10	1.14	$0.012
Refrigeration	Vending Machine	1700 kWh/year	0.15	$0.03	10	1.20	$0.022
Food Prep.	Oven	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Oven	Energy Star	0.10	$0.00	12	1.14	$0.000
Food Prep.	Fryer	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Fryer	Energy Star	0.06	$0.01	12	1.04	$0.024
Food Prep.	Dishwasher	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Dishwasher	Energy Star	0.50	$0.02	12	1.36	$0.005
Food Prep.	Hot Food Container	Standard	-	$0.00	12	1.00	$0.000

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Food Prep.	Hot Food Container	Energy Star	0.34	$0.08	12	1.37	$0.024
Office Equip.	Desktop Computer	Standard	-	$0.00	5	1.00	$0.000
Office Equip.	Desktop Computer	Energy Star	0.06	$0.00	5	1.05	$0.000
Office Equip.	Laptop	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Laptop	Energy Star	0.01	$0.00	4	1.02	$0.000
Office Equip.	Server	Standard	-	$0.00	3	1.00	$0.000
Office Equip.	Server	Energy Star	0.03	$0.00	3	1.04	$0.000
Office Equip.	Monitor	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Monitor	Energy Star	0.01	$0.00	4	1.02	$0.000
Office Equip.	Printer/Copier/Fax	Standard	-	$0.00	6	1.00	$0.000
Office Equip.	Printer/Copier/Fax	Energy Star	0.01	$0.00	6	1.10	$0.000
Office Equip.	POS Terminal	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	POS Terminal	Energy Star	0.04	$0.02	4	0.95	$0.152
Miscellaneous	Non-HVAC Motors	Standard (EPAct)	-	$0.00	15	1.00	$0.000
Miscellaneous	Non-HVAC Motors	Standard (EPAct 2015)	0.00	$0.00	15	-	$0.000
Miscellaneous	Non-HVAC Motors	High Eff.	0.00	$0.00	15	1.01	$0.010
Miscellaneous	Non-HVAC Motors	High Eff. (2015)	0.01	$0.00	15	-	$0.007
Miscellaneous	Non-HVAC Motors	Premium (NEMA)	0.01	$0.00	15	1.02	$0.010
Miscellaneous	Non-HVAC Motors	Premium (NEMA 2015)	0.01	$0.00	15	-	$0.008
Miscellaneous	Pool Pump	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff.	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff. Multi-Speed	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Heat Pump	-	$0.00	15	1.00	$0.000
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table C-12 Energy Efficiency Equipment Data, Electric— Grocery, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	0.87	$0.26	20	1.20	$0.023
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	0.99	$0.34	20	1.22	$0.026
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	1.17	$0.42	20	1.27	$0.028
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	1.40	$0.50	20	1.34	$0.027
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	1.29	$0.14	20	1.21	$0.009
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	1.46	$0.29	20	1.24	$0.015
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	1.72	$0.35	20	1.30	$0.016
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	2.06	$0.54	20	1.37	$0.020
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	2.15	$0.60	20	1.38	$0.021
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	2.32	$0.65	20	1.43	$0.022
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	0.82	$1.81	16	-	$0.195
Cooling	Roof top AC	EER 11.2	1.65	$3.49	16	1.00	$0.188
Cooling	Roof top AC	EER 12.0	2.15	$6.70	16	0.95	$0.276
Cooling	Roof top AC	Ductless Minisplit	2.70	$21.99	16	0.69	$0.722
Cooling	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air Source Heat Pump	EER 10.3, COP 3.2	0.85	$2.14	16	-	$0.222
Cooling	Air Source Heat Pump	EER 11.0, COP 3.3	1.36	$3.07	16	1.00	$0.201
Cooling	Air Source Heat Pump	EER 11.7, COP 3.4	1.80	$7.88	16	0.91	$0.388
Cooling	Air Source Heat Pump	EER 12.0, COP 3.4	1.97	$10.28	16	0.86	$0.461
Cooling	Air Source Heat Pump	Ductless Minisplit	2.50	$19.70	16	0.72	$0.698
Cooling	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geo Heat Pump	EER 16, COP 3.5	0.51	$4.99	16	0.93	$0.869
Cooling	Geo Heat Pump	EER 18, COP 3.8	0.93	$9.98	16	0.86	$0.953
Cooling	Geo Heat Pump	EER 30, COP 5.0	2.27	$13.17	16	0.87	$0.514
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	0.12	$0.03	14	1.02	$0.027

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Other Cooling	EER 10.8	0.23	$0.37	14	1.01	$0.155
Cooling	Other Cooling	EER 11	0.34	$0.39	14	1.03	$0.111
Cooling	Other Cooling	EER 11.5	0.44	$0.44	14	1.05	$0.097
Heating	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air Source Heat Pump	EER 10.3, COP 3.2	0.02	$0.80	16	-	$3.329
Heating	Air Source Heat Pump	EER 11.0, COP 3.3	0.04	$1.15	16	1.00	$2.585
Heating	Air Source Heat Pump	EER 11.7, COP 3.4	0.10	$2.94	16	0.86	$2.519
Heating	Air Source Heat Pump	EER 12.0, COP 3.4	0.10	$3.84	16	0.80	$3.288
Heating	Air Source Heat Pump	Ductless Minisplit	0.17	$7.36	16	0.63	$3.871
Heating	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geo Heat Pump	EER 16, COP 3.5	0.41	$1.76	16	0.91	$0.377
Heating	Geo Heat Pump	EER 18, COP 3.8	0.75	$3.51	16	0.83	$0.413
Heating	Geo Heat Pump	EER 30, COP 5.0	0.00	$4.63	16	0.76	$84.135
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	0.07	-$0.66	10	1.03	-$1.189
Water Heating	Water Heating	EF .97	-	$0.00	15	1.00	$0.000
Water Heating	Water Heating	EF .98	0.02	$0.00	15	1.01	$0.018
Water Heating	Water Heating	EF 2.0	1.20	$0.01	15	2.02	$0.001
Water Heating	Water Heating	EF 2.3	1.35	$0.01	15	2.30	$0.001
Water Heating	Water Heating	EF 2.4	1.39	$0.01	15	2.39	$0.001
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	1.38	$0.04	3	-	$0.010
Int. Lighting	Screw-in	70W HIR PAR-38	2.12	$0.05	3	-	$0.009
Int. Lighting	Screw-in	CFL	3.97	$0.03	6	3.60	$0.001
Int. Lighting	Screw-in	LED (2010)	4.30	$0.84	20	2.48	$0.015
Int. Lighting	Screw-in	LED (2020)	4.94	$0.24	20	-	$0.004
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	0.14	$0.14	15	0.84	$0.097
Int. Lighting	High-Bay Fixtures	T8	0.14	$0.00	10	1.72	-$0.003
Int. Lighting	High-Bay Fixtures	HP Sodium	0.15	$0.00	6	1.77	$0.001
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	0.18	$0.00	15	1.91	$0.001
Int. Lighting	High-Bay Fixtures	T5	0.18	$0.00	10	2.14	-$0.002
Int. Lighting	High-Bay Fixtures	LED (2020)	0.26	$0.04	15	-	$0.013
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	2.05	$5.47	15	0.63	$0.246
Int. Lighting	Linear Fluorescent	T8	2.13	$0.00	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	2.96	$0.04	10	1.53	$0.002
Int. Lighting	Linear Fluorescent	T5	3.43	$0.06	10	1.66	$0.002
Int. Lighting	Linear Fluorescent	LED (2020)	6.26	$1.52	15	-	$0.022
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	0.14	$0.00	3	-	$0.010
Ext. Lighting	Screw-in	70W HIR PAR-38	0.21	$0.01	3	-	$0.009
Ext. Lighting	Screw-in	CFL	0.39	$0.00	6	3.42	$0.001
Ext. Lighting	Screw-in	LED (2010)	0.43	$0.08	20	2.03	$0.015
Ext. Lighting	Screw-in	LED (2020)	0.49	$0.02	20	-	$0.004
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	0.54	$0.47	15	0.78	$0.080
Ext. Lighting	HID	T8	0.55	-$0.01	10	1.67	-$0.003
Ext. Lighting	HID	HP Sodium	0.59	$0.00	6	1.73	$0.001
Ext. Lighting	HID	Light Emitting Plasma	0.69	$0.01	15	1.80	$0.001
Ext. Lighting	HID	T5	0.70	-$0.01	10	2.06	-$0.001
Ext. Lighting	HID	LED (2020)	1.03	$0.12	15	-	$0.011
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.01	$0.03	15	0.54	$0.246
Ext. Lighting	Linear Fluorescent	T8	0.01	$0.00	10	1.34	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.02	$0.00	10	1.52	$0.002
Ext. Lighting	Linear Fluorescent	T5	0.02	$0.00	10	1.65	$0.002
Ext. Lighting	Linear Fluorescent	LED (2020)	0.04	$0.01	15	-	$0.022
Refrigeration	Walk-in Refrigerator	14600 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	10800 kWh/yr	1.06	$0.58	12	1.01	$0.059

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Refrigeration	Walk-in Refrigerator	10000 kWh/yr	1.28	$0.73	12	1.00	$0.062
Refrigeration	Walk-in Refrigerator	9000 kWh/yr	1.56	$1.31	12	0.96	$0.091
Refrigeration	Reach-in Refrigerator	3800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	3100 kWh/yr	0.06	$0.05	12	0.97	$0.089
Refrigeration	Reach-in Refrigerator	2500 kWh/yr	0.11	$0.10	12	0.93	$0.094
Refrigeration	Reach-in Refrigerator	2400 kWh/yr	0.12	$0.10	12	0.93	$0.092
Refrigeration	Reach-in Refrigerator	1500 kWh/yr	0.20	$0.11	12	1.02	$0.059
Refrigeration	Glass Door Display	14480 kWh/yr	-	$0.00	12	-	$0.000
Refrigeration	Glass Door Display	11700 kWh/yr	2.44	$1.62	12	-	$0.072
Refrigeration	Glass Door Display	8400 kWh/yr	5.33	$0.00	12	1.00	$0.000
Refrigeration	Glass Door Display	6800 kWh/yr	6.73	$1.62	12	0.91	$0.026
Refrigeration	Open Display Case	6500 kWh/yr	-	$0.00	18	-	$0.000
Refrigeration	Open Display Case	5350 kWh/yr	1.04	$0.00	18	1.00	$0.000
Refrigeration	Open Display Case	5300 kWh/yr	1.08	$0.74	18	-	$0.056
Refrigeration	Open Display Case	4330 kWh/yr	1.92	$0.74	18	1.00	$0.032
Refrigeration	Icemaker	7.0 kWh/100 lbs	-	$0.00	10	1.00	$0.000
Refrigeration	Icemaker	6.3 kWh/100 lbs	0.02	$0.01	10	1.01	$0.054
Refrigeration	Icemaker	6.0 kWh/100 lbs	0.03	$0.01	10	1.01	$0.057
Refrigeration	Icemaker	5.5 kWh/100 lbs	0.04	$0.04	10	0.88	$0.142
Refrigeration	Vending Machine	3400 kWh/year	-	$0.00	10	1.00	$0.000
Refrigeration	Vending Machine	3000 kWh/year	0.04	$0.00	10	1.05	$0.012
Refrigeration	Vending Machine	2400 kWh/year	0.09	$0.01	10	1.14	$0.012
Refrigeration	Vending Machine	1700 kWh/year	0.15	$0.03	10	1.20	$0.022
Food Prep.	Oven	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Oven	Energy Star	0.10	$0.00	12	1.14	$0.000
Food Prep.	Fryer	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Fryer	Energy Star	0.06	$0.01	12	1.04	$0.024
Food Prep.	Dishwasher	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Dishwasher	Energy Star	0.50	$0.02	12	1.36	$0.005
Food Prep.	Hot Food Container	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Hot Food Container	Energy Star	0.34	$0.08	12	1.37	$0.024
Office Equip.	Desktop Computer	Standard	-	$0.00	5	1.00	$0.000
Office Equip.	Desktop Computer	Energy Star	0.06	$0.00	5	1.05	$0.000
Office Equip.	Laptop	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Laptop	Energy Star	0.01	$0.00	4	1.02	$0.000
Office Equip.	Server	Standard	-	$0.00	3	1.00	$0.000
Office Equip.	Server	Energy Star	0.03	$0.00	3	1.04	$0.000
Office Equip.	Monitor	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Monitor	Energy Star	0.01	$0.00	4	1.02	$0.000
Office Equip.	Printer/Copier/Fax	Standard	-	$0.00	6	1.00	$0.000
Office Equip.	Printer/Copier/Fax	Energy Star	0.01	$0.00	6	1.10	$0.000
Office Equip.	POS Terminal	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	POS Terminal	Energy Star	0.04	$0.02	4	0.95	$0.152
Miscellaneous	Non-HVAC Motors	Standard (EPAct)	-	$0.00	15	1.00	$0.000
Miscellaneous	Non-HVAC Motors	Standard (EPAct 2015)	0.00	$0.00	15	-	$0.000
Miscellaneous	Non-HVAC Motors	High Eff.	0.00	$0.00	15	1.01	$0.010
Miscellaneous	Non-HVAC Motors	High Eff. (2015)	0.01	$0.00	15	-	$0.007
Miscellaneous	Non-HVAC Motors	Premium (NEMA)	0.01	$0.00	15	1.02	$0.010
Miscellaneous	Non-HVAC Motors	Premium (NEMA 2015)	0.01	$0.00	15	-	$0.008
Miscellaneous	Pool Pump	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff.	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff. Multi-Speed	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Heat Pump	-	$0.00	15	1.00	$0.000
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table C-13 Energy Efficiency Equipment Data, Electric—College, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	0.96	$0.45	20	1.12	$0.036
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	1.08	$0.59	20	1.13	$0.042
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	1.28	$0.72	20	1.16	$0.044
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	1.53	$0.86	20	1.19	$0.043
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	1.24	$0.22	20	1.17	$0.014
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	1.40	$0.44	20	1.17	$0.024
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	1.65	$0.53	20	1.21	$0.025
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	1.98	$0.82	20	1.24	$0.032
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	2.07	$0.90	20	1.24	$0.034
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	2.23	$0.99	20	1.26	$0.034
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	0.43	$0.44	16	-	$0.089
Cooling	Roof top AC	EER 11.2	0.87	$0.84	16	1.00	$0.085
Cooling	Roof top AC	EER 12.0	1.14	$1.61	16	0.96	$0.125
Cooling	Roof top AC	Ductless Minisplit	1.42	$5.27	16	0.71	$0.328
Cooling	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air Source Heat Pump	EER 10.3, COP 3.2	0.41	$0.47	16	-	$0.101
Cooling	Air Source Heat Pump	EER 11.0, COP 3.3	0.66	$0.68	16	1.00	$0.092
Cooling	Air Source Heat Pump	EER 11.7, COP 3.4	0.87	$1.74	16	0.92	$0.177
Cooling	Air Source Heat Pump	EER 12.0, COP 3.4	0.96	$2.28	16	0.88	$0.210
Cooling	Air Source Heat Pump	Ductless Minisplit	1.21	$4.36	16	0.74	$0.319
Cooling	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geo Heat Pump	EER 16, COP 3.5	0.52	$2.31	16	0.93	$0.393
Cooling	Geo Heat Pump	EER 18, COP 3.8	0.95	$4.61	16	0.87	$0.431
Cooling	Geo Heat Pump	EER 30, COP 5.0	2.32	$6.09	16	0.88	$0.232
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	0.06	$0.05	14	1.01	$0.076
Cooling	Other Cooling	EER 10.8	0.11	$0.52	14	0.92	$0.443
Cooling	Other Cooling	EER 11	0.17	$0.55	14	0.92	$0.318
Cooling	Other Cooling	EER 11.5	0.22	$0.63	14	0.92	$0.277
Heating	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air Source Heat Pump	EER 10.3, COP 3.2	0.14	$0.17	16	-	$0.109
Heating	Air Source Heat Pump	EER 11.0, COP 3.3	0.27	$0.25	16	1.00	$0.081
Heating	Air Source Heat Pump	EER 11.7, COP 3.4	0.39	$0.63	16	0.95	$0.142
Heating	Air Source Heat Pump	EER 12.0, COP 3.4	0.39	$0.82	16	0.92	$0.186
Heating	Air Source Heat Pump	Ductless Minisplit	0.51	$1.58	16	0.82	$0.276
Heating	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geo Heat Pump	EER 16, COP 3.5	0.60	$0.53	16	0.98	$0.079
Heating	Geo Heat Pump	EER 18, COP 3.8	1.09	$1.07	16	0.96	$0.087
Heating	Geo Heat Pump	EER 30, COP 5.0	1.40	$1.41	16	0.94	$0.089
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	1.01	-$0.29	10	1.08	-$0.036
Water Heating	Water Heating	EF .97	-	$0.00	15	1.00	$0.000
Water Heating	Water Heating	EF .98	0.02	$0.00	15	1.01	$0.024
Water Heating	Water Heating	EF 2.0	0.89	$0.01	15	2.01	$0.001
Water Heating	Water Heating	EF 2.3	1.00	$0.01	15	2.28	$0.001
Water Heating	Water Heating	EF 2.4	1.03	$0.01	15	2.37	$0.001
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	1.32	$0.03	3	-	$0.009
Int. Lighting	Screw-in	70W HIR PAR-38	2.03	$0.05	3	-	$0.008
Int. Lighting	Screw-in	CFL	3.81	$0.03	6	3.59	$0.001
Int. Lighting	Screw-in	LED (2010)	4.12	$0.74	20	2.48	$0.014
Int. Lighting	Screw-in	LED (2020)	4.74	$0.21	20	-	$0.003
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	0.08	$0.07	15	0.85	$0.089

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Int. Lighting	High-Bay Fixtures	T8	0.08	$0.00	10	1.71	-$0.003
Int. Lighting	High-Bay Fixtures	HP Sodium	0.08	$0.00	6	1.76	$0.001
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	0.10	$0.00	15	1.88	$0.001
Int. Lighting	High-Bay Fixtures	T5	0.10	$0.00	10	2.12	-$0.001
Int. Lighting	High-Bay Fixtures	LED (2020)	0.15	$0.02	15	-	$0.012
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	0.92	$2.25	15	0.64	$0.227
Int. Lighting	Linear Fluorescent	T8	0.95	$0.00	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	1.32	$0.02	10	1.53	$0.001
Int. Lighting	Linear Fluorescent	T5	1.53	$0.02	10	1.66	$0.002
Int. Lighting	Linear Fluorescent	LED (2020)	2.80	$0.62	15	-	$0.021
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	0.05	$0.00	3	-	$0.009
Ext. Lighting	Screw-in	70W HIR PAR-38	0.07	$0.00	3	-	$0.008
Ext. Lighting	Screw-in	CFL	0.13	$0.00	6	3.44	$0.001
Ext. Lighting	Screw-in	LED (2010)	0.14	$0.03	20	2.12	$0.014
Ext. Lighting	Screw-in	LED (2020)	0.16	$0.01	20	-	$0.003
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	0.35	$0.28	15	0.80	$0.074
Ext. Lighting	HID	T8	0.36	-$0.01	10	1.66	-$0.003
Ext. Lighting	HID	HP Sodium	0.38	$0.00	6	1.73	$0.001
Ext. Lighting	HID	Light Emitting Plasma	0.44	$0.00	15	1.80	$0.001
Ext. Lighting	HID	T5	0.45	$0.00	10	2.05	-$0.001
Ext. Lighting	HID	LED (2020)	0.67	$0.07	15	-	$0.010
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.00	$0.00	15	0.56	$0.227
Ext. Lighting	Linear Fluorescent	T8	0.00	$0.00	10	1.34	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.00	$0.00	10	1.52	$0.001
Ext. Lighting	Linear Fluorescent	T5	0.00	$0.00	10	1.65	$0.002
Ext. Lighting	Linear Fluorescent	LED (2020)	0.00	$0.00	15	-	$0.021
Refrigeration	Walk-in Refrigerator	14600 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	10800 kWh/yr	0.03	$0.00	12	1.16	$0.011
Refrigeration	Walk-in Refrigerator	10000 kWh/yr	0.03	$0.00	12	1.20	$0.012
Refrigeration	Walk-in Refrigerator	9000 kWh/yr	0.04	$0.01	12	1.22	$0.017
Refrigeration	Reach-in Refrigerator	3800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	3100 kWh/yr	0.01	$0.00	12	1.12	$0.017
Refrigeration	Reach-in Refrigerator	2500 kWh/yr	0.02	$0.00	12	1.25	$0.018
Refrigeration	Reach-in Refrigerator	2400 kWh/yr	0.02	$0.00	12	1.28	$0.018
Refrigeration	Reach-in Refrigerator	1500 kWh/yr	0.04	$0.00	12	1.69	$0.011
Refrigeration	Glass Door Display	14480 kWh/yr	-	$0.00	12	-	$0.000
Refrigeration	Glass Door Display	11700 kWh/yr	0.02	$0.01	12	-	$0.072
Refrigeration	Glass Door Display	8400 kWh/yr	0.05	$0.00	12	1.00	$0.000
Refrigeration	Glass Door Display	6800 kWh/yr	0.06	$0.01	12	0.91	$0.026
Refrigeration	Open Display Case	6500 kWh/yr	-	$0.00	18	-	$0.000
Refrigeration	Open Display Case	5350 kWh/yr	0.01	$0.00	18	1.00	$0.000
Refrigeration	Open Display Case	5300 kWh/yr	0.01	$0.01	18	-	$0.056
Refrigeration	Open Display Case	4330 kWh/yr	0.02	$0.01	18	1.00	$0.032
Refrigeration	Icemaker	7.0 kWh/100 lbs	-	$0.00	10	1.00	$0.000
Refrigeration	Icemaker	6.3 kWh/100 lbs	0.01	$0.00	10	1.01	$0.054
Refrigeration	Icemaker	6.0 kWh/100 lbs	0.01	$0.00	10	1.01	$0.057
Refrigeration	Icemaker	5.5 kWh/100 lbs	0.01	$0.02	10	0.88	$0.142
Refrigeration	Vending Machine	3400 kWh/year	-	$0.00	10	1.00	$0.000
Refrigeration	Vending Machine	3000 kWh/year	0.01	$0.00	10	1.05	$0.012
Refrigeration	Vending Machine	2400 kWh/year	0.02	$0.00	10	1.14	$0.012
Refrigeration	Vending Machine	1700 kWh/year	0.03	$0.00	10	1.20	$0.022
Food Prep.	Oven	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Oven	Energy Star	0.04	$0.00	12	1.13	$0.000
Food Prep.	Fryer	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Fryer	Energy Star	0.02	$0.01	12	1.04	$0.024
Food Prep.	Dishwasher	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Dishwasher	Energy Star	0.18	$0.01	12	1.35	$0.005
Food Prep.	Hot Food Container	Standard	-	$0.00	12	1.00	$0.000

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Food Prep.	Hot Food Container	Energy Star	0.12	$0.03	12	1.33	$0.024
Office Equip.	Desktop Computer	Standard	-	$0.00	5	1.00	$0.000
Office Equip.	Desktop Computer	Energy Star	0.16	$0.00	5	1.05	$0.000
Office Equip.	Laptop	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Laptop	Energy Star	0.02	$0.00	4	1.02	$0.000
Office Equip.	Server	Standard	-	$0.00	3	1.00	$0.000
Office Equip.	Server	Energy Star	0.05	$0.00	3	1.03	$0.000
Office Equip.	Monitor	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Monitor	Energy Star	0.02	$0.00	4	1.02	$0.000
Office Equip.	Printer/Copier/Fax	Standard	-	$0.00	6	1.00	$0.000
Office Equip.	Printer/Copier/Fax	Energy Star	0.04	$0.00	6	1.09	$0.000
Office Equip.	POS Terminal	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	POS Terminal	Energy Star	0.04	$0.02	4	0.95	$0.152
Miscellaneous	Non-HVAC Motors	Standard (EPAct)	-	$0.00	15	1.00	$0.000
Miscellaneous	Non-HVAC Motors	Standard (EPAct 2015)	0.00	$0.00	15	-	$0.000
Miscellaneous	Non-HVAC Motors	High Eff.	0.00	$0.00	15	1.01	$0.010
Miscellaneous	Non-HVAC Motors	High Eff. (2015)	0.00	$0.00	15	-	$0.007
Miscellaneous	Non-HVAC Motors	Premium (NEMA)	0.00	$0.00	15	1.02	$0.010
Miscellaneous	Non-HVAC Motors	Premium (NEMA 2015)	0.00	$0.00	15	-	$0.008
Miscellaneous	Pool Pump	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff.	0.00	$0.00	15	1.05	$0.030
Miscellaneous	Pool Pump	High Eff. Multi-Speed	0.00	$0.00	15	1.10	$0.051
Miscellaneous	Pool Heater	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Heat Pump	0.01	$0.01	15	1.09	$0.059
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table C-14 Energy Efficiency Equipment Data, Electric— College, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	0.86	$0.47	20	1.11	$0.042
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	0.98	$0.61	20	1.12	$0.048
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	1.15	$0.75	20	1.14	$0.050
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	1.38	$0.88	20	1.17	$0.049
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	1.13	$0.23	20	1.16	$0.016
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	1.28	$0.46	20	1.16	$0.028
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	1.50	$0.55	20	1.19	$0.028
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	1.81	$0.85	20	1.21	$0.036
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	1.88	$0.94	20	1.22	$0.039
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	2.03	$1.04	20	1.24	$0.039
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	0.41	$0.45	16	-	$0.098
Cooling	Roof top AC	EER 11.2	0.83	$0.87	16	1.00	$0.094
Cooling	Roof top AC	EER 12.0	1.08	$1.68	16	0.95	$0.138
Cooling	Roof top AC	Ductless Minisplit	1.35	$5.51	16	0.69	$0.360
Cooling	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air Source Heat Pump	EER 10.3, COP 3.2	0.38	$0.47	16	-	$0.111
Cooling	Air Source Heat Pump	EER 11.0, COP 3.3	0.60	$0.68	16	1.00	$0.101
Cooling	Air Source Heat Pump	EER 11.7, COP 3.4	0.80	$1.75	16	0.91	$0.194
Cooling	Air Source Heat Pump	EER 12.0, COP 3.4	0.87	$2.28	16	0.87	$0.231
Cooling	Air Source Heat Pump	Ductless Minisplit	1.10	$4.37	16	0.73	$0.350
Cooling	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geo Heat Pump	EER 16, COP 3.5	0.49	$2.39	16	0.93	$0.432
Cooling	Geo Heat Pump	EER 18, COP 3.8	0.89	$4.77	16	0.86	$0.473
Cooling	Geo Heat Pump	EER 30, COP 5.0	2.18	$6.29	16	0.87	$0.255
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	0.06	$0.05	14	1.00	$0.085

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Other Cooling	EER 10.8	0.11	$0.55	14	0.91	$0.494
Cooling	Other Cooling	EER 11	0.16	$0.59	14	0.91	$0.355
Cooling	Other Cooling	EER 11.5	0.21	$0.67	14	0.91	$0.309
Heating	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air Source Heat Pump	EER 10.3, COP 3.2	0.13	$0.23	16	-	$0.154
Heating	Air Source Heat Pump	EER 11.0, COP 3.3	0.25	$0.33	16	1.00	$0.114
Heating	Air Source Heat Pump	EER 11.7, COP 3.4	0.37	$0.84	16	0.93	$0.202
Heating	Air Source Heat Pump	EER 12.0, COP 3.4	0.37	$1.09	16	0.89	$0.264
Heating	Air Source Heat Pump	Ductless Minisplit	0.47	$2.09	16	0.78	$0.392
Heating	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geo Heat Pump	EER 16, COP 3.5	0.58	$0.73	16	0.96	$0.111
Heating	Geo Heat Pump	EER 18, COP 3.8	1.06	$1.45	16	0.92	$0.122
Heating	Geo Heat Pump	EER 30, COP 5.0	1.29	$1.92	16	0.89	$0.132
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	1.02	-$0.29	10	1.08	-$0.035
Water Heating	Water Heating	EF .97	-	$0.00	15	1.00	$0.000
Water Heating	Water Heating	EF .98	0.02	$0.00	15	1.01	$0.023
Water Heating	Water Heating	EF 2.0	0.88	$0.01	15	2.01	$0.001
Water Heating	Water Heating	EF 2.3	0.99	$0.01	15	2.29	$0.001
Water Heating	Water Heating	EF 2.4	1.02	$0.01	15	2.38	$0.001
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	1.32	$0.03	3	-	$0.009
Int. Lighting	Screw-in	70W HIR PAR-38	2.03	$0.05	3	-	$0.008
Int. Lighting	Screw-in	CFL	3.81	$0.03	6	3.59	$0.001
Int. Lighting	Screw-in	LED (2010)	4.12	$0.74	20	2.48	$0.014
Int. Lighting	Screw-in	LED (2020)	4.74	$0.21	20	-	$0.003
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	0.08	$0.07	15	0.85	$0.089
Int. Lighting	High-Bay Fixtures	T8	0.08	$0.00	10	1.71	-$0.003
Int. Lighting	High-Bay Fixtures	HP Sodium	0.08	$0.00	6	1.76	$0.001
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	0.10	$0.00	15	1.88	$0.001
Int. Lighting	High-Bay Fixtures	T5	0.10	$0.00	10	2.12	-$0.001
Int. Lighting	High-Bay Fixtures	LED (2020)	0.15	$0.02	15	-	$0.012
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	0.92	$2.25	15	0.64	$0.227
Int. Lighting	Linear Fluorescent	T8	0.95	$0.00	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	1.32	$0.02	10	1.53	$0.001
Int. Lighting	Linear Fluorescent	T5	1.53	$0.02	10	1.66	$0.002
Int. Lighting	Linear Fluorescent	LED (2020)	2.80	$0.62	15	-	$0.021
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	0.05	$0.00	3	-	$0.009
Ext. Lighting	Screw-in	70W HIR PAR-38	0.07	$0.00	3	-	$0.008
Ext. Lighting	Screw-in	CFL	0.13	$0.00	6	3.44	$0.001
Ext. Lighting	Screw-in	LED (2010)	0.14	$0.03	20	2.12	$0.014
Ext. Lighting	Screw-in	LED (2020)	0.16	$0.01	20	-	$0.003
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	0.35	$0.28	15	0.80	$0.074
Ext. Lighting	HID	T8	0.36	-$0.01	10	1.66	-$0.003
Ext. Lighting	HID	HP Sodium	0.38	$0.00	6	1.73	$0.001
Ext. Lighting	HID	Light Emitting Plasma	0.44	$0.00	15	1.80	$0.001
Ext. Lighting	HID	T5	0.45	$0.00	10	2.05	-$0.001
Ext. Lighting	HID	LED (2020)	0.67	$0.07	15	-	$0.010
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.00	$0.00	15	0.56	$0.227
Ext. Lighting	Linear Fluorescent	T8	0.00	$0.00	10	1.34	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.00	$0.00	10	1.52	$0.001
Ext. Lighting	Linear Fluorescent	T5	0.00	$0.00	10	1.65	$0.002
Ext. Lighting	Linear Fluorescent	LED (2020)	0.00	$0.00	15	-	$0.021
Refrigeration	Walk-in Refrigerator	14600 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	10800 kWh/yr	0.03	$0.00	12	1.15	$0.012

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Refrigeration	Walk-in Refrigerator	10000 kWh/yr	0.03	$0.00	12	1.19	$0.013
Refrigeration	Walk-in Refrigerator	9000 kWh/yr	0.04	$0.01	12	1.20	$0.019
Refrigeration	Reach-in Refrigerator	3800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	3100 kWh/yr	0.01	$0.00	12	1.12	$0.019
Refrigeration	Reach-in Refrigerator	2500 kWh/yr	0.02	$0.00	12	1.23	$0.020
Refrigeration	Reach-in Refrigerator	2400 kWh/yr	0.02	$0.00	12	1.26	$0.020
Refrigeration	Reach-in Refrigerator	1500 kWh/yr	0.04	$0.00	12	1.64	$0.013
Refrigeration	Glass Door Display	14480 kWh/yr	-	$0.00	12	-	$0.000
Refrigeration	Glass Door Display	11700 kWh/yr	0.02	$0.01	12	-	$0.072
Refrigeration	Glass Door Display	8400 kWh/yr	0.05	$0.00	12	1.00	$0.000
Refrigeration	Glass Door Display	6800 kWh/yr	0.06	$0.01	12	0.91	$0.026
Refrigeration	Open Display Case	6500 kWh/yr	-	$0.00	18	-	$0.000
Refrigeration	Open Display Case	5350 kWh/yr	0.01	$0.00	18	1.00	$0.000
Refrigeration	Open Display Case	5300 kWh/yr	0.01	$0.01	18	-	$0.056
Refrigeration	Open Display Case	4330 kWh/yr	0.02	$0.01	18	1.00	$0.032
Refrigeration	Icemaker	7.0 kWh/100 lbs	-	$0.00	10	1.00	$0.000
Refrigeration	Icemaker	6.3 kWh/100 lbs	0.01	$0.00	10	1.01	$0.054
Refrigeration	Icemaker	6.0 kWh/100 lbs	0.01	$0.00	10	1.01	$0.057
Refrigeration	Icemaker	5.5 kWh/100 lbs	0.01	$0.02	10	0.88	$0.142
Refrigeration	Vending Machine	3400 kWh/year	-	$0.00	10	1.00	$0.000
Refrigeration	Vending Machine	3000 kWh/year	0.01	$0.00	10	1.05	$0.012
Refrigeration	Vending Machine	2400 kWh/year	0.02	$0.00	10	1.14	$0.012
Refrigeration	Vending Machine	1700 kWh/year	0.03	$0.00	10	1.20	$0.022
Food Prep.	Oven	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Oven	Energy Star	0.04	$0.00	12	1.13	$0.000
Food Prep.	Fryer	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Fryer	Energy Star	0.02	$0.01	12	1.04	$0.024
Food Prep.	Dishwasher	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Dishwasher	Energy Star	0.18	$0.01	12	1.35	$0.005
Food Prep.	Hot Food Container	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Hot Food Container	Energy Star	0.12	$0.03	12	1.33	$0.024
Office Equip.	Desktop Computer	Standard	-	$0.00	5	1.00	$0.000
Office Equip.	Desktop Computer	Energy Star	0.16	$0.00	5	1.05	$0.000
Office Equip.	Laptop	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Laptop	Energy Star	0.02	$0.00	4	1.02	$0.000
Office Equip.	Server	Standard	-	$0.00	3	1.00	$0.000
Office Equip.	Server	Energy Star	0.05	$0.00	3	1.03	$0.000
Office Equip.	Monitor	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Monitor	Energy Star	0.02	$0.00	4	1.02	$0.000
Office Equip.	Printer/Copier/Fax	Standard	-	$0.00	6	1.00	$0.000
Office Equip.	Printer/Copier/Fax	Energy Star	0.04	$0.00	6	1.09	$0.000
Office Equip.	POS Terminal	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	POS Terminal	Energy Star	0.04	$0.02	4	0.95	$0.152
Miscellaneous	Non-HVAC Motors	Standard (EPAct)	-	$0.00	15	1.00	$0.000
Miscellaneous	Non-HVAC Motors	Standard (EPAct 2015)	0.00	$0.00	15	-	$0.000
Miscellaneous	Non-HVAC Motors	High Eff.	0.00	$0.00	15	1.01	$0.010
Miscellaneous	Non-HVAC Motors	High Eff. (2015)	0.00	$0.00	15	-	$0.007
Miscellaneous	Non-HVAC Motors	Premium (NEMA)	0.00	$0.00	15	1.02	$0.010
Miscellaneous	Non-HVAC Motors	Premium (NEMA 2015)	0.00	$0.00	15	-	$0.008
Miscellaneous	Pool Pump	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff.	0.00	$0.00	15	1.05	$0.030
Miscellaneous	Pool Pump	High Eff. Multi-Speed	0.00	$0.00	15	1.10	$0.051
Miscellaneous	Pool Heater	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Heat Pump	0.01	$0.01	15	1.09	$0.059
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table C-15 Energy Efficiency Equipment Data, Electric—School, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	0.59	$0.28	20	1.16	$0.036
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	0.66	$0.36	20	1.18	$0.042
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	0.78	$0.44	20	1.21	$0.044
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	0.94	$0.52	20	1.27	$0.043
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	0.76	$0.13	20	1.19	$0.014
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	0.86	$0.27	20	1.21	$0.024
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	1.01	$0.32	20	1.25	$0.025
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	1.22	$0.50	20	1.30	$0.032
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	1.27	$0.55	20	1.31	$0.034
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	1.37	$0.61	20	1.34	$0.034
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	0.27	$0.27	16	-	$0.089
Cooling	Roof top AC	EER 11.2	0.53	$0.51	16	1.00	$0.085
Cooling	Roof top AC	EER 12.0	0.70	$0.98	16	0.98	$0.125
Cooling	Roof top AC	Ductless Minisplit	0.87	$3.23	16	0.78	$0.328
Cooling	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air Source Heat Pump	EER 10.3, COP 3.2	0.25	$0.29	16	-	$0.101
Cooling	Air Source Heat Pump	EER 11.0, COP 3.3	0.40	$0.42	16	1.00	$0.092
Cooling	Air Source Heat Pump	EER 11.7, COP 3.4	0.53	$1.07	16	0.95	$0.177
Cooling	Air Source Heat Pump	EER 12.0, COP 3.4	0.59	$1.39	16	0.92	$0.210
Cooling	Air Source Heat Pump	Ductless Minisplit	0.74	$2.67	16	0.81	$0.319
Cooling	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geo Heat Pump	EER 16, COP 3.5	0.32	$1.41	16	0.96	$0.393
Cooling	Geo Heat Pump	EER 18, COP 3.8	0.58	$2.83	16	0.91	$0.431
Cooling	Geo Heat Pump	EER 30, COP 5.0	1.42	$3.73	16	0.96	$0.232
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	0.04	$0.03	14	1.01	$0.076
Cooling	Other Cooling	EER 10.8	0.07	$0.32	14	0.95	$0.443
Cooling	Other Cooling	EER 11	0.10	$0.34	14	0.96	$0.318
Cooling	Other Cooling	EER 11.5	0.13	$0.38	14	0.97	$0.277
Heating	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air Source Heat Pump	EER 10.3, COP 3.2	0.10	$0.12	16	-	$0.109
Heating	Air Source Heat Pump	EER 11.0, COP 3.3	0.19	$0.17	16	1.00	$0.081
Heating	Air Source Heat Pump	EER 11.7, COP 3.4	0.27	$0.44	16	0.95	$0.142
Heating	Air Source Heat Pump	EER 12.0, COP 3.4	0.27	$0.57	16	0.92	$0.186
Heating	Air Source Heat Pump	Ductless Minisplit	0.35	$1.09	16	0.82	$0.276
Heating	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geo Heat Pump	EER 16, COP 3.5	0.42	$0.37	16	0.98	$0.079
Heating	Geo Heat Pump	EER 18, COP 3.8	0.76	$0.74	16	0.96	$0.087
Heating	Geo Heat Pump	EER 30, COP 5.0	0.97	$0.98	16	0.94	$0.089
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	0.62	-$0.18	10	1.08	-$0.036
Water Heating	Water Heating	EF .97	-	$0.00	15	1.00	$0.000
Water Heating	Water Heating	EF .98	0.01	$0.00	15	1.01	$0.024
Water Heating	Water Heating	EF 2.0	0.56	$0.01	15	2.00	$0.001
Water Heating	Water Heating	EF 2.3	0.63	$0.01	15	2.27	$0.001
Water Heating	Water Heating	EF 2.4	0.65	$0.01	15	2.36	$0.001
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	1.59	$0.10	3	-	$0.022
Int. Lighting	Screw-in	70W HIR PAR-38	2.45	$0.14	3	-	$0.020
Int. Lighting	Screw-in	CFL	4.58	$0.08	6	3.19	$0.003
Int. Lighting	Screw-in	LED (2010)	4.96	$2.14	20	1.41	$0.033
Int. Lighting	Screw-in	LED (2020)	5.70	$0.60	20	-	$0.008
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	0.15	$0.36	15	0.53	$0.215

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Int. Lighting	High-Bay Fixtures	T8	0.16	-$0.01	10	1.88	-$0.008
Int. Lighting	High-Bay Fixtures	HP Sodium	0.17	$0.00	6	1.74	$0.002
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	0.20	$0.01	15	1.92	$0.003
Int. Lighting	High-Bay Fixtures	T5	0.20	-$0.01	10	2.26	-$0.004
Int. Lighting	High-Bay Fixtures	LED (2020)	0.30	$0.09	15	-	$0.029
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	0.49	$2.91	15	0.35	$0.546
Int. Lighting	Linear Fluorescent	T8	0.51	$0.00	10	1.33	$0.000
Int. Lighting	Linear Fluorescent	Super T8	0.71	$0.02	10	1.49	$0.003
Int. Lighting	Linear Fluorescent	T5	0.82	$0.03	10	1.59	$0.005
Int. Lighting	Linear Fluorescent	LED (2020)	1.50	$0.81	15	-	$0.050
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	0.03	$0.00	3	-	$0.022
Ext. Lighting	Screw-in	70W HIR PAR-38	0.04	$0.00	3	-	$0.020
Ext. Lighting	Screw-in	CFL	0.08	$0.00	6	3.08	$0.003
Ext. Lighting	Screw-in	LED (2010)	0.09	$0.04	20	1.27	$0.033
Ext. Lighting	Screw-in	LED (2020)	0.10	$0.01	20	-	$0.008
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	0.27	$0.53	15	0.54	$0.178
Ext. Lighting	HID	T8	0.28	-$0.01	10	1.83	-$0.006
Ext. Lighting	HID	HP Sodium	0.30	$0.00	6	1.73	$0.002
Ext. Lighting	HID	Light Emitting Plasma	0.35	$0.01	15	1.87	$0.002
Ext. Lighting	HID	T5	0.36	-$0.01	10	2.20	-$0.003
Ext. Lighting	HID	LED (2020)	0.52	$0.14	15	-	$0.024
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.00	$0.00	15	0.32	$0.546
Ext. Lighting	Linear Fluorescent	T8	0.00	$0.00	10	1.33	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.00	$0.00	10	1.48	$0.003
Ext. Lighting	Linear Fluorescent	T5	0.00	$0.00	10	1.58	$0.005
Ext. Lighting	Linear Fluorescent	LED (2020)	0.00	$0.00	15	-	$0.050
Refrigeration	Walk-in Refrigerator	14600 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	10800 kWh/yr	0.03	$0.01	12	1.07	$0.028
Refrigeration	Walk-in Refrigerator	10000 kWh/yr	0.04	$0.01	12	1.08	$0.029
Refrigeration	Walk-in Refrigerator	9000 kWh/yr	0.05	$0.02	12	1.06	$0.043
Refrigeration	Reach-in Refrigerator	3800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	3100 kWh/yr	0.01	$0.00	12	1.04	$0.042
Refrigeration	Reach-in Refrigerator	2500 kWh/yr	0.02	$0.01	12	1.07	$0.044
Refrigeration	Reach-in Refrigerator	2400 kWh/yr	0.03	$0.01	12	1.08	$0.044
Refrigeration	Reach-in Refrigerator	1500 kWh/yr	0.04	$0.01	12	1.28	$0.028
Refrigeration	Glass Door Display	14480 kWh/yr	-	$0.00	12	-	$0.000
Refrigeration	Glass Door Display	11700 kWh/yr	0.03	$0.02	12	-	$0.072
Refrigeration	Glass Door Display	8400 kWh/yr	0.06	$0.00	12	1.00	$0.000
Refrigeration	Glass Door Display	6800 kWh/yr	0.07	$0.02	12	0.91	$0.026
Refrigeration	Open Display Case	6500 kWh/yr	-	$0.00	18	-	$0.000
Refrigeration	Open Display Case	5350 kWh/yr	0.01	$0.00	18	1.00	$0.000
Refrigeration	Open Display Case	5300 kWh/yr	0.01	$0.01	18	-	$0.056
Refrigeration	Open Display Case	4330 kWh/yr	0.02	$0.01	18	1.00	$0.032
Refrigeration	Icemaker	7.0 kWh/100 lbs	-	$0.00	10	1.00	$0.000
Refrigeration	Icemaker	6.3 kWh/100 lbs	0.01	$0.00	10	1.01	$0.054
Refrigeration	Icemaker	6.0 kWh/100 lbs	0.01	$0.00	10	1.00	$0.057
Refrigeration	Icemaker	5.5 kWh/100 lbs	0.02	$0.02	10	0.88	$0.142
Refrigeration	Vending Machine	3400 kWh/year	-	$0.00	10	1.00	$0.000
Refrigeration	Vending Machine	3000 kWh/year	0.01	$0.00	10	1.05	$0.012
Refrigeration	Vending Machine	2400 kWh/year	0.02	$0.00	10	1.14	$0.012
Refrigeration	Vending Machine	1700 kWh/year	0.03	$0.01	10	1.20	$0.022
Food Prep.	Oven	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Oven	Energy Star	0.02	$0.00	12	1.13	$0.000
Food Prep.	Fryer	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Fryer	Energy Star	0.01	$0.00	12	1.03	$0.024
Food Prep.	Dishwasher	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Dishwasher	Energy Star	0.12	$0.01	12	1.33	$0.005
Food Prep.	Hot Food Container	Standard	-	$0.00	12	1.00	$0.000

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Food Prep.	Hot Food Container	Energy Star	0.08	$0.02	12	1.26	$0.024
Office Equip.	Desktop Computer	Standard	-	$0.00	5	1.00	$0.000
Office Equip.	Desktop Computer	Energy Star	0.08	$0.00	5	1.04	$0.000
Office Equip.	Laptop	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Laptop	Energy Star	0.01	$0.00	4	1.01	$0.000
Office Equip.	Server	Standard	-	$0.00	3	1.00	$0.000
Office Equip.	Server	Energy Star	0.05	$0.00	3	1.03	$0.000
Office Equip.	Monitor	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Monitor	Energy Star	0.01	$0.00	4	1.02	$0.000
Office Equip.	Printer/Copier/Fax	Standard	-	$0.00	6	1.00	$0.000
Office Equip.	Printer/Copier/Fax	Energy Star	0.04	$0.00	6	1.09	$0.000
Office Equip.	POS Terminal	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	POS Terminal	Energy Star	0.01	$0.01	4	0.95	$0.152
Miscellaneous	Non-HVAC Motors	Standard (EPAct)	-	$0.00	15	1.00	$0.000
Miscellaneous	Non-HVAC Motors	Standard (EPAct 2015)	0.00	$0.00	15	-	$0.000
Miscellaneous	Non-HVAC Motors	High Eff.	0.00	$0.00	15	1.01	$0.010
Miscellaneous	Non-HVAC Motors	High Eff. (2015)	0.00	$0.00	15	-	$0.007
Miscellaneous	Non-HVAC Motors	Premium (NEMA)	0.00	$0.00	15	1.02	$0.010
Miscellaneous	Non-HVAC Motors	Premium (NEMA 2015)	0.00	$0.00	15	-	$0.008
Miscellaneous	Pool Pump	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff.	0.00	$0.00	15	1.04	$0.030
Miscellaneous	Pool Pump	High Eff. Multi-Speed	0.00	$0.00	15	1.06	$0.051
Miscellaneous	Pool Heater	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Heat Pump	0.00	$0.00	15	1.02	$0.059
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table C-16 Energy Efficiency Equipment Data, Electric— School, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	0.53	$0.29	20	1.15	$0.042
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	0.60	$0.37	20	1.16	$0.048
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	0.70	$0.46	20	1.20	$0.050
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	0.85	$0.54	20	1.25	$0.049
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	0.69	$0.14	20	1.19	$0.016
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	0.78	$0.28	20	1.20	$0.028
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	0.92	$0.34	20	1.24	$0.028
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	1.11	$0.52	20	1.28	$0.036
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	1.15	$0.58	20	1.29	$0.039
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	1.25	$0.63	20	1.32	$0.039
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	0.25	$0.28	16	-	$0.098
Cooling	Roof top AC	EER 11.2	0.51	$0.54	16	1.00	$0.094
Cooling	Roof top AC	EER 12.0	0.66	$1.03	16	0.98	$0.138
Cooling	Roof top AC	Ductless Minisplit	0.83	$3.37	16	0.77	$0.360
Cooling	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air Source Heat Pump	EER 10.3, COP 3.2	0.23	$0.29	16	-	$0.111
Cooling	Air Source Heat Pump	EER 11.0, COP 3.3	0.37	$0.42	16	1.00	$0.101
Cooling	Air Source Heat Pump	EER 11.7, COP 3.4	0.49	$1.07	16	0.94	$0.194
Cooling	Air Source Heat Pump	EER 12.0, COP 3.4	0.54	$1.40	16	0.91	$0.231
Cooling	Air Source Heat Pump	Ductless Minisplit	0.68	$2.68	16	0.80	$0.350
Cooling	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geo Heat Pump	EER 16, COP 3.5	0.30	$1.46	16	0.95	$0.432
Cooling	Geo Heat Pump	EER 18, COP 3.8	0.55	$2.92	16	0.90	$0.473
Cooling	Geo Heat Pump	EER 30, COP 5.0	1.34	$3.86	16	0.94	$0.255

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	0.03	$0.03	14	1.01	$0.085
Cooling	Other Cooling	EER 10.8	0.07	$0.34	14	0.94	$0.494
Cooling	Other Cooling	EER 11	0.10	$0.36	14	0.95	$0.355
Cooling	Other Cooling	EER 11.5	0.13	$0.41	14	0.96	$0.309
Heating	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air Source Heat Pump	EER 10.3, COP 3.2	0.09	$0.16	16	-	$0.154
Heating	Air Source Heat Pump	EER 11.0, COP 3.3	0.18	$0.23	16	1.00	$0.114
Heating	Air Source Heat Pump	EER 11.7, COP 3.4	0.25	$0.58	16	0.93	$0.202
Heating	Air Source Heat Pump	EER 12.0, COP 3.4	0.25	$0.76	16	0.89	$0.264
Heating	Air Source Heat Pump	Ductless Minisplit	0.33	$1.45	16	0.78	$0.392
Heating	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geo Heat Pump	EER 16, COP 3.5	0.40	$0.50	16	0.96	$0.111
Heating	Geo Heat Pump	EER 18, COP 3.8	0.73	$1.01	16	0.92	$0.122
Heating	Geo Heat Pump	EER 30, COP 5.0	0.90	$1.33	16	0.89	$0.132
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	0.63	-$0.18	10	1.08	-$0.035
Water Heating	Water Heating	EF .97	-	$0.00	15	1.00	$0.000
Water Heating	Water Heating	EF .98	0.01	$0.00	15	1.01	$0.023
Water Heating	Water Heating	EF 2.0	0.55	$0.01	15	2.01	$0.001
Water Heating	Water Heating	EF 2.3	0.62	$0.01	15	2.28	$0.001
Water Heating	Water Heating	EF 2.4	0.64	$0.01	15	2.37	$0.001
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	1.59	$0.10	3	-	$0.022
Int. Lighting	Screw-in	70W HIR PAR-38	2.45	$0.14	3	-	$0.020
Int. Lighting	Screw-in	CFL	4.58	$0.08	6	3.19	$0.003
Int. Lighting	Screw-in	LED (2010)	4.96	$2.14	20	1.41	$0.033
Int. Lighting	Screw-in	LED (2020)	5.70	$0.60	20	-	$0.008
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	0.15	$0.36	15	0.53	$0.215
Int. Lighting	High-Bay Fixtures	T8	0.16	-$0.01	10	1.88	-$0.008
Int. Lighting	High-Bay Fixtures	HP Sodium	0.17	$0.00	6	1.74	$0.002
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	0.20	$0.01	15	1.92	$0.003
Int. Lighting	High-Bay Fixtures	T5	0.20	-$0.01	10	2.26	-$0.004
Int. Lighting	High-Bay Fixtures	LED (2020)	0.30	$0.09	15	-	$0.029
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	0.49	$2.91	15	0.35	$0.546
Int. Lighting	Linear Fluorescent	T8	0.51	$0.00	10	1.33	$0.000
Int. Lighting	Linear Fluorescent	Super T8	0.71	$0.02	10	1.49	$0.003
Int. Lighting	Linear Fluorescent	T5	0.82	$0.03	10	1.59	$0.005
Int. Lighting	Linear Fluorescent	LED (2020)	1.50	$0.81	15	-	$0.050
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	0.03	$0.00	3	-	$0.022
Ext. Lighting	Screw-in	70W HIR PAR-38	0.04	$0.00	3	-	$0.020
Ext. Lighting	Screw-in	CFL	0.08	$0.00	6	3.08	$0.003
Ext. Lighting	Screw-in	LED (2010)	0.09	$0.04	20	1.27	$0.033
Ext. Lighting	Screw-in	LED (2020)	0.10	$0.01	20	-	$0.008
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	0.27	$0.53	15	0.54	$0.178
Ext. Lighting	HID	T8	0.28	-$0.01	10	1.83	-$0.006
Ext. Lighting	HID	HP Sodium	0.30	$0.00	6	1.73	$0.002
Ext. Lighting	HID	Light Emitting Plasma	0.35	$0.01	15	1.87	$0.002
Ext. Lighting	HID	T5	0.36	-$0.01	10	2.20	-$0.003
Ext. Lighting	HID	LED (2020)	0.52	$0.14	15	-	$0.024
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.00	$0.00	15	0.32	$0.546
Ext. Lighting	Linear Fluorescent	T8	0.00	$0.00	10	1.33	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.00	$0.00	10	1.48	$0.003
Ext. Lighting	Linear Fluorescent	T5	0.00	$0.00	10	1.58	$0.005
Ext. Lighting	Linear Fluorescent	LED (2020)	0.00	$0.00	15	-	$0.050

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Refrigeration	Walk-in Refrigerator	14600 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	10800 kWh/yr	0.03	$0.01	12	1.04	$0.039
Refrigeration	Walk-in Refrigerator	10000 kWh/yr	0.04	$0.01	12	1.04	$0.041
Refrigeration	Walk-in Refrigerator	9000 kWh/yr	0.05	$0.03	12	1.01	$0.060
Refrigeration	Reach-in Refrigerator	3800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	3100 kWh/yr	0.01	$0.01	12	1.01	$0.059
Refrigeration	Reach-in Refrigerator	2500 kWh/yr	0.02	$0.01	12	1.00	$0.062
Refrigeration	Reach-in Refrigerator	2400 kWh/yr	0.03	$0.01	12	1.01	$0.061
Refrigeration	Reach-in Refrigerator	1500 kWh/yr	0.04	$0.02	12	1.15	$0.040
Refrigeration	Glass Door Display	14480 kWh/yr	-	$0.00	12	-	$0.000
Refrigeration	Glass Door Display	11700 kWh/yr	0.03	$0.02	12	-	$0.072
Refrigeration	Glass Door Display	8400 kWh/yr	0.06	$0.00	12	1.00	$0.000
Refrigeration	Glass Door Display	6800 kWh/yr	0.07	$0.02	12	0.91	$0.026
Refrigeration	Open Display Case	6500 kWh/yr	-	$0.00	18	-	$0.000
Refrigeration	Open Display Case	5350 kWh/yr	0.01	$0.00	18	1.00	$0.000
Refrigeration	Open Display Case	5300 kWh/yr	0.01	$0.01	18	-	$0.056
Refrigeration	Open Display Case	4330 kWh/yr	0.02	$0.01	18	1.00	$0.032
Refrigeration	Icemaker	7.0 kWh/100 lbs	-	$0.00	10	1.00	$0.000
Refrigeration	Icemaker	6.3 kWh/100 lbs	0.01	$0.00	10	1.01	$0.054
Refrigeration	Icemaker	6.0 kWh/100 lbs	0.01	$0.00	10	1.00	$0.057
Refrigeration	Icemaker	5.5 kWh/100 lbs	0.02	$0.02	10	0.88	$0.142
Refrigeration	Vending Machine	3400 kWh/year	-	$0.00	10	1.00	$0.000
Refrigeration	Vending Machine	3000 kWh/year	0.01	$0.00	10	1.05	$0.012
Refrigeration	Vending Machine	2400 kWh/year	0.02	$0.00	10	1.14	$0.012
Refrigeration	Vending Machine	1700 kWh/year	0.03	$0.01	10	1.20	$0.022
Food Prep.	Oven	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Oven	Energy Star	0.02	$0.00	12	1.13	$0.000
Food Prep.	Fryer	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Fryer	Energy Star	0.01	$0.00	12	1.03	$0.024
Food Prep.	Dishwasher	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Dishwasher	Energy Star	0.12	$0.01	12	1.33	$0.005
Food Prep.	Hot Food Container	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Hot Food Container	Energy Star	0.08	$0.02	12	1.26	$0.024
Office Equip.	Desktop Computer	Standard	-	$0.00	5	1.00	$0.000
Office Equip.	Desktop Computer	Energy Star	0.08	$0.00	5	1.04	$0.000
Office Equip.	Laptop	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Laptop	Energy Star	0.01	$0.00	4	1.01	$0.000
Office Equip.	Server	Standard	-	$0.00	3	1.00	$0.000
Office Equip.	Server	Energy Star	0.05	$0.00	3	1.03	$0.000
Office Equip.	Monitor	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Monitor	Energy Star	0.01	$0.00	4	1.02	$0.000
Office Equip.	Printer/Copier/Fax	Standard	-	$0.00	6	1.00	$0.000
Office Equip.	Printer/Copier/Fax	Energy Star	0.04	$0.00	6	1.09	$0.000
Office Equip.	POS Terminal	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	POS Terminal	Energy Star	0.01	$0.01	4	0.95	$0.152
Miscellaneous	Non-HVAC Motors	Standard (EPAct)	-	$0.00	15	1.00	$0.000
Miscellaneous	Non-HVAC Motors	Standard (EPAct 2015)	0.00	$0.00	15	-	$0.000
Miscellaneous	Non-HVAC Motors	High Eff.	0.00	$0.00	15	1.01	$0.010
Miscellaneous	Non-HVAC Motors	High Eff. (2015)	0.00	$0.00	15	-	$0.007
Miscellaneous	Non-HVAC Motors	Premium (NEMA)	0.00	$0.00	15	1.02	$0.010
Miscellaneous	Non-HVAC Motors	Premium (NEMA 2015)	0.00	$0.00	15	-	$0.008
Miscellaneous	Pool Pump	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff.	0.00	$0.00	15	1.04	$0.030
Miscellaneous	Pool Pump	High Eff. Multi-Speed	0.00	$0.00	15	1.06	$0.051
Miscellaneous	Pool Heater	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Heat Pump	0.00	$0.00	15	1.02	$0.059
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table C-17 Energy Efficiency Equipment Data, Electric—Health, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	1.28	$0.52	20	1.11	$0.031
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	1.45	$0.67	20	1.11	$0.036
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	1.71	$0.83	20	1.13	$0.037
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	2.05	$0.99	20	1.16	$0.037
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	1.62	$0.25	20	1.16	$0.012
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	1.83	$0.49	20	1.16	$0.021
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	2.16	$0.59	20	1.19	$0.021
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	2.59	$0.92	20	1.21	$0.027
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	2.69	$1.01	20	1.21	$0.029
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	2.91	$1.11	20	1.23	$0.029
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	0.99	$0.52	16	-	$0.046
Cooling	Roof top AC	EER 11.2	1.99	$0.99	16	1.00	$0.044
Cooling	Roof top AC	EER 12.0	2.60	$1.91	16	0.97	$0.065
Cooling	Roof top AC	Ductless Minisplit	3.26	$6.26	16	0.75	$0.170
Cooling	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air Source Heat Pump	EER 10.3, COP 3.2	1.03	$0.61	16	-	$0.052
Cooling	Air Source Heat Pump	EER 11.0, COP 3.3	1.64	$0.88	16	1.00	$0.047
Cooling	Air Source Heat Pump	EER 11.7, COP 3.4	2.17	$2.25	16	0.94	$0.092
Cooling	Air Source Heat Pump	EER 12.0, COP 3.4	2.38	$2.93	16	0.90	$0.109
Cooling	Air Source Heat Pump	Ductless Minisplit	3.01	$5.61	16	0.79	$0.165
Cooling	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geo Heat Pump	EER 16, COP 3.5	0.64	$1.46	16	0.95	$0.203
Cooling	Geo Heat Pump	EER 18, COP 3.8	1.16	$2.93	16	0.89	$0.223
Cooling	Geo Heat Pump	EER 30, COP 5.0	2.84	$3.86	16	0.93	$0.120
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	0.13	$0.10	14	1.00	$0.076
Cooling	Other Cooling	EER 10.8	0.25	$1.14	14	0.88	$0.443
Cooling	Other Cooling	EER 11	0.37	$1.21	14	0.89	$0.318
Cooling	Other Cooling	EER 11.5	0.48	$1.38	14	0.88	$0.277
Heating	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air Source Heat Pump	EER 10.3, COP 3.2	0.17	$0.18	16	-	$0.094
Heating	Air Source Heat Pump	EER 11.0, COP 3.3	0.33	$0.26	16	1.00	$0.070
Heating	Air Source Heat Pump	EER 11.7, COP 3.4	0.48	$0.66	16	0.96	$0.123
Heating	Air Source Heat Pump	EER 12.0, COP 3.4	0.48	$0.86	16	0.93	$0.160
Heating	Air Source Heat Pump	Ductless Minisplit	0.62	$1.66	16	0.85	$0.238
Heating	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geo Heat Pump	EER 16, COP 3.5	0.61	$0.43	16	1.00	$0.062
Heating	Geo Heat Pump	EER 18, COP 3.8	1.11	$0.85	16	0.98	$0.068
Heating	Geo Heat Pump	EER 30, COP 5.0	1.36	$1.12	16	0.97	$0.073
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	2.68	-$0.24	10	1.18	-$0.011
Water Heating	Water Heating	EF .97	-	$0.00	15	1.00	$0.000
Water Heating	Water Heating	EF .98	0.03	$0.00	15	1.01	$0.013
Water Heating	Water Heating	EF 2.0	1.54	$0.01	15	2.03	$0.001
Water Heating	Water Heating	EF 2.3	1.73	$0.01	15	2.32	$0.001
Water Heating	Water Heating	EF 2.4	1.79	$0.01	15	2.42	$0.001
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	1.37	$0.04	3	-	$0.010
Int. Lighting	Screw-in	70W HIR PAR-38	2.11	$0.06	3	-	$0.009
Int. Lighting	Screw-in	CFL	3.95	$0.03	6	3.53	$0.002
Int. Lighting	Screw-in	LED (2010)	4.27	$0.85	20	2.28	$0.015
Int. Lighting	Screw-in	LED (2020)	4.91	$0.24	20	-	$0.004
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	0.02	$0.02	15	0.79	$0.099

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Int. Lighting	High-Bay Fixtures	T8	0.02	$0.00	10	1.71	-$0.003
Int. Lighting	High-Bay Fixtures	HP Sodium	0.02	$0.00	6	1.75	$0.001
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	0.03	$0.00	15	1.87	$0.001
Int. Lighting	High-Bay Fixtures	T5	0.03	$0.00	10	2.12	-$0.002
Int. Lighting	High-Bay Fixtures	LED (2020)	0.04	$0.01	15	-	$0.013
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	1.29	$3.51	15	0.59	$0.251
Int. Lighting	Linear Fluorescent	T8	1.35	$0.00	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	1.87	$0.02	10	1.53	$0.002
Int. Lighting	Linear Fluorescent	T5	2.16	$0.04	10	1.66	$0.002
Int. Lighting	Linear Fluorescent	LED (2020)	3.94	$0.97	15	-	$0.023
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	0.02	$0.00	3	-	$0.010
Ext. Lighting	Screw-in	70W HIR PAR-38	0.02	$0.00	3	-	$0.009
Ext. Lighting	Screw-in	CFL	0.04	$0.00	6	3.41	$0.002
Ext. Lighting	Screw-in	LED (2010)	0.05	$0.01	20	2.01	$0.015
Ext. Lighting	Screw-in	LED (2020)	0.06	$0.00	20	-	$0.004
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	0.26	$0.23	15	0.77	$0.082
Ext. Lighting	HID	T8	0.27	-$0.01	10	1.67	-$0.003
Ext. Lighting	HID	HP Sodium	0.29	$0.00	6	1.73	$0.001
Ext. Lighting	HID	Light Emitting Plasma	0.34	$0.00	15	1.80	$0.001
Ext. Lighting	HID	T5	0.34	$0.00	10	2.07	-$0.001
Ext. Lighting	HID	LED (2020)	0.51	$0.06	15	-	$0.011
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.00	$0.00	15	0.53	$0.251
Ext. Lighting	Linear Fluorescent	T8	0.00	$0.00	10	1.34	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.00	$0.00	10	1.52	$0.002
Ext. Lighting	Linear Fluorescent	T5	0.00	$0.00	10	1.65	$0.002
Ext. Lighting	Linear Fluorescent	LED (2020)	0.00	$0.00	15	-	$0.023
Refrigeration	Walk-in Refrigerator	14600 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	10800 kWh/yr	0.04	$0.01	12	1.04	$0.037
Refrigeration	Walk-in Refrigerator	10000 kWh/yr	0.05	$0.02	12	1.05	$0.039
Refrigeration	Walk-in Refrigerator	9000 kWh/yr	0.06	$0.03	12	1.01	$0.057
Refrigeration	Reach-in Refrigerator	3800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	3100 kWh/yr	0.01	$0.00	12	1.01	$0.056
Refrigeration	Reach-in Refrigerator	2500 kWh/yr	0.02	$0.01	12	1.01	$0.059
Refrigeration	Reach-in Refrigerator	2400 kWh/yr	0.02	$0.01	12	1.02	$0.058
Refrigeration	Reach-in Refrigerator	1500 kWh/yr	0.03	$0.01	12	1.17	$0.037
Refrigeration	Glass Door Display	14480 kWh/yr	-	$0.00	12	-	$0.000
Refrigeration	Glass Door Display	11700 kWh/yr	0.03	$0.02	12	-	$0.072
Refrigeration	Glass Door Display	8400 kWh/yr	0.07	$0.00	12	1.00	$0.000
Refrigeration	Glass Door Display	6800 kWh/yr	0.09	$0.02	12	0.91	$0.026
Refrigeration	Open Display Case	6500 kWh/yr	-	$0.00	18	-	$0.000
Refrigeration	Open Display Case	5350 kWh/yr	0.01	$0.00	18	1.00	$0.000
Refrigeration	Open Display Case	5300 kWh/yr	0.01	$0.01	18	-	$0.056
Refrigeration	Open Display Case	4330 kWh/yr	0.03	$0.01	18	1.00	$0.032
Refrigeration	Icemaker	7.0 kWh/100 lbs	-	$0.00	10	1.00	$0.000
Refrigeration	Icemaker	6.3 kWh/100 lbs	0.01	$0.00	10	1.01	$0.054
Refrigeration	Icemaker	6.0 kWh/100 lbs	0.01	$0.01	10	1.00	$0.057
Refrigeration	Icemaker	5.5 kWh/100 lbs	0.02	$0.02	10	0.88	$0.142
Refrigeration	Vending Machine	3400 kWh/year	-	$0.00	10	1.00	$0.000
Refrigeration	Vending Machine	3000 kWh/year	0.01	$0.00	10	1.05	$0.012
Refrigeration	Vending Machine	2400 kWh/year	0.02	$0.00	10	1.14	$0.012
Refrigeration	Vending Machine	1700 kWh/year	0.04	$0.01	10	1.20	$0.022
Food Prep.	Oven	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Oven	Energy Star	0.09	$0.00	12	1.13	$0.000
Food Prep.	Fryer	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Fryer	Energy Star	0.06	$0.01	12	1.03	$0.024
Food Prep.	Dishwasher	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Dishwasher	Energy Star	0.45	$0.02	12	1.34	$0.005
Food Prep.	Hot Food Container	Standard	-	$0.00	12	1.00	$0.000

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Food Prep.	Hot Food Container	Energy Star	0.31	$0.07	12	1.29	$0.024
Office Equip.	Desktop Computer	Standard	-	$0.00	5	1.00	$0.000
Office Equip.	Desktop Computer	Energy Star	0.20	$0.00	5	1.05	$0.000
Office Equip.	Laptop	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Laptop	Energy Star	0.03	$0.00	4	1.02	$0.000
Office Equip.	Server	Standard	-	$0.00	3	1.00	$0.000
Office Equip.	Server	Energy Star	0.05	$0.00	3	1.03	$0.000
Office Equip.	Monitor	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Monitor	Energy Star	0.02	$0.00	4	1.02	$0.000
Office Equip.	Printer/Copier/Fax	Standard	-	$0.00	6	1.00	$0.000
Office Equip.	Printer/Copier/Fax	Energy Star	0.07	$0.00	6	1.09	$0.000
Office Equip.	POS Terminal	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	POS Terminal	Energy Star	0.07	$0.04	4	0.95	$0.152
Miscellaneous	Non-HVAC Motors	Standard (EPAct)	-	$0.00	15	1.00	$0.000
Miscellaneous	Non-HVAC Motors	Standard (EPAct 2015)	0.01	$0.00	15	-	$0.000
Miscellaneous	Non-HVAC Motors	High Eff.	0.02	$0.00	15	1.01	$0.010
Miscellaneous	Non-HVAC Motors	High Eff. (2015)	0.02	$0.00	15	-	$0.007
Miscellaneous	Non-HVAC Motors	Premium (NEMA)	0.03	$0.00	15	1.02	$0.010
Miscellaneous	Non-HVAC Motors	Premium (NEMA 2015)	0.04	$0.00	15	-	$0.008
Miscellaneous	Pool Pump	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff.	0.00	$0.00	15	1.05	$0.030
Miscellaneous	Pool Pump	High Eff. Multi-Speed	0.01	$0.00	15	1.08	$0.051
Miscellaneous	Pool Heater	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Heat Pump	0.02	$0.01	15	1.07	$0.059
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table C-18 Energy Efficiency Equipment Data, Electric— Health, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	1.14	$0.42	20	1.12	$0.028
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	1.29	$0.54	20	1.12	$0.032
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	1.52	$0.67	20	1.14	$0.034
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	1.82	$0.79	20	1.18	$0.034
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	1.48	$0.20	20	1.16	$0.011
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	1.68	$0.41	20	1.17	$0.019
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	1.98	$0.49	20	1.20	$0.019
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	2.37	$0.76	20	1.22	$0.025
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	2.47	$0.84	20	1.23	$0.026
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	2.67	$0.92	20	1.25	$0.027
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	0.95	$0.35	16	-	$0.032
Cooling	Roof top AC	EER 11.2	1.91	$0.67	16	1.00	$0.031
Cooling	Roof top AC	EER 12.0	2.50	$1.29	16	0.99	$0.046
Cooling	Roof top AC	Ductless Minisplit	3.13	$4.23	16	0.81	$0.120
Cooling	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air Source Heat Pump	EER 10.3, COP 3.2	0.93	$0.39	16	-	$0.037
Cooling	Air Source Heat Pump	EER 11.0, COP 3.3	1.47	$0.56	16	1.00	$0.033
Cooling	Air Source Heat Pump	EER 11.7, COP 3.4	1.96	$1.43	16	0.96	$0.065
Cooling	Air Source Heat Pump	EER 12.0, COP 3.4	2.14	$1.86	16	0.94	$0.077
Cooling	Air Source Heat Pump	Ductless Minisplit	2.71	$3.57	16	0.85	$0.116
Cooling	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geo Heat Pump	EER 16, COP 3.5	0.87	$1.41	16	0.97	$0.143
Cooling	Geo Heat Pump	EER 18, COP 3.8	1.59	$2.82	16	0.93	$0.157
Cooling	Geo Heat Pump	EER 30, COP 5.0	3.89	$3.72	16	1.00	$0.085

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	0.12	$0.11	14	1.00	$0.085
Cooling	Other Cooling	EER 10.8	0.24	$1.21	14	0.87	$0.494
Cooling	Other Cooling	EER 11	0.35	$1.29	14	0.88	$0.355
Cooling	Other Cooling	EER 11.5	0.46	$1.46	14	0.87	$0.309
Heating	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air Source Heat Pump	EER 10.3, COP 3.2	0.07	$0.17	16	-	$0.229
Heating	Air Source Heat Pump	EER 11.0, COP 3.3	0.13	$0.24	16	1.00	$0.164
Heating	Air Source Heat Pump	EER 11.7, COP 3.4	0.20	$0.62	16	0.95	$0.279
Heating	Air Source Heat Pump	EER 12.0, COP 3.4	0.20	$0.81	16	0.92	$0.365
Heating	Air Source Heat Pump	Ductless Minisplit	0.26	$1.56	16	0.84	$0.522
Heating	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geo Heat Pump	EER 16, COP 3.5	0.58	$0.33	16	1.01	$0.051
Heating	Geo Heat Pump	EER 18, COP 3.8	1.05	$0.66	16	1.01	$0.056
Heating	Geo Heat Pump	EER 30, COP 5.0	1.05	$0.88	16	0.97	$0.074
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	2.95	-$0.25	10	1.19	-$0.011
Water Heating	Water Heating	EF .97	-	$0.00	15	1.00	$0.000
Water Heating	Water Heating	EF .98	0.03	$0.00	15	1.01	$0.012
Water Heating	Water Heating	EF 2.0	1.52	$0.01	15	2.03	$0.001
Water Heating	Water Heating	EF 2.3	1.71	$0.01	15	2.32	$0.001
Water Heating	Water Heating	EF 2.4	1.76	$0.01	15	2.42	$0.001
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	1.37	$0.04	3	-	$0.010
Int. Lighting	Screw-in	70W HIR PAR-38	2.11	$0.06	3	-	$0.009
Int. Lighting	Screw-in	CFL	3.95	$0.03	6	3.53	$0.002
Int. Lighting	Screw-in	LED (2010)	4.27	$0.85	20	2.28	$0.015
Int. Lighting	Screw-in	LED (2020)	4.91	$0.24	20	-	$0.004
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	0.02	$0.02	15	0.79	$0.099
Int. Lighting	High-Bay Fixtures	T8	0.02	$0.00	10	1.71	-$0.003
Int. Lighting	High-Bay Fixtures	HP Sodium	0.02	$0.00	6	1.75	$0.001
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	0.03	$0.00	15	1.87	$0.001
Int. Lighting	High-Bay Fixtures	T5	0.03	$0.00	10	2.12	-$0.002
Int. Lighting	High-Bay Fixtures	LED (2020)	0.04	$0.01	15	-	$0.013
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	1.29	$3.51	15	0.59	$0.251
Int. Lighting	Linear Fluorescent	T8	1.35	$0.00	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	1.87	$0.02	10	1.53	$0.002
Int. Lighting	Linear Fluorescent	T5	2.16	$0.04	10	1.66	$0.002
Int. Lighting	Linear Fluorescent	LED (2020)	3.94	$0.97	15	-	$0.023
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	0.02	$0.00	3	-	$0.010
Ext. Lighting	Screw-in	70W HIR PAR-38	0.02	$0.00	3	-	$0.009
Ext. Lighting	Screw-in	CFL	0.04	$0.00	6	3.41	$0.002
Ext. Lighting	Screw-in	LED (2010)	0.05	$0.01	20	2.01	$0.015
Ext. Lighting	Screw-in	LED (2020)	0.06	$0.00	20	-	$0.004
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	0.26	$0.23	15	0.77	$0.082
Ext. Lighting	HID	T8	0.27	-$0.01	10	1.67	-$0.003
Ext. Lighting	HID	HP Sodium	0.29	$0.00	6	1.73	$0.001
Ext. Lighting	HID	Light Emitting Plasma	0.34	$0.00	15	1.80	$0.001
Ext. Lighting	HID	T5	0.34	$0.00	10	2.07	-$0.001
Ext. Lighting	HID	LED (2020)	0.51	$0.06	15	-	$0.011
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.00	$0.00	15	0.53	$0.251
Ext. Lighting	Linear Fluorescent	T8	0.00	$0.00	10	1.34	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.00	$0.00	10	1.52	$0.002
Ext. Lighting	Linear Fluorescent	T5	0.00	$0.00	10	1.65	$0.002
Ext. Lighting	Linear Fluorescent	LED (2020)	0.00	$0.00	15	-	$0.023

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Refrigeration	Walk-in Refrigerator	14600 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	10800 kWh/yr	0.04	$0.02	12	1.02	$0.048
Refrigeration	Walk-in Refrigerator	10000 kWh/yr	0.05	$0.02	12	1.02	$0.050
Refrigeration	Walk-in Refrigerator	9000 kWh/yr	0.06	$0.04	12	0.98	$0.074
Refrigeration	Reach-in Refrigerator	3800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	3100 kWh/yr	0.01	$0.01	12	0.99	$0.072
Refrigeration	Reach-in Refrigerator	2500 kWh/yr	0.02	$0.01	12	0.96	$0.077
Refrigeration	Reach-in Refrigerator	2400 kWh/yr	0.02	$0.01	12	0.97	$0.075
Refrigeration	Reach-in Refrigerator	1500 kWh/yr	0.03	$0.01	12	1.08	$0.049
Refrigeration	Glass Door Display	14480 kWh/yr	-	$0.00	12	-	$0.000
Refrigeration	Glass Door Display	11700 kWh/yr	0.03	$0.02	12	-	$0.072
Refrigeration	Glass Door Display	8400 kWh/yr	0.07	$0.00	12	1.00	$0.000
Refrigeration	Glass Door Display	6800 kWh/yr	0.09	$0.02	12	0.91	$0.026
Refrigeration	Open Display Case	6500 kWh/yr	-	$0.00	18	-	$0.000
Refrigeration	Open Display Case	5350 kWh/yr	0.01	$0.00	18	1.00	$0.000
Refrigeration	Open Display Case	5300 kWh/yr	0.01	$0.01	18	-	$0.056
Refrigeration	Open Display Case	4330 kWh/yr	0.03	$0.01	18	1.00	$0.032
Refrigeration	Icemaker	7.0 kWh/100 lbs	-	$0.00	10	1.00	$0.000
Refrigeration	Icemaker	6.3 kWh/100 lbs	0.01	$0.00	10	1.01	$0.054
Refrigeration	Icemaker	6.0 kWh/100 lbs	0.01	$0.01	10	1.00	$0.057
Refrigeration	Icemaker	5.5 kWh/100 lbs	0.02	$0.02	10	0.88	$0.142
Refrigeration	Vending Machine	3400 kWh/year	-	$0.00	10	1.00	$0.000
Refrigeration	Vending Machine	3000 kWh/year	0.01	$0.00	10	1.05	$0.012
Refrigeration	Vending Machine	2400 kWh/year	0.02	$0.00	10	1.14	$0.012
Refrigeration	Vending Machine	1700 kWh/year	0.04	$0.01	10	1.20	$0.022
Food Prep.	Oven	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Oven	Energy Star	0.09	$0.00	12	1.13	$0.000
Food Prep.	Fryer	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Fryer	Energy Star	0.06	$0.01	12	1.03	$0.024
Food Prep.	Dishwasher	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Dishwasher	Energy Star	0.45	$0.02	12	1.34	$0.005
Food Prep.	Hot Food Container	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Hot Food Container	Energy Star	0.31	$0.07	12	1.29	$0.024
Office Equip.	Desktop Computer	Standard	-	$0.00	5	1.00	$0.000
Office Equip.	Desktop Computer	Energy Star	0.20	$0.00	5	1.05	$0.000
Office Equip.	Laptop	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Laptop	Energy Star	0.03	$0.00	4	1.02	$0.000
Office Equip.	Server	Standard	-	$0.00	3	1.00	$0.000
Office Equip.	Server	Energy Star	0.05	$0.00	3	1.03	$0.000
Office Equip.	Monitor	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Monitor	Energy Star	0.02	$0.00	4	1.02	$0.000
Office Equip.	Printer/Copier/Fax	Standard	-	$0.00	6	1.00	$0.000
Office Equip.	Printer/Copier/Fax	Energy Star	0.07	$0.00	6	1.09	$0.000
Office Equip.	POS Terminal	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	POS Terminal	Energy Star	0.07	$0.04	4	0.95	$0.152
Miscellaneous	Non-HVAC Motors	Standard (EPAct)	-	$0.00	15	1.00	$0.000
Miscellaneous	Non-HVAC Motors	Standard (EPAct 2015)	0.01	$0.00	15	-	$0.000
Miscellaneous	Non-HVAC Motors	High Eff.	0.02	$0.00	15	1.01	$0.010
Miscellaneous	Non-HVAC Motors	High Eff. (2015)	0.02	$0.00	15	-	$0.007
Miscellaneous	Non-HVAC Motors	Premium (NEMA)	0.03	$0.00	15	1.02	$0.010
Miscellaneous	Non-HVAC Motors	Premium (NEMA 2015)	0.04	$0.00	15	-	$0.008
Miscellaneous	Pool Pump	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff.	0.00	$0.00	15	1.05	$0.030
Miscellaneous	Pool Pump	High Eff. Multi-Speed	0.01	$0.00	15	1.08	$0.051
Miscellaneous	Pool Heater	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Heat Pump	0.02	$0.01	15	1.07	$0.059
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table C-19 Energy Efficiency Equipment Data, Electric—Lodging, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	0.37	$0.12	20	1.14	$0.025
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	0.41	$0.16	20	1.15	$0.029
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	0.49	$0.19	20	1.17	$0.030
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	0.58	$0.23	20	1.22	$0.030
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	0.44	$0.05	20	1.18	$0.009
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	0.49	$0.11	20	1.18	$0.017
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	0.58	$0.13	20	1.22	$0.017
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	0.70	$0.20	20	1.26	$0.022
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	0.73	$0.22	20	1.26	$0.023
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	0.79	$0.24	20	1.29	$0.024
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	0.15	$0.07	16	-	$0.041
Cooling	Roof top AC	EER 11.2	0.29	$0.13	16	1.00	$0.040
Cooling	Roof top AC	EER 12.0	0.38	$0.25	16	0.99	$0.058
Cooling	Roof top AC	Ductless Minisplit	0.48	$0.82	16	0.90	$0.152
Cooling	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air Source Heat Pump	EER 10.3, COP 3.2	0.15	$0.08	16	-	$0.047
Cooling	Air Source Heat Pump	EER 11.0, COP 3.3	0.24	$0.12	16	1.00	$0.043
Cooling	Air Source Heat Pump	EER 11.7, COP 3.4	0.32	$0.30	16	0.98	$0.082
Cooling	Air Source Heat Pump	EER 12.0, COP 3.4	0.35	$0.39	16	0.97	$0.098
Cooling	Air Source Heat Pump	Ductless Minisplit	0.45	$0.75	16	0.92	$0.148
Cooling	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geo Heat Pump	EER 16, COP 3.5	0.45	$0.24	16	1.05	$0.046
Cooling	Geo Heat Pump	EER 18, COP 3.8	0.83	$0.48	16	1.08	$0.051
Cooling	Geo Heat Pump	EER 30, COP 5.0	2.03	$0.63	16	1.37	$0.027
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	0.06	$0.05	14	1.00	$0.076
Cooling	Other Cooling	EER 10.8	0.12	$0.54	14	0.89	$0.443
Cooling	Other Cooling	EER 11	0.17	$0.57	14	0.90	$0.318
Cooling	Other Cooling	EER 11.5	0.23	$0.65	14	0.89	$0.277
Heating	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air Source Heat Pump	EER 10.3, COP 3.2	0.03	$0.03	16	-	$0.093
Heating	Air Source Heat Pump	EER 11.0, COP 3.3	0.06	$0.05	16	1.00	$0.069
Heating	Air Source Heat Pump	EER 11.7, COP 3.4	0.09	$0.12	16	0.98	$0.122
Heating	Air Source Heat Pump	EER 12.0, COP 3.4	0.09	$0.15	16	0.97	$0.159
Heating	Air Source Heat Pump	Ductless Minisplit	0.11	$0.29	16	0.93	$0.237
Heating	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geo Heat Pump	EER 16, COP 3.5	0.25	$0.04	16	1.09	$0.013
Heating	Geo Heat Pump	EER 18, COP 3.8	0.45	$0.07	16	1.16	$0.014
Heating	Geo Heat Pump	EER 30, COP 5.0	-0.33	$0.09	16	0.84	-$0.025
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	0.62	-$0.10	10	1.12	-$0.020
Water Heating	Water Heating	EF .97	-	$0.00	15	1.00	$0.000
Water Heating	Water Heating	EF .98	0.04	$0.02	15	1.00	$0.034
Water Heating	Water Heating	EF 2.0	2.10	$0.03	15	1.98	$0.001
Water Heating	Water Heating	EF 2.3	2.36	$0.04	15	2.24	$0.002
Water Heating	Water Heating	EF 2.4	2.43	$0.05	15	2.32	$0.002
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	2.55	$0.13	3	-	$0.017
Int. Lighting	Screw-in	70W HIR PAR-38	3.92	$0.17	3	-	$0.015
Int. Lighting	Screw-in	CFL	7.34	$0.10	6	3.32	$0.003
Int. Lighting	Screw-in	LED (2010)	7.94	$2.64	20	1.67	$0.026
Int. Lighting	Screw-in	LED (2020)	9.13	$0.75	20	-	$0.006
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	0.04	$0.08	15	0.61	$0.166

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Int. Lighting	High-Bay Fixtures	T8	0.04	$0.00	10	1.81	-$0.006
Int. Lighting	High-Bay Fixtures	HP Sodium	0.05	$0.00	6	1.74	$0.001
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	0.05	$0.00	15	1.90	$0.002
Int. Lighting	High-Bay Fixtures	T5	0.06	$0.00	10	2.20	-$0.003
Int. Lighting	High-Bay Fixtures	LED (2020)	0.08	$0.02	15	-	$0.022
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	0.17	$0.77	15	0.42	$0.421
Int. Lighting	Linear Fluorescent	T8	0.18	$0.00	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	0.24	$0.01	10	1.50	$0.003
Int. Lighting	Linear Fluorescent	T5	0.28	$0.01	10	1.62	$0.004
Int. Lighting	Linear Fluorescent	LED (2020)	0.52	$0.21	15	-	$0.038
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	0.12	$0.01	3	-	$0.017
Ext. Lighting	Screw-in	70W HIR PAR-38	0.18	$0.01	3	-	$0.015
Ext. Lighting	Screw-in	CFL	0.33	$0.00	6	3.21	$0.003
Ext. Lighting	Screw-in	LED (2010)	0.36	$0.12	20	1.50	$0.026
Ext. Lighting	Screw-in	LED (2020)	0.41	$0.03	20	-	$0.006
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	0.26	$0.39	15	0.61	$0.137
Ext. Lighting	HID	T8	0.27	-$0.01	10	1.76	-$0.005
Ext. Lighting	HID	HP Sodium	0.28	$0.00	6	1.73	$0.001
Ext. Lighting	HID	Light Emitting Plasma	0.33	$0.01	15	1.84	$0.002
Ext. Lighting	HID	T5	0.34	-$0.01	10	2.15	-$0.002
Ext. Lighting	HID	LED (2020)	0.50	$0.10	15	-	$0.018
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.00	$0.00	15	0.39	$0.421
Ext. Lighting	Linear Fluorescent	T8	0.00	$0.00	10	1.34	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.00	$0.00	10	1.50	$0.003
Ext. Lighting	Linear Fluorescent	T5	0.00	$0.00	10	1.61	$0.004
Ext. Lighting	Linear Fluorescent	LED (2020)	0.00	$0.00	15	-	$0.038
Refrigeration	Walk-in Refrigerator	14600 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	10800 kWh/yr	0.07	$0.02	12	1.08	$0.025
Refrigeration	Walk-in Refrigerator	10000 kWh/yr	0.08	$0.02	12	1.09	$0.026
Refrigeration	Walk-in Refrigerator	9000 kWh/yr	0.10	$0.03	12	1.07	$0.039
Refrigeration	Reach-in Refrigerator	3800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	3100 kWh/yr	0.01	$0.00	12	1.05	$0.038
Refrigeration	Reach-in Refrigerator	2500 kWh/yr	0.02	$0.01	12	1.09	$0.040
Refrigeration	Reach-in Refrigerator	2400 kWh/yr	0.03	$0.01	12	1.10	$0.039
Refrigeration	Reach-in Refrigerator	1500 kWh/yr	0.04	$0.01	12	1.32	$0.025
Refrigeration	Glass Door Display	14480 kWh/yr	-	$0.00	12	-	$0.000
Refrigeration	Glass Door Display	11700 kWh/yr	0.05	$0.04	12	-	$0.072
Refrigeration	Glass Door Display	8400 kWh/yr	0.12	$0.00	12	1.00	$0.000
Refrigeration	Glass Door Display	6800 kWh/yr	0.15	$0.04	12	0.91	$0.026
Refrigeration	Open Display Case	6500 kWh/yr	-	$0.00	18	-	$0.000
Refrigeration	Open Display Case	5350 kWh/yr	0.02	$0.00	18	1.00	$0.000
Refrigeration	Open Display Case	5300 kWh/yr	0.02	$0.02	18	-	$0.056
Refrigeration	Open Display Case	4330 kWh/yr	0.04	$0.02	18	1.00	$0.032
Refrigeration	Icemaker	7.0 kWh/100 lbs	-	$0.00	10	1.00	$0.000
Refrigeration	Icemaker	6.3 kWh/100 lbs	0.01	$0.00	10	1.01	$0.054
Refrigeration	Icemaker	6.0 kWh/100 lbs	0.01	$0.01	10	1.00	$0.057
Refrigeration	Icemaker	5.5 kWh/100 lbs	0.02	$0.02	10	0.88	$0.142
Refrigeration	Vending Machine	3400 kWh/year	-	$0.00	10	1.00	$0.000
Refrigeration	Vending Machine	3000 kWh/year	0.02	$0.00	10	1.05	$0.012
Refrigeration	Vending Machine	2400 kWh/year	0.04	$0.00	10	1.14	$0.012
Refrigeration	Vending Machine	1700 kWh/year	0.07	$0.01	10	1.20	$0.022
Food Prep.	Oven	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Oven	Energy Star	0.05	$0.00	12	1.13	$0.000
Food Prep.	Fryer	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Fryer	Energy Star	0.03	$0.01	12	1.03	$0.024
Food Prep.	Dishwasher	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Dishwasher	Energy Star	0.23	$0.01	12	1.35	$0.005
Food Prep.	Hot Food Container	Standard	-	$0.00	12	1.00	$0.000

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Food Prep.	Hot Food Container	Energy Star	0.15	$0.03	12	1.30	$0.024
Office Equip.	Desktop Computer	Standard	-	$0.00	5	1.00	$0.000
Office Equip.	Desktop Computer	Energy Star	0.03	$0.00	5	1.05	$0.000
Office Equip.	Laptop	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Laptop	Energy Star	0.00	$0.00	4	1.01	$0.000
Office Equip.	Server	Standard	-	$0.00	3	1.00	$0.000
Office Equip.	Server	Energy Star	0.02	$0.00	3	1.03	$0.000
Office Equip.	Monitor	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Monitor	Energy Star	0.00	$0.00	4	1.02	$0.000
Office Equip.	Printer/Copier/Fax	Standard	-	$0.00	6	1.00	$0.000
Office Equip.	Printer/Copier/Fax	Energy Star	0.00	$0.00	6	1.09	$0.000
Office Equip.	POS Terminal	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	POS Terminal	Energy Star	0.00	$0.00	4	0.95	$0.152
Miscellaneous	Non-HVAC Motors	Standard (EPAct)	-	$0.00	15	1.00	$0.000
Miscellaneous	Non-HVAC Motors	Standard (EPAct 2015)	0.00	$0.00	15	-	$0.000
Miscellaneous	Non-HVAC Motors	High Eff.	0.00	$0.00	15	1.01	$0.010
Miscellaneous	Non-HVAC Motors	High Eff. (2015)	0.00	$0.00	15	-	$0.007
Miscellaneous	Non-HVAC Motors	Premium (NEMA)	0.00	$0.00	15	1.02	$0.010
Miscellaneous	Non-HVAC Motors	Premium (NEMA 2015)	0.00	$0.00	15	-	$0.008
Miscellaneous	Pool Pump	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff.	0.00	$0.00	15	1.05	$0.030
Miscellaneous	Pool Pump	High Eff. Multi-Speed	0.01	$0.00	15	1.08	$0.051
Miscellaneous	Pool Heater	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Heat Pump	0.02	$0.01	15	1.06	$0.059
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table C-20 Energy Efficiency Equipment Data, Electric— Lodging, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	0.34	$0.10	20	1.14	$0.024
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	0.38	$0.14	20	1.15	$0.027
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	0.45	$0.17	20	1.18	$0.029
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	0.54	$0.20	20	1.23	$0.028
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	0.41	$0.05	20	1.18	$0.009
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	0.46	$0.09	20	1.19	$0.016
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	0.54	$0.11	20	1.23	$0.016
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	0.65	$0.18	20	1.27	$0.021
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	0.68	$0.19	20	1.27	$0.022
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	0.73	$0.21	20	1.30	$0.023
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	0.13	$0.06	16	-	$0.039
Cooling	Roof top AC	EER 11.2	0.27	$0.11	16	1.00	$0.037
Cooling	Roof top AC	EER 12.0	0.35	$0.22	16	1.00	$0.055
Cooling	Roof top AC	Ductless Minisplit	0.44	$0.72	16	0.91	$0.144
Cooling	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air Source Heat Pump	EER 10.3, COP 3.2	0.14	$0.07	16	-	$0.045
Cooling	Air Source Heat Pump	EER 11.0, COP 3.3	0.22	$0.10	16	1.00	$0.040
Cooling	Air Source Heat Pump	EER 11.7, COP 3.4	0.30	$0.26	16	0.98	$0.078
Cooling	Air Source Heat Pump	EER 12.0, COP 3.4	0.33	$0.34	16	0.97	$0.092
Cooling	Air Source Heat Pump	Ductless Minisplit	0.41	$0.66	16	0.92	$0.140
Cooling	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geo Heat Pump	EER 16, COP 3.5	0.47	$0.23	16	1.05	$0.044
Cooling	Geo Heat Pump	EER 18, COP 3.8	0.85	$0.47	16	1.08	$0.048
Cooling	Geo Heat Pump	EER 30, COP 5.0	2.09	$0.61	16	1.39	$0.026

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	0.06	$0.05	14	1.00	$0.085
Cooling	Other Cooling	EER 10.8	0.11	$0.58	14	0.88	$0.494
Cooling	Other Cooling	EER 11	0.17	$0.61	14	0.89	$0.355
Cooling	Other Cooling	EER 11.5	0.22	$0.69	14	0.88	$0.309
Heating	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air Source Heat Pump	EER 10.3, COP 3.2	0.03	$0.04	16	-	$0.113
Heating	Air Source Heat Pump	EER 11.0, COP 3.3	0.06	$0.06	16	1.00	$0.083
Heating	Air Source Heat Pump	EER 11.7, COP 3.4	0.09	$0.15	16	0.97	$0.146
Heating	Air Source Heat Pump	EER 12.0, COP 3.4	0.09	$0.19	16	0.96	$0.190
Heating	Air Source Heat Pump	Ductless Minisplit	0.12	$0.37	16	0.90	$0.280
Heating	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geo Heat Pump	EER 16, COP 3.5	0.23	$0.03	16	1.09	$0.012
Heating	Geo Heat Pump	EER 18, COP 3.8	0.42	$0.06	16	1.17	$0.013
Heating	Geo Heat Pump	EER 30, COP 5.0	-0.39	$0.08	16	0.81	-$0.018
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	0.17	-$0.10	10	1.05	-$0.068
Water Heating	Water Heating	EF .97	-	$0.00	15	1.00	$0.000
Water Heating	Water Heating	EF .98	0.04	$0.01	15	1.00	$0.034
Water Heating	Water Heating	EF 2.0	2.04	$0.03	15	1.98	$0.001
Water Heating	Water Heating	EF 2.3	2.29	$0.04	15	2.24	$0.002
Water Heating	Water Heating	EF 2.4	2.36	$0.05	15	2.32	$0.002
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	2.55	$0.13	3	-	$0.017
Int. Lighting	Screw-in	70W HIR PAR-38	3.92	$0.17	3	-	$0.015
Int. Lighting	Screw-in	CFL	7.34	$0.10	6	3.32	$0.003
Int. Lighting	Screw-in	LED (2010)	7.94	$2.64	20	1.67	$0.026
Int. Lighting	Screw-in	LED (2020)	9.13	$0.75	20	-	$0.006
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	0.04	$0.08	15	0.61	$0.166
Int. Lighting	High-Bay Fixtures	T8	0.04	$0.00	10	1.81	-$0.006
Int. Lighting	High-Bay Fixtures	HP Sodium	0.05	$0.00	6	1.74	$0.001
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	0.05	$0.00	15	1.90	$0.002
Int. Lighting	High-Bay Fixtures	T5	0.06	$0.00	10	2.20	-$0.003
Int. Lighting	High-Bay Fixtures	LED (2020)	0.08	$0.02	15	-	$0.022
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	0.17	$0.77	15	0.42	$0.421
Int. Lighting	Linear Fluorescent	T8	0.18	$0.00	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	0.24	$0.01	10	1.50	$0.003
Int. Lighting	Linear Fluorescent	T5	0.28	$0.01	10	1.62	$0.004
Int. Lighting	Linear Fluorescent	LED (2020)	0.52	$0.21	15	-	$0.038
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	0.12	$0.01	3	-	$0.017
Ext. Lighting	Screw-in	70W HIR PAR-38	0.18	$0.01	3	-	$0.015
Ext. Lighting	Screw-in	CFL	0.33	$0.00	6	3.21	$0.003
Ext. Lighting	Screw-in	LED (2010)	0.36	$0.12	20	1.50	$0.026
Ext. Lighting	Screw-in	LED (2020)	0.41	$0.03	20	-	$0.006
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	0.26	$0.39	15	0.61	$0.137
Ext. Lighting	HID	T8	0.27	-$0.01	10	1.76	-$0.005
Ext. Lighting	HID	HP Sodium	0.28	$0.00	6	1.73	$0.001
Ext. Lighting	HID	Light Emitting Plasma	0.33	$0.01	15	1.84	$0.002
Ext. Lighting	HID	T5	0.34	-$0.01	10	2.15	-$0.002
Ext. Lighting	HID	LED (2020)	0.50	$0.10	15	-	$0.018
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.00	$0.00	15	0.39	$0.421
Ext. Lighting	Linear Fluorescent	T8	0.00	$0.00	10	1.34	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.00	$0.00	10	1.50	$0.003
Ext. Lighting	Linear Fluorescent	T5	0.00	$0.00	10	1.61	$0.004
Ext. Lighting	Linear Fluorescent	LED (2020)	0.00	$0.00	15	-	$0.038

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Refrigeration	Walk-in Refrigerator	14600 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	10800 kWh/yr	0.07	$0.02	12	1.06	$0.030
Refrigeration	Walk-in Refrigerator	10000 kWh/yr	0.08	$0.02	12	1.07	$0.032
Refrigeration	Walk-in Refrigerator	9000 kWh/yr	0.10	$0.04	12	1.04	$0.046
Refrigeration	Reach-in Refrigerator	3800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	3100 kWh/yr	0.01	$0.01	12	1.03	$0.045
Refrigeration	Reach-in Refrigerator	2500 kWh/yr	0.02	$0.01	12	1.06	$0.048
Refrigeration	Reach-in Refrigerator	2400 kWh/yr	0.03	$0.01	12	1.06	$0.047
Refrigeration	Reach-in Refrigerator	1500 kWh/yr	0.04	$0.01	12	1.25	$0.030
Refrigeration	Glass Door Display	14480 kWh/yr	-	$0.00	12	-	$0.000
Refrigeration	Glass Door Display	11700 kWh/yr	0.05	$0.04	12	-	$0.072
Refrigeration	Glass Door Display	8400 kWh/yr	0.12	$0.00	12	1.00	$0.000
Refrigeration	Glass Door Display	6800 kWh/yr	0.15	$0.04	12	0.91	$0.026
Refrigeration	Open Display Case	6500 kWh/yr	-	$0.00	18	-	$0.000
Refrigeration	Open Display Case	5350 kWh/yr	0.02	$0.00	18	1.00	$0.000
Refrigeration	Open Display Case	5300 kWh/yr	0.02	$0.02	18	-	$0.056
Refrigeration	Open Display Case	4330 kWh/yr	0.04	$0.02	18	1.00	$0.032
Refrigeration	Icemaker	7.0 kWh/100 lbs	-	$0.00	10	1.00	$0.000
Refrigeration	Icemaker	6.3 kWh/100 lbs	0.01	$0.00	10	1.01	$0.054
Refrigeration	Icemaker	6.0 kWh/100 lbs	0.01	$0.01	10	1.00	$0.057
Refrigeration	Icemaker	5.5 kWh/100 lbs	0.02	$0.02	10	0.88	$0.142
Refrigeration	Vending Machine	3400 kWh/year	-	$0.00	10	1.00	$0.000
Refrigeration	Vending Machine	3000 kWh/year	0.02	$0.00	10	1.05	$0.012
Refrigeration	Vending Machine	2400 kWh/year	0.04	$0.00	10	1.14	$0.012
Refrigeration	Vending Machine	1700 kWh/year	0.07	$0.01	10	1.20	$0.022
Food Prep.	Oven	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Oven	Energy Star	0.05	$0.00	12	1.13	$0.000
Food Prep.	Fryer	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Fryer	Energy Star	0.03	$0.01	12	1.03	$0.024
Food Prep.	Dishwasher	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Dishwasher	Energy Star	0.23	$0.01	12	1.35	$0.005
Food Prep.	Hot Food Container	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Hot Food Container	Energy Star	0.15	$0.03	12	1.30	$0.024
Office Equip.	Desktop Computer	Standard	-	$0.00	5	1.00	$0.000
Office Equip.	Desktop Computer	Energy Star	0.03	$0.00	5	1.05	$0.000
Office Equip.	Laptop	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Laptop	Energy Star	0.00	$0.00	4	1.01	$0.000
Office Equip.	Server	Standard	-	$0.00	3	1.00	$0.000
Office Equip.	Server	Energy Star	0.02	$0.00	3	1.03	$0.000
Office Equip.	Monitor	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Monitor	Energy Star	0.00	$0.00	4	1.02	$0.000
Office Equip.	Printer/Copier/Fax	Standard	-	$0.00	6	1.00	$0.000
Office Equip.	Printer/Copier/Fax	Energy Star	0.00	$0.00	6	1.09	$0.000
Office Equip.	POS Terminal	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	POS Terminal	Energy Star	0.00	$0.00	4	0.95	$0.152
Miscellaneous	Non-HVAC Motors	Standard (EPAct)	-	$0.00	15	1.00	$0.000
Miscellaneous	Non-HVAC Motors	Standard (EPAct 2015)	0.00	$0.00	15	-	$0.000
Miscellaneous	Non-HVAC Motors	High Eff.	0.00	$0.00	15	1.01	$0.010
Miscellaneous	Non-HVAC Motors	High Eff. (2015)	0.00	$0.00	15	-	$0.007
Miscellaneous	Non-HVAC Motors	Premium (NEMA)	0.00	$0.00	15	1.02	$0.010
Miscellaneous	Non-HVAC Motors	Premium (NEMA 2015)	0.00	$0.00	15	-	$0.008
Miscellaneous	Pool Pump	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff.	0.00	$0.00	15	1.05	$0.030
Miscellaneous	Pool Pump	High Eff. Multi-Speed	0.01	$0.00	15	1.08	$0.051
Miscellaneous	Pool Heater	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Heat Pump	0.02	$0.01	15	1.06	$0.059
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table C-21 Energy Efficiency Equipment Data, Electric—Warehouse, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	0.45	$0.12	20	1.20	$0.020
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	0.51	$0.15	20	1.23	$0.023
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	0.60	$0.19	20	1.28	$0.024
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	0.72	$0.22	20	1.36	$0.024
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	0.58	$0.06	20	1.22	$0.007
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	0.66	$0.11	20	1.25	$0.013
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	0.78	$0.14	20	1.31	$0.013
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	0.93	$0.21	20	1.38	$0.017
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	0.97	$0.23	20	1.40	$0.018
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	1.05	$0.26	20	1.45	$0.019
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	0.38	$0.20	16	-	$0.046
Cooling	Roof top AC	EER 11.2	0.76	$0.38	16	1.00	$0.044
Cooling	Roof top AC	EER 12.0	0.99	$0.72	16	1.03	$0.065
Cooling	Roof top AC	Ductless Minisplit	1.24	$2.37	16	0.93	$0.169
Cooling	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air Source Heat Pump	EER 10.3, COP 3.2	0.41	$0.24	16	-	$0.052
Cooling	Air Source Heat Pump	EER 11.0, COP 3.3	0.66	$0.35	16	1.00	$0.047
Cooling	Air Source Heat Pump	EER 11.7, COP 3.4	0.87	$0.90	16	1.00	$0.091
Cooling	Air Source Heat Pump	EER 12.0, COP 3.4	0.96	$1.17	16	1.00	$0.109
Cooling	Air Source Heat Pump	Ductless Minisplit	1.21	$2.24	16	0.97	$0.164
Cooling	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geo Heat Pump	EER 16, COP 3.5	0.26	$0.58	16	1.01	$0.203
Cooling	Geo Heat Pump	EER 18, COP 3.8	0.47	$1.17	16	1.01	$0.222
Cooling	Geo Heat Pump	EER 30, COP 5.0	1.14	$1.54	16	1.19	$0.120
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	0.05	$0.04	14	1.01	$0.076
Cooling	Other Cooling	EER 10.8	0.10	$0.45	14	0.97	$0.443
Cooling	Other Cooling	EER 11	0.15	$0.48	14	0.98	$0.318
Cooling	Other Cooling	EER 11.5	0.19	$0.55	14	0.99	$0.277
Heating	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air Source Heat Pump	EER 10.3, COP 3.2	0.03	$0.54	16	-	$1.430
Heating	Air Source Heat Pump	EER 11.0, COP 3.3	0.06	$0.78	16	1.00	$1.075
Heating	Air Source Heat Pump	EER 11.7, COP 3.4	0.09	$2.00	16	0.90	$1.929
Heating	Air Source Heat Pump	EER 12.0, COP 3.4	0.09	$2.61	16	0.85	$2.517
Heating	Air Source Heat Pump	Ductless Minisplit	0.12	$5.00	16	0.71	$3.781
Heating	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geo Heat Pump	EER 16, COP 3.5	0.63	$1.04	16	0.95	$0.145
Heating	Geo Heat Pump	EER 18, COP 3.8	1.16	$2.08	16	0.89	$0.159
Heating	Geo Heat Pump	EER 30, COP 5.0	0.15	$2.74	16	0.80	$1.569
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	0.29	-$0.59	10	1.04	-$0.252
Water Heating	Water Heating	EF .97	-	$0.00	15	1.00	$0.000
Water Heating	Water Heating	EF .98	0.00	$0.00	15	1.01	$0.018
Water Heating	Water Heating	EF 2.0	0.17	$0.00	15	2.02	$0.001
Water Heating	Water Heating	EF 2.3	0.19	$0.00	15	2.30	$0.001
Water Heating	Water Heating	EF 2.4	0.19	$0.00	15	2.39	$0.001
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	0.47	$0.03	3	-	$0.019
Int. Lighting	Screw-in	70W HIR PAR-38	0.72	$0.04	3	-	$0.017
Int. Lighting	Screw-in	CFL	1.34	$0.02	6	3.39	$0.003
Int. Lighting	Screw-in	LED (2010)	1.45	$0.55	20	1.76	$0.029
Int. Lighting	Screw-in	LED (2020)	1.67	$0.15	20	-	$0.007
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	0.08	$0.15	15	0.63	$0.187

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Int. Lighting	High-Bay Fixtures	T8	0.08	$0.00	10	1.84	-$0.007
Int. Lighting	High-Bay Fixtures	HP Sodium	0.08	$0.00	6	1.76	$0.002
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	0.10	$0.00	15	1.95	$0.002
Int. Lighting	High-Bay Fixtures	T5	0.10	$0.00	10	2.23	-$0.003
Int. Lighting	High-Bay Fixtures	LED (2020)	0.15	$0.04	15	-	$0.025
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	0.76	$3.91	15	0.43	$0.476
Int. Lighting	Linear Fluorescent	T8	0.79	$0.00	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	1.10	$0.03	10	1.51	$0.003
Int. Lighting	Linear Fluorescent	T5	1.27	$0.04	10	1.62	$0.004
Int. Lighting	Linear Fluorescent	LED (2020)	2.32	$1.08	15	-	$0.043
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	0.00	$0.00	3	-	$0.019
Ext. Lighting	Screw-in	70W HIR PAR-38	0.00	$0.00	3	-	$0.017
Ext. Lighting	Screw-in	CFL	0.00	$0.00	6	3.16	$0.003
Ext. Lighting	Screw-in	LED (2010)	0.00	$0.00	20	1.39	$0.029
Ext. Lighting	Screw-in	LED (2020)	0.00	$0.00	20	-	$0.007
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	0.34	$0.57	15	0.58	$0.155
Ext. Lighting	HID	T8	0.35	-$0.02	10	1.79	-$0.005
Ext. Lighting	HID	HP Sodium	0.37	$0.00	6	1.73	$0.001
Ext. Lighting	HID	Light Emitting Plasma	0.43	$0.01	15	1.85	$0.002
Ext. Lighting	HID	T5	0.44	-$0.01	10	2.17	-$0.003
Ext. Lighting	HID	LED (2020)	0.65	$0.15	15	-	$0.021
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.00	$0.00	15	0.36	$0.476
Ext. Lighting	Linear Fluorescent	T8	0.00	$0.00	10	1.33	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.00	$0.00	10	1.49	$0.003
Ext. Lighting	Linear Fluorescent	T5	0.00	$0.00	10	1.59	$0.004
Ext. Lighting	Linear Fluorescent	LED (2020)	0.00	$0.00	15	-	$0.043
Refrigeration	Walk-in Refrigerator	14600 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	10800 kWh/yr	0.21	$0.01	12	1.20	$0.008
Refrigeration	Walk-in Refrigerator	10000 kWh/yr	0.25	$0.02	12	1.25	$0.008
Refrigeration	Walk-in Refrigerator	9000 kWh/yr	0.31	$0.03	12	1.30	$0.012
Refrigeration	Reach-in Refrigerator	3800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	3100 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	2500 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	2400 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	1500 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Glass Door Display	14480 kWh/yr	-	$0.00	12	-	$0.000
Refrigeration	Glass Door Display	11700 kWh/yr	-	$0.00	12	-	$0.000
Refrigeration	Glass Door Display	8400 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Glass Door Display	6800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Open Display Case	6500 kWh/yr	-	$0.00	18	-	$0.000
Refrigeration	Open Display Case	5350 kWh/yr	-	$0.00	18	1.00	$0.000
Refrigeration	Open Display Case	5300 kWh/yr	-	$0.00	18	-	$0.000
Refrigeration	Open Display Case	4330 kWh/yr	-	$0.00	18	1.00	$0.000
Refrigeration	Icemaker	7.0 kWh/100 lbs	-	$0.00	10	1.00	$0.000
Refrigeration	Icemaker	6.3 kWh/100 lbs	0.10	$0.04	10	1.01	$0.054
Refrigeration	Icemaker	6.0 kWh/100 lbs	0.14	$0.07	10	1.01	$0.057
Refrigeration	Icemaker	5.5 kWh/100 lbs	0.21	$0.24	10	0.88	$0.142
Refrigeration	Vending Machine	3400 kWh/year	-	$0.00	10	1.00	$0.000
Refrigeration	Vending Machine	3000 kWh/year	0.10	$0.01	10	1.05	$0.012
Refrigeration	Vending Machine	2400 kWh/year	0.24	$0.02	10	1.14	$0.012
Refrigeration	Vending Machine	1700 kWh/year	0.41	$0.07	10	1.20	$0.022
Food Prep.	Oven	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Oven	Energy Star	0.04	$0.00	12	1.14	$0.000
Food Prep.	Fryer	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Fryer	Energy Star	-	$0.00	12	1.00	$0.000
Food Prep.	Dishwasher	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Dishwasher	Energy Star	-	$0.00	12	1.00	$0.000
Food Prep.	Hot Food Container	Standard	-	$0.00	12	1.00	$0.000

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Food Prep.	Hot Food Container	Energy Star	-	$0.00	12	1.00	$0.000
Office Equip.	Desktop Computer	Standard	-	$0.00	5	1.00	$0.000
Office Equip.	Desktop Computer	Energy Star	0.04	$0.00	5	1.05	$0.000
Office Equip.	Laptop	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Laptop	Energy Star	0.00	$0.00	4	1.02	$0.000
Office Equip.	Server	Standard	-	$0.00	3	1.00	$0.000
Office Equip.	Server	Energy Star	0.03	$0.00	3	1.04	$0.000
Office Equip.	Monitor	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Monitor	Energy Star	0.00	$0.00	4	1.02	$0.000
Office Equip.	Printer/Copier/Fax	Standard	-	$0.00	6	1.00	$0.000
Office Equip.	Printer/Copier/Fax	Energy Star	0.01	$0.00	6	1.10	$0.000
Office Equip.	POS Terminal	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	POS Terminal	Energy Star	0.01	$0.01	4	0.95	$0.152
Miscellaneous	Non-HVAC Motors	Standard (EPAct)	-	$0.00	15	1.00	$0.000
Miscellaneous	Non-HVAC Motors	Standard (EPAct 2015)	0.00	$0.00	15	-	$0.000
Miscellaneous	Non-HVAC Motors	High Eff.	0.00	$0.00	15	1.01	$0.010
Miscellaneous	Non-HVAC Motors	High Eff. (2015)	0.01	$0.00	15	-	$0.007
Miscellaneous	Non-HVAC Motors	Premium (NEMA)	0.01	$0.00	15	1.02	$0.010
Miscellaneous	Non-HVAC Motors	Premium (NEMA 2015)	0.01	$0.00	15	-	$0.008
Miscellaneous	Pool Pump	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff.	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff. Multi-Speed	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Heat Pump	-	$0.00	15	1.00	$0.000
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table C-22 Energy Efficiency Equipment Data, Electric— Warehouse, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	0.38	$0.13	20	1.19	$0.027
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	0.43	$0.17	20	1.22	$0.031
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	0.51	$0.21	20	1.26	$0.032
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	0.61	$0.25	20	1.33	$0.032
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	0.58	$0.08	20	1.21	$0.010
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	0.65	$0.15	20	1.24	$0.018
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	0.77	$0.18	20	1.29	$0.018
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	0.92	$0.28	20	1.36	$0.023
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	0.96	$0.31	20	1.37	$0.025
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	1.04	$0.34	20	1.42	$0.025
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	0.36	$0.18	16	-	$0.045
Cooling	Roof top AC	EER 11.2	0.72	$0.35	16	1.00	$0.043
Cooling	Roof top AC	EER 12.0	0.94	$0.67	16	1.03	$0.063
Cooling	Roof top AC	Ductless Minisplit	1.18	$2.21	16	0.94	$0.166
Cooling	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air Source Heat Pump	EER 10.3, COP 3.2	0.38	$0.22	16	-	$0.051
Cooling	Air Source Heat Pump	EER 11.0, COP 3.3	0.60	$0.31	16	1.00	$0.046
Cooling	Air Source Heat Pump	EER 11.7, COP 3.4	0.79	$0.80	16	1.01	$0.090
Cooling	Air Source Heat Pump	EER 12.0, COP 3.4	0.87	$1.05	16	1.00	$0.107
Cooling	Air Source Heat Pump	Ductless Minisplit	1.10	$2.01	16	0.97	$0.162
Cooling	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geo Heat Pump	EER 16, COP 3.5	0.23	$0.53	16	1.01	$0.199
Cooling	Geo Heat Pump	EER 18, COP 3.8	0.43	$1.05	16	1.01	$0.218
Cooling	Geo Heat Pump	EER 30, COP 5.0	1.05	$1.39	16	1.20	$0.118

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	0.05	$0.04	14	1.01	$0.085
Cooling	Other Cooling	EER 10.8	0.09	$0.48	14	0.96	$0.494
Cooling	Other Cooling	EER 11	0.14	$0.51	14	0.97	$0.355
Cooling	Other Cooling	EER 11.5	0.18	$0.58	14	0.98	$0.309
Heating	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air Source Heat Pump	EER 10.3, COP 3.2	0.09	$0.62	16	-	$0.582
Heating	Air Source Heat Pump	EER 11.0, COP 3.3	0.19	$0.89	16	1.00	$0.420
Heating	Air Source Heat Pump	EER 11.7, COP 3.4	0.28	$2.27	16	0.89	$0.720
Heating	Air Source Heat Pump	EER 12.0, COP 3.4	0.28	$2.97	16	0.84	$0.939
Heating	Air Source Heat Pump	Ductless Minisplit	0.37	$5.68	16	0.69	$1.354
Heating	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geo Heat Pump	EER 16, COP 3.5	0.57	$1.23	16	0.93	$0.190
Heating	Geo Heat Pump	EER 18, COP 3.8	1.04	$2.45	16	0.87	$0.208
Heating	Geo Heat Pump	EER 30, COP 5.0	1.23	$3.24	16	0.83	$0.233
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	0.25	-$0.60	10	1.04	-$0.299
Water Heating	Water Heating	EF .97	-	$0.00	15	1.00	$0.000
Water Heating	Water Heating	EF .98	0.00	$0.00	15	1.01	$0.017
Water Heating	Water Heating	EF 2.0	0.16	$0.00	15	2.02	$0.001
Water Heating	Water Heating	EF 2.3	0.18	$0.00	15	2.30	$0.001
Water Heating	Water Heating	EF 2.4	0.19	$0.00	15	2.40	$0.001
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	0.47	$0.03	3	-	$0.019
Int. Lighting	Screw-in	70W HIR PAR-38	0.72	$0.04	3	-	$0.017
Int. Lighting	Screw-in	CFL	1.34	$0.02	6	3.39	$0.003
Int. Lighting	Screw-in	LED (2010)	1.45	$0.55	20	1.76	$0.029
Int. Lighting	Screw-in	LED (2020)	1.67	$0.15	20	-	$0.007
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	0.08	$0.15	15	0.63	$0.187
Int. Lighting	High-Bay Fixtures	T8	0.08	$0.00	10	1.84	-$0.007
Int. Lighting	High-Bay Fixtures	HP Sodium	0.08	$0.00	6	1.76	$0.002
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	0.10	$0.00	15	1.95	$0.002
Int. Lighting	High-Bay Fixtures	T5	0.10	$0.00	10	2.23	-$0.003
Int. Lighting	High-Bay Fixtures	LED (2020)	0.15	$0.04	15	-	$0.025
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	0.76	$3.91	15	0.43	$0.476
Int. Lighting	Linear Fluorescent	T8	0.79	$0.00	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	1.10	$0.03	10	1.51	$0.003
Int. Lighting	Linear Fluorescent	T5	1.27	$0.04	10	1.62	$0.004
Int. Lighting	Linear Fluorescent	LED (2020)	2.32	$1.08	15	-	$0.043
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	0.00	$0.00	3	-	$0.019
Ext. Lighting	Screw-in	70W HIR PAR-38	0.00	$0.00	3	-	$0.017
Ext. Lighting	Screw-in	CFL	0.00	$0.00	6	3.16	$0.003
Ext. Lighting	Screw-in	LED (2010)	0.00	$0.00	20	1.39	$0.029
Ext. Lighting	Screw-in	LED (2020)	0.00	$0.00	20	-	$0.007
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	0.34	$0.57	15	0.58	$0.155
Ext. Lighting	HID	T8	0.35	-$0.02	10	1.79	-$0.005
Ext. Lighting	HID	HP Sodium	0.37	$0.00	6	1.73	$0.001
Ext. Lighting	HID	Light Emitting Plasma	0.43	$0.01	15	1.85	$0.002
Ext. Lighting	HID	T5	0.44	-$0.01	10	2.17	-$0.003
Ext. Lighting	HID	LED (2020)	0.65	$0.15	15	-	$0.021
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.00	$0.00	15	0.36	$0.476
Ext. Lighting	Linear Fluorescent	T8	0.00	$0.00	10	1.33	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.00	$0.00	10	1.49	$0.003
Ext. Lighting	Linear Fluorescent	T5	0.00	$0.00	10	1.59	$0.004
Ext. Lighting	Linear Fluorescent	LED (2020)	0.00	$0.00	15	-	$0.043

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Refrigeration	Walk-in Refrigerator	14600 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	10800 kWh/yr	0.21	$0.02	12	1.18	$0.009
Refrigeration	Walk-in Refrigerator	10000 kWh/yr	0.25	$0.02	12	1.23	$0.010
Refrigeration	Walk-in Refrigerator	9000 kWh/yr	0.31	$0.04	12	1.26	$0.014
Refrigeration	Reach-in Refrigerator	3800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	3100 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	2500 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	2400 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	1500 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Glass Door Display	14480 kWh/yr	-	$0.00	12	-	$0.000
Refrigeration	Glass Door Display	11700 kWh/yr	-	$0.00	12	-	$0.000
Refrigeration	Glass Door Display	8400 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Glass Door Display	6800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Open Display Case	6500 kWh/yr	-	$0.00	18	-	$0.000
Refrigeration	Open Display Case	5350 kWh/yr	-	$0.00	18	1.00	$0.000
Refrigeration	Open Display Case	5300 kWh/yr	-	$0.00	18	-	$0.000
Refrigeration	Open Display Case	4330 kWh/yr	-	$0.00	18	1.00	$0.000
Refrigeration	Icemaker	7.0 kWh/100 lbs	-	$0.00	10	1.00	$0.000
Refrigeration	Icemaker	6.3 kWh/100 lbs	0.10	$0.04	10	1.01	$0.054
Refrigeration	Icemaker	6.0 kWh/100 lbs	0.14	$0.07	10	1.01	$0.057
Refrigeration	Icemaker	5.5 kWh/100 lbs	0.21	$0.24	10	0.88	$0.142
Refrigeration	Vending Machine	3400 kWh/year	-	$0.00	10	1.00	$0.000
Refrigeration	Vending Machine	3000 kWh/year	0.10	$0.01	10	1.05	$0.012
Refrigeration	Vending Machine	2400 kWh/year	0.24	$0.02	10	1.14	$0.012
Refrigeration	Vending Machine	1700 kWh/year	0.41	$0.07	10	1.20	$0.022
Food Prep.	Oven	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Oven	Energy Star	0.04	$0.00	12	1.14	$0.000
Food Prep.	Fryer	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Fryer	Energy Star	-	$0.00	12	1.00	$0.000
Food Prep.	Dishwasher	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Dishwasher	Energy Star	-	$0.00	12	1.00	$0.000
Food Prep.	Hot Food Container	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Hot Food Container	Energy Star	-	$0.00	12	1.00	$0.000
Office Equip.	Desktop Computer	Standard	-	$0.00	5	1.00	$0.000
Office Equip.	Desktop Computer	Energy Star	0.04	$0.00	5	1.05	$0.000
Office Equip.	Laptop	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Laptop	Energy Star	0.00	$0.00	4	1.02	$0.000
Office Equip.	Server	Standard	-	$0.00	3	1.00	$0.000
Office Equip.	Server	Energy Star	0.03	$0.00	3	1.04	$0.000
Office Equip.	Monitor	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Monitor	Energy Star	0.00	$0.00	4	1.02	$0.000
Office Equip.	Printer/Copier/Fax	Standard	-	$0.00	6	1.00	$0.000
Office Equip.	Printer/Copier/Fax	Energy Star	0.01	$0.00	6	1.10	$0.000
Office Equip.	POS Terminal	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	POS Terminal	Energy Star	0.01	$0.01	4	0.95	$0.152
Miscellaneous	Non-HVAC Motors	Standard (EPAct)	-	$0.00	15	1.00	$0.000
Miscellaneous	Non-HVAC Motors	Standard (EPAct 2015)	0.00	$0.00	15	-	$0.000
Miscellaneous	Non-HVAC Motors	High Eff.	0.00	$0.00	15	1.01	$0.010
Miscellaneous	Non-HVAC Motors	High Eff. (2015)	0.01	$0.00	15	-	$0.007
Miscellaneous	Non-HVAC Motors	Premium (NEMA)	0.01	$0.00	15	1.02	$0.010
Miscellaneous	Non-HVAC Motors	Premium (NEMA 2015)	0.01	$0.00	15	-	$0.008
Miscellaneous	Pool Pump	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff.	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff. Multi-Speed	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Heat Pump	-	$0.00	15	1.00	$0.000
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table C-23 Energy Efficiency Equipment Data, Electric—Miscellaneous Commercial, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	0.34	$0.07	20	1.19	$0.015
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	0.38	$0.09	20	1.22	$0.017
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	0.45	$0.11	20	1.26	$0.018
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	0.54	$0.13	20	1.33	$0.018
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	0.44	$0.03	20	1.21	$0.006
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	0.50	$0.06	20	1.24	$0.010
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	0.58	$0.08	20	1.29	$0.010
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	0.70	$0.12	20	1.36	$0.013
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	0.73	$0.13	20	1.37	$0.014
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	0.79	$0.15	20	1.41	$0.014
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	0.28	$0.09	16	-	$0.029
Cooling	Roof top AC	EER 11.2	0.57	$0.18	16	1.00	$0.028
Cooling	Roof top AC	EER 12.0	0.75	$0.34	16	1.02	$0.041
Cooling	Roof top AC	Ductless Minisplit	0.93	$1.13	16	0.91	$0.107
Cooling	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air Source Heat Pump	EER 10.3, COP 3.2	0.31	$0.12	16	-	$0.033
Cooling	Air Source Heat Pump	EER 11.0, COP 3.3	0.49	$0.17	16	1.00	$0.030
Cooling	Air Source Heat Pump	EER 11.7, COP 3.4	0.65	$0.43	16	1.00	$0.058
Cooling	Air Source Heat Pump	EER 12.0, COP 3.4	0.72	$0.56	16	0.99	$0.069
Cooling	Air Source Heat Pump	Ductless Minisplit	0.91	$1.07	16	0.94	$0.104
Cooling	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geo Heat Pump	EER 16, COP 3.5	0.19	$0.28	16	1.00	$0.128
Cooling	Geo Heat Pump	EER 18, COP 3.8	0.35	$0.56	16	0.99	$0.141
Cooling	Geo Heat Pump	EER 30, COP 5.0	0.86	$0.73	16	1.14	$0.076
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	0.04	$0.01	14	1.02	$0.027
Cooling	Other Cooling	EER 10.8	0.07	$0.12	14	0.99	$0.156
Cooling	Other Cooling	EER 11	0.11	$0.13	14	1.01	$0.112
Cooling	Other Cooling	EER 11.5	0.14	$0.14	14	1.02	$0.097
Heating	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air Source Heat Pump	EER 10.3, COP 3.2	0.00	$1.38	16	-	$48.418
Heating	Air Source Heat Pump	EER 11.0, COP 3.3	0.00	$1.98	16	1.00	$40.414
Heating	Air Source Heat Pump	EER 11.7, COP 3.4	0.01	$5.08	16	0.82	$82.404
Heating	Air Source Heat Pump	EER 12.0, COP 3.4	0.01	$6.63	16	0.75	$107.545
Heating	Air Source Heat Pump	Ductless Minisplit	0.01	$12.71	16	0.57	$191.296
Heating	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geo Heat Pump	EER 16, COP 3.5	0.26	$2.68	16	0.89	$0.912
Heating	Geo Heat Pump	EER 18, COP 3.8	0.47	$5.35	16	0.80	$1.000
Heating	Geo Heat Pump	EER 30, COP 5.0	-0.03	$7.06	16	0.74	-$23.528
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	0.27	-$0.12	10	1.06	-$0.057
Water Heating	Water Heating	EF .97	-	$0.00	15	1.00	$0.000
Water Heating	Water Heating	EF .98	0.01	$0.00	15	1.01	$0.018
Water Heating	Water Heating	EF 2.0	0.53	$0.00	15	2.02	$0.001
Water Heating	Water Heating	EF 2.3	0.59	$0.01	15	2.31	$0.001
Water Heating	Water Heating	EF 2.4	0.61	$0.01	15	2.40	$0.001
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	0.59	$0.03	3	-	$0.020
Int. Lighting	Screw-in	70W HIR PAR-38	0.90	$0.05	3	-	$0.018
Int. Lighting	Screw-in	CFL	1.69	$0.03	6	3.30	$0.003
Int. Lighting	Screw-in	LED (2010)	1.83	$0.72	20	1.60	$0.030
Int. Lighting	Screw-in	LED (2020)	2.10	$0.20	20	-	$0.007
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Int. Lighting	High-Bay Fixtures	LED (2010)	0.80	$1.71	15	0.59	$0.196
Int. Lighting	High-Bay Fixtures	T8	0.82	-$0.05	10	1.85	-$0.007
Int. Lighting	High-Bay Fixtures	HP Sodium	0.87	$0.01	6	1.75	$0.002
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	1.02	$0.03	15	1.94	$0.002
Int. Lighting	High-Bay Fixtures	T5	1.04	-$0.03	10	2.24	-$0.003
Int. Lighting	High-Bay Fixtures	LED (2020)	1.53	$0.44	15	-	$0.026
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	0.19	$1.01	15	0.40	$0.499
Int. Lighting	Linear Fluorescent	T8	0.20	$0.00	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	0.27	$0.01	10	1.50	$0.003
Int. Lighting	Linear Fluorescent	T5	0.31	$0.01	10	1.61	$0.004
Int. Lighting	Linear Fluorescent	LED (2020)	0.57	$0.28	15	-	$0.045
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	0.19	$0.01	3	-	$0.020
Ext. Lighting	Screw-in	70W HIR PAR-38	0.29	$0.02	3	-	$0.018
Ext. Lighting	Screw-in	CFL	0.54	$0.01	6	3.13	$0.003
Ext. Lighting	Screw-in	LED (2010)	0.59	$0.23	20	1.35	$0.030
Ext. Lighting	Screw-in	LED (2020)	0.67	$0.07	20	-	$0.007
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	0.29	$0.50	15	0.57	$0.162
Ext. Lighting	HID	T8	0.29	-$0.01	10	1.80	-$0.006
Ext. Lighting	HID	HP Sodium	0.31	$0.00	6	1.73	$0.001
Ext. Lighting	HID	Light Emitting Plasma	0.36	$0.01	15	1.86	$0.002
Ext. Lighting	HID	T5	0.37	-$0.01	10	2.18	-$0.003
Ext. Lighting	HID	LED (2020)	0.55	$0.13	15	-	$0.022
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.10	$0.54	15	0.35	$0.499
Ext. Lighting	Linear Fluorescent	T8	0.10	$0.00	10	1.33	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.15	$0.00	10	1.49	$0.003
Ext. Lighting	Linear Fluorescent	T5	0.17	$0.01	10	1.59	$0.004
Ext. Lighting	Linear Fluorescent	LED (2020)	0.31	$0.15	15	-	$0.045
Refrigeration	Walk-in Refrigerator	14600 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	10800 kWh/yr	0.05	$0.00	12	1.18	$0.009
Refrigeration	Walk-in Refrigerator	10000 kWh/yr	0.06	$0.01	12	1.23	$0.010
Refrigeration	Walk-in Refrigerator	9000 kWh/yr	0.07	$0.01	12	1.26	$0.014
Refrigeration	Reach-in Refrigerator	3800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	3100 kWh/yr	0.01	$0.00	12	1.14	$0.014
Refrigeration	Reach-in Refrigerator	2500 kWh/yr	0.02	$0.00	12	1.29	$0.015
Refrigeration	Reach-in Refrigerator	2400 kWh/yr	0.02	$0.00	12	1.32	$0.014
Refrigeration	Reach-in Refrigerator	1500 kWh/yr	0.03	$0.00	12	1.78	$0.009
Refrigeration	Glass Door Display	14480 kWh/yr	-	$0.00	12	-	$0.000
Refrigeration	Glass Door Display	11700 kWh/yr	0.04	$0.03	12	-	$0.072
Refrigeration	Glass Door Display	8400 kWh/yr	0.08	$0.00	12	1.00	$0.000
Refrigeration	Glass Door Display	6800 kWh/yr	0.11	$0.03	12	0.91	$0.026
Refrigeration	Open Display Case	6500 kWh/yr	-	$0.00	18	-	$0.000
Refrigeration	Open Display Case	5350 kWh/yr	0.02	$0.00	18	1.00	$0.000
Refrigeration	Open Display Case	5300 kWh/yr	0.02	$0.01	18	-	$0.056
Refrigeration	Open Display Case	4330 kWh/yr	0.03	$0.01	18	1.00	$0.032
Refrigeration	Icemaker	7.0 kWh/100 lbs	-	$0.00	10	1.00	$0.000
Refrigeration	Icemaker	6.3 kWh/100 lbs	0.01	$0.00	10	1.01	$0.054
Refrigeration	Icemaker	6.0 kWh/100 lbs	0.01	$0.00	10	1.00	$0.057
Refrigeration	Icemaker	5.5 kWh/100 lbs	0.01	$0.01	10	0.88	$0.142
Refrigeration	Vending Machine	3400 kWh/year	-	$0.00	10	1.00	$0.000
Refrigeration	Vending Machine	3000 kWh/year	0.01	$0.00	10	1.05	$0.012
Refrigeration	Vending Machine	2400 kWh/year	0.03	$0.00	10	1.14	$0.012
Refrigeration	Vending Machine	1700 kWh/year	0.05	$0.01	10	1.20	$0.022
Food Prep.	Oven	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Oven	Energy Star	0.02	$0.00	12	1.12	$0.000
Food Prep.	Fryer	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Fryer	Energy Star	0.01	$0.00	12	1.03	$0.024
Food Prep.	Dishwasher	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Dishwasher	Energy Star	0.10	$0.00	12	1.32	$0.005

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Food Prep.	Hot Food Container	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Hot Food Container	Energy Star	0.07	$0.01	12	1.22	$0.024
Office Equip.	Desktop Computer	Standard	-	$0.00	5	1.00	$0.000
Office Equip.	Desktop Computer	Energy Star	0.06	$0.00	5	1.05	$0.000
Office Equip.	Laptop	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Laptop	Energy Star	0.01	$0.00	4	1.02	$0.000
Office Equip.	Server	Standard	-	$0.00	3	1.00	$0.000
Office Equip.	Server	Energy Star	0.03	$0.00	3	1.04	$0.000
Office Equip.	Monitor	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Monitor	Energy Star	0.01	$0.00	4	1.02	$0.000
Office Equip.	Printer/Copier/Fax	Standard	-	$0.00	6	1.00	$0.000
Office Equip.	Printer/Copier/Fax	Energy Star	0.02	$0.00	6	1.10	$0.000
Office Equip.	POS Terminal	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	POS Terminal	Energy Star	0.03	$0.02	4	0.95	$0.152
Miscellaneous	Non-HVAC Motors	Standard (EPAct)	-	$0.00	15	1.00	$0.000
Miscellaneous	Non-HVAC Motors	Standard (EPAct 2015)	0.00	$0.00	15	-	$0.000
Miscellaneous	Non-HVAC Motors	High Eff.	0.00	$0.00	15	1.01	$0.010
Miscellaneous	Non-HVAC Motors	High Eff. (2015)	0.01	$0.00	15	-	$0.007
Miscellaneous	Non-HVAC Motors	Premium (NEMA)	0.01	$0.00	15	1.02	$0.010
Miscellaneous	Non-HVAC Motors	Premium (NEMA 2015)	0.01	$0.00	15	-	$0.008
Miscellaneous	Pool Pump	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff.	0.00	$0.00	15	1.05	$0.030
Miscellaneous	Pool Pump	High Eff. Multi-Speed	0.00	$0.00	15	1.11	$0.051
Miscellaneous	Pool Heater	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Heat Pump	0.00	$0.00	15	1.12	$0.059
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table C-24 Energy Efficiency Equipment Data, Electric— Miscellaneous Commercial, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	0.29	$0.09	20	1.17	$0.023
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	0.33	$0.11	20	1.18	$0.026
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	0.39	$0.14	20	1.22	$0.028
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	0.46	$0.16	20	1.28	$0.027
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	0.40	$0.04	20	1.20	$0.009
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	0.45	$0.09	20	1.21	$0.015
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	0.53	$0.11	20	1.26	$0.016
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	0.64	$0.17	20	1.31	$0.020
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	0.67	$0.19	20	1.32	$0.021
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	0.72	$0.20	20	1.36	$0.022
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	0.26	$0.10	16	-	$0.033
Cooling	Roof top AC	EER 11.2	0.52	$0.18	16	1.00	$0.031
Cooling	Roof top AC	EER 12.0	0.69	$0.36	16	1.02	$0.046
Cooling	Roof top AC	Ductless Minisplit	0.86	$1.16	16	0.89	$0.120
Cooling	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air Source Heat Pump	EER 10.3, COP 3.2	0.26	$0.11	16	-	$0.037
Cooling	Air Source Heat Pump	EER 11.0, COP 3.3	0.42	$0.16	16	1.00	$0.034
Cooling	Air Source Heat Pump	EER 11.7, COP 3.4	0.56	$0.41	16	0.99	$0.065
Cooling	Air Source Heat Pump	EER 12.0, COP 3.4	0.61	$0.53	16	0.98	$0.077
Cooling	Air Source Heat Pump	Ductless Minisplit	0.77	$1.02	16	0.92	$0.117
Cooling	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geo Heat Pump	EER 16, COP 3.5	0.17	$0.28	16	0.99	$0.144
Cooling	Geo Heat Pump	EER 18, COP 3.8	0.31	$0.56	16	0.98	$0.158
Cooling	Geo Heat Pump	EER 30, COP 5.0	0.77	$0.74	16	1.11	$0.085

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	0.04	$0.01	14	1.02	$0.027
Cooling	Other Cooling	EER 10.8	0.07	$0.12	14	0.99	$0.155
Cooling	Other Cooling	EER 11	0.11	$0.12	14	1.01	$0.111
Cooling	Other Cooling	EER 11.5	0.14	$0.14	14	1.02	$0.097
Heating	Air Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air Source Heat Pump	EER 10.3, COP 3.2	0.02	$0.72	16	-	$2.617
Heating	Air Source Heat Pump	EER 11.0, COP 3.3	0.05	$1.04	16	1.00	$1.881
Heating	Air Source Heat Pump	EER 11.7, COP 3.4	0.07	$2.67	16	0.84	$3.223
Heating	Air Source Heat Pump	EER 12.0, COP 3.4	0.07	$3.49	16	0.78	$4.206
Heating	Air Source Heat Pump	Ductless Minisplit	0.10	$6.68	16	0.60	$6.044
Heating	Geo Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geo Heat Pump	EER 16, COP 3.5	0.24	$1.41	16	0.90	$0.508
Heating	Geo Heat Pump	EER 18, COP 3.8	0.45	$2.81	16	0.82	$0.557
Heating	Geo Heat Pump	EER 30, COP 5.0	0.48	$3.71	16	0.77	$0.682
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	0.02	-$0.17	10	1.03	-$1.189
Water Heating	Water Heating	EF .97	-	$0.00	15	1.00	$0.000
Water Heating	Water Heating	EF .98	0.01	$0.00	15	1.01	$0.017
Water Heating	Water Heating	EF 2.0	0.52	$0.00	15	2.02	$0.001
Water Heating	Water Heating	EF 2.3	0.58	$0.01	15	2.31	$0.001
Water Heating	Water Heating	EF 2.4	0.60	$0.01	15	2.40	$0.001
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	0.59	$0.03	3	-	$0.020
Int. Lighting	Screw-in	70W HIR PAR-38	0.90	$0.05	3	-	$0.018
Int. Lighting	Screw-in	CFL	1.69	$0.03	6	3.30	$0.003
Int. Lighting	Screw-in	LED (2010)	1.83	$0.72	20	1.60	$0.030
Int. Lighting	Screw-in	LED (2020)	2.10	$0.20	20	-	$0.007
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	0.80	$1.71	15	0.59	$0.196
Int. Lighting	High-Bay Fixtures	T8	0.82	-$0.05	10	1.85	-$0.007
Int. Lighting	High-Bay Fixtures	HP Sodium	0.87	$0.01	6	1.75	$0.002
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	1.02	$0.03	15	1.94	$0.002
Int. Lighting	High-Bay Fixtures	T5	1.04	-$0.03	10	2.24	-$0.003
Int. Lighting	High-Bay Fixtures	LED (2020)	1.53	$0.44	15	-	$0.026
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	0.19	$1.01	15	0.40	$0.499
Int. Lighting	Linear Fluorescent	T8	0.20	$0.00	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	0.27	$0.01	10	1.50	$0.003
Int. Lighting	Linear Fluorescent	T5	0.31	$0.01	10	1.61	$0.004
Int. Lighting	Linear Fluorescent	LED (2020)	0.57	$0.28	15	-	$0.045
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	0.19	$0.01	3	-	$0.020
Ext. Lighting	Screw-in	70W HIR PAR-38	0.29	$0.02	3	-	$0.018
Ext. Lighting	Screw-in	CFL	0.54	$0.01	6	3.13	$0.003
Ext. Lighting	Screw-in	LED (2010)	0.59	$0.23	20	1.35	$0.030
Ext. Lighting	Screw-in	LED (2020)	0.67	$0.07	20	-	$0.007
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	0.29	$0.50	15	0.57	$0.162
Ext. Lighting	HID	T8	0.29	-$0.01	10	1.80	-$0.006
Ext. Lighting	HID	HP Sodium	0.31	$0.00	6	1.73	$0.001
Ext. Lighting	HID	Light Emitting Plasma	0.36	$0.01	15	1.86	$0.002
Ext. Lighting	HID	T5	0.37	-$0.01	10	2.18	-$0.003
Ext. Lighting	HID	LED (2020)	0.55	$0.13	15	-	$0.022
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.10	$0.54	15	0.35	$0.499
Ext. Lighting	Linear Fluorescent	T8	0.10	$0.00	10	1.33	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.15	$0.00	10	1.49	$0.003
Ext. Lighting	Linear Fluorescent	T5	0.17	$0.01	10	1.59	$0.004
Ext. Lighting	Linear Fluorescent	LED (2020)	0.31	$0.15	15	-	$0.045

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Refrigeration	Walk-in Refrigerator	14600 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Walk-in Refrigerator	10800 kWh/yr	0.05	$0.00	12	1.16	$0.011
Refrigeration	Walk-in Refrigerator	10000 kWh/yr	0.06	$0.01	12	1.20	$0.012
Refrigeration	Walk-in Refrigerator	9000 kWh/yr	0.07	$0.01	12	1.22	$0.017
Refrigeration	Reach-in Refrigerator	3800 kWh/yr	-	$0.00	12	1.00	$0.000
Refrigeration	Reach-in Refrigerator	3100 kWh/yr	0.01	$0.00	12	1.13	$0.017
Refrigeration	Reach-in Refrigerator	2500 kWh/yr	0.02	$0.00	12	1.26	$0.018
Refrigeration	Reach-in Refrigerator	2400 kWh/yr	0.02	$0.00	12	1.28	$0.017
Refrigeration	Reach-in Refrigerator	1500 kWh/yr	0.03	$0.00	12	1.70	$0.011
Refrigeration	Glass Door Display	14480 kWh/yr	-	$0.00	12	-	$0.000
Refrigeration	Glass Door Display	11700 kWh/yr	0.04	$0.03	12	-	$0.072
Refrigeration	Glass Door Display	8400 kWh/yr	0.08	$0.00	12	1.00	$0.000
Refrigeration	Glass Door Display	6800 kWh/yr	0.11	$0.03	12	0.91	$0.026
Refrigeration	Open Display Case	6500 kWh/yr	-	$0.00	18	-	$0.000
Refrigeration	Open Display Case	5350 kWh/yr	0.02	$0.00	18	1.00	$0.000
Refrigeration	Open Display Case	5300 kWh/yr	0.02	$0.01	18	-	$0.056
Refrigeration	Open Display Case	4330 kWh/yr	0.03	$0.01	18	1.00	$0.032
Refrigeration	Icemaker	7.0 kWh/100 lbs	-	$0.00	10	1.00	$0.000
Refrigeration	Icemaker	6.3 kWh/100 lbs	0.01	$0.00	10	1.01	$0.054
Refrigeration	Icemaker	6.0 kWh/100 lbs	0.01	$0.00	10	1.00	$0.057
Refrigeration	Icemaker	5.5 kWh/100 lbs	0.01	$0.01	10	0.88	$0.142
Refrigeration	Vending Machine	3400 kWh/year	-	$0.00	10	1.00	$0.000
Refrigeration	Vending Machine	3000 kWh/year	0.01	$0.00	10	1.05	$0.012
Refrigeration	Vending Machine	2400 kWh/year	0.03	$0.00	10	1.14	$0.012
Refrigeration	Vending Machine	1700 kWh/year	0.05	$0.01	10	1.20	$0.022
Food Prep.	Oven	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Oven	Energy Star	0.02	$0.00	12	1.12	$0.000
Food Prep.	Fryer	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Fryer	Energy Star	0.01	$0.00	12	1.03	$0.024
Food Prep.	Dishwasher	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Dishwasher	Energy Star	0.10	$0.00	12	1.32	$0.005
Food Prep.	Hot Food Container	Standard	-	$0.00	12	1.00	$0.000
Food Prep.	Hot Food Container	Energy Star	0.07	$0.01	12	1.22	$0.024
Office Equip.	Desktop Computer	Standard	-	$0.00	5	1.00	$0.000
Office Equip.	Desktop Computer	Energy Star	0.06	$0.00	5	1.05	$0.000
Office Equip.	Laptop	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Laptop	Energy Star	0.01	$0.00	4	1.02	$0.000
Office Equip.	Server	Standard	-	$0.00	3	1.00	$0.000
Office Equip.	Server	Energy Star	0.03	$0.00	3	1.04	$0.000
Office Equip.	Monitor	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	Monitor	Energy Star	0.01	$0.00	4	1.02	$0.000
Office Equip.	Printer/Copier/Fax	Standard	-	$0.00	6	1.00	$0.000
Office Equip.	Printer/Copier/Fax	Energy Star	0.02	$0.00	6	1.10	$0.000
Office Equip.	POS Terminal	Standard	-	$0.00	4	1.00	$0.000
Office Equip.	POS Terminal	Energy Star	0.03	$0.02	4	0.95	$0.152
Miscellaneous	Non-HVAC Motors	Standard (EPAct)	-	$0.00	15	1.00	$0.000
Miscellaneous	Non-HVAC Motors	Standard (EPAct 2015)	0.00	$0.00	15	-	$0.000
Miscellaneous	Non-HVAC Motors	High Eff.	0.00	$0.00	15	1.01	$0.010
Miscellaneous	Non-HVAC Motors	High Eff. (2015)	0.01	$0.00	15	-	$0.007
Miscellaneous	Non-HVAC Motors	Premium (NEMA)	0.01	$0.00	15	1.02	$0.010
Miscellaneous	Non-HVAC Motors	Premium (NEMA 2015)	0.01	$0.00	15	-	$0.008
Miscellaneous	Pool Pump	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Pump	High Eff.	0.00	$0.00	15	1.05	$0.030
Miscellaneous	Pool Pump	High Eff. Multi-Speed	0.00	$0.00	15	1.11	$0.051
Miscellaneous	Pool Heater	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Pool Heater	Heat Pump	0.00	$0.00	15	1.12	$0.059
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table C-25 Energy Efficiency Equipment Data — Traffic Signals, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Exterior Lighting	Traffic Lights	Incandescent	-	$0.00	2	1.00	$0.000
Exterior Lighting	Traffic Lights	LED	369.13	$47.00	6	6.55	$0.024
Exterior Lighting	Crosswalk Lights	Incandescent	-	$0.00	2	1.00	$0.000
Exterior Lighting	Crosswalk Lights	LED	201.33	$97.00	8	5.95	$0.071

Table C-26 Energy Efficiency Equipment Data — Traffic Lights, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/SQ FT/yr)	Incremental Cost ($/SQ FT)	Lifetime (Years)	BC Ratio	Levelized Cost of Energy ($/kWh)
Exterior Lighting	Traffic Lights	Incandescent	-	$0.00	2	1.00	$0.000
Exterior Lighting	Traffic Lights	LED	369.13	$47.00	6	6.55	$0.024
Exterior Lighting	Crosswalk Lights	Incandescent	-	$0.00	2	1.00	$0.000
Exterior Lighting	Crosswalk Lights	LED	201.33	$97.00	8	5.95	$0.071

Table C-27 Energy Efficiency Non-Equipment Data—Small Office, Existing Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/Sq Ft)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	7.0%	12.5%	20	$1.04	0.569	0.71	$0.141
Insulation - Ducting	14.7%	50.0%	20	$0.77	0.269	0.43	$0.220
Insulation - Radiant Barrier	7.0%	12.5%	15	$0.00	0.222	3.00	$0.000
Insulation - Wall Cavity	15.9%	67.5%	20	$1.12	0.865	1.23	$0.099
HVAC - Duct Repair and Sealing	5.0%	25.0%	18	$0.50	0.625	2.01	$0.066
Doors - High Efficiency	0.0%	0.0%	0	$0.00	-	3.00	$0.000
Windows - High Efficiency	66.5%	75.0%	20	$13.19	1.241	0.17	$0.820
Roof - High Reflectivity	41.6%	95.0%	15	$0.64	0.323	0.71	$0.183
Air-Cooled Chiller - Condenser Water Temperature Reset	0.0%	0.0%	10	$0.86	0.638	0.72	$0.167
Air-Cooled Chiller - Economizer	4.1%	48.8%	10	$0.05	0.686	12.74	$0.009
Air-Cooled Chiller - Thermal Energy Storage	44.5%	48.8%	15	$0.15	-	-	$0.000
Air-Cooled Chiller - VSD on Fans	0.0%	0.0%	15	$1.17	1.553	2.02	$0.070
Air-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$1.66	1.031	0.61	$0.199
Air-Cooled Chiller - Chilled Water Variable-Flow System	0.0%	0.0%	15	$0.08	0.203	3.89	$0.036
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	0.0%	0.0%	15	$2.86	0.683	0.36	$0.387
Air-Cooled Chiller - Maintenance	48.6%	90.0%	3	$0.22	0.848	1.08	$0.090
Air-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.074	1.65	$0.053
Water-Cooled Chiller - Condenser Water Temperature Reset	0.0%	0.0%	10	$0.86	0.386	0.41	$0.276
Water-Cooled Chiller - Economizer	4.1%	48.8%	10	$0.05	1.956	34.22	$0.003
Water-Cooled Chiller - Thermal Energy Storage	44.5%	48.8%	15	$0.15	-	-	$0.000
Water-Cooled Chiller - VSD on Fans	0.0%	0.0%	15	$1.17	1.706	2.08	$0.063
Water-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$1.66	1.113	0.62	$0.184
Water-Cooled Chiller - Chilled Water Variable-Flow System	0.0%	0.0%	15	$0.08	0.219	3.93	$0.033
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	0.0%	0.0%	15	$2.86	0.003	0.00	$76.504
Water-Cooled Chiller - Maintenance	48.6%	90.0%	3	$0.22	0.915	1.12	$0.083
Water-Cooled Chiller - Chiller Heat	0.0%	50.0%	14	$0.04	0.074	1.65	$0.053

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/Sq Ft)	BC Ratio	Levelized Cost of Energy ($/kWh)
Recovery							
RTU - Evaporative Precooler	0.0%	17.0%	20	$3.00	2.598	1.68	$0.089
RTU - Maintenance	48.6%	90.0%	18	$0.15	0.745	8.60	$0.017
Space Heating - Heat Recovery Ventilator	44.5%	48.8%	15	$1,150.00	0.624	0.00	$170.343
Heat Pump - Maintenance	3.7%	95.0%	4	$0.03	2.519	21.06	$0.003
Ventilation - ECM on VAV Boxes	0.0%	0.0%	18	$0.22	0.043	0.20	$0.420
Ventilation - Variable Speed Control	0.8%	81.0%	15	$0.36	0.390	0.91	$0.085
Water Heater - Drainwater Heat Recovery	0.0%	50.0%	5	$0.04	0.074	0.50	$0.120
Water Heater - Faucet Aerators/Low Flow Nozzles	25.7%	90.0%	10	$0.02	0.033	1.26	$0.059
Water Heater - High Efficiency Circulation Pump	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Water Heater - Desuperheater	0.0%	50.0%	5	$0.04	0.164	1.12	$0.054
Water Heater - Solar System	0.0%	50.0%	20	$0.83	0.410	0.68	$0.157
Water Heater - Install Timer	15.5%	50.0%	15	$0.28	0.164	0.57	$0.158
Water Heater - Pipe Insulation	15.5%	50.0%	13	$5.22	0.046	0.01	$11.570
Water Heater - Tank Blanket/Insulation	40.4%	50.0%	7	$0.03	0.041	0.61	$0.107
Interior Lighting - Daylighting Controls	10.6%	50.0%	8	$12.50	0.469	0.02	$3.946
Interior Lighting - LED Exit Lighting	50.0%	85.5%	16	$0.04	0.003	0.08	$1.108
Interior Lighting - Occupancy Sensors	5.3%	56.3%	8	$0.19	0.156	0.38	$0.176
Interior Lighting - Timeclocks and Timers	4.9%	56.3%	8	$0.21	0.078	0.17	$0.395
Interior Lighting - Task Lighting	17.1%	75.0%	5	$0.24	0.162	0.15	$0.326
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.50	0.249	0.26	$0.298
Interior Fluorescent - Delamp and Install Reflectors	15.1%	45.0%	11	$0.50	0.211	0.31	$0.273
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.015	0.02	$1.961
Exterior Lighting - Daylighting Controls	18.0%	37.5%	8	$0.02	0.075	1.21	$0.039
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.045	0.01	$4.482
Refrigerator - Anti-Sweat Heater	0.0%	75.0%	12	$0.66	-	-	$0.000
Refrigerator - Decommissioning	50.0%	51.7%	9	$0.09	-	-	$0.000
Refrigerator - Demand Defrost	0.0%	75.0%	16	$0.20	-	-	$0.000
Refrigerator - Door Gasket Replacement	5.0%	75.0%	4	$6.50	0.007	0.00	$237.870
Refrigerator - Evaporator Fan Controls	0.0%	7.5%	16	$0.11	-	-	$0.000
Refrigerator - Floating Head Pressure	17.9%	37.5%	15	$0.08	-	-	$0.000
Refrigerator - Strip Curtain	5.0%	56.3%	4	$2.30	-	-	$0.000
Refrigerator - High Efficiency Compressor	10.0%	37.5%	15	$0.29	-	-	$0.000
Refrigerator - Variable Speed Compressor	10.0%	37.5%	15	$0.20	-	-	$0.000
Refrigerator - eCube	5.0%	75.0%	12	$0.00	-	-	$0.000
Vending Machine - Controller	2.0%	10.0%	5	$0.27	0.028	0.02	$2.103
Office Equipment - ENERGY STAR Power Supplies	10.0%	95.0%	4	$0.00	0.009	18.24	$0.003
Office Equipment - Plug Load Occupancy Sensors	7.1%	56.3%	8	$0.20	0.096	0.22	$0.309
Pool Heater - Solar	0.0%	33.8%	20	$0.83	-	-	$0.000
Pool Pump - Timer	2.0%	33.8%	10	$0.44	-	-	$0.000
Ventilation - CO2 Controlled	1.0%	15.0%	15	$0.65	0.273	0.35	$0.220
Non-HVAC Motors - Variable Speed Control	1.6%	37.5%	10	$0.10	-	-	$0.000
Energy Management System	6.1%	50.0%	15	$0.35	1.493	4.68	$0.022
Thermostat - Clock/Programmable	57.6%	62.6%	11	$0.13	0.509	2.75	$0.029
HVAC - Occupancy Sensors	14.3%	56.3%	8	$0.14	0.699	2.34	$0.030
Commissioning - HVAC	0.0%	0.0%	0	$0.00	-	3.00	$0.000
Commissioning - Lighting	0.0%	0.0%	0	$0.00	-	2.00	$0.000
Retrocommissioning - HVAC	5.0%	24.0%	10	$0.75	1.221	1.10	$0.076
Retrocommissioning - Lighting	25.7%	30.7%	5	$0.10	0.164	0.45	$0.135

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/Sq Ft)	BC Ratio	Levelized Cost of Energy ($/kWh)
Advanced New Construction Designs	0.0%	0.0%	0	$0.00	-	6.00	$0.000
Custom Measures	10.0%	45.0%	15	$1.50	-	-	$0.000
PC Power Management Software	13.0%	90.0%	5	$0.05	0.666	4.03	$0.015
Pre-rinse Sprayer	21.0%	5.0%	5	$0.00	0.049	7.25	$0.008

Table C-28 Energy Efficiency Non-Equipment Data— Small Office, New Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	7.0%	12.5%	20	$1.36	0.276	0.25	$0.380
Insulation - Ducting	11.1%	50.0%	20	$0.77	0.595	0.94	$0.100
Insulation - Radiant Barrier	7.0%	12.5%	15	$0.00	0.102	3.00	$0.000
Insulation - Wall Cavity	12.7%	67.5%	20	$0.67	0.167	0.33	$0.308
HVAC - Duct Repair and Sealing	25.0%	25.0%	18	$0.50	1.010	2.15	$0.041
Doors - High Efficiency	100.0%	100.0%	0	$0.00	-	3.00	$0.000
Windows - High Efficiency	77.8%	82.8%	20	$12.36	0.996	0.10	$0.957
Roof - High Reflectivity	41.3%	95.0%	15	$0.64	0.172	0.24	$0.344
Air-Cooled Chiller - Condenser Water Temperature Reset	0.0%	0.0%	10	$0.86	0.382	0.24	$0.279
Air-Cooled Chiller - Economizer	37.4%	48.8%	10	$0.05	0.667	7.63	$0.009
Air-Cooled Chiller - Thermal Energy Storage	44.5%	48.8%	15	$0.15	-	0.03	$0.000
Air-Cooled Chiller - VSD on Fans	0.0%	0.0%	15	$1.17	1.096	0.81	$0.099
Air-Cooled Chiller - Chilled Water Reset	25.0%	75.0%	10	$1.45	0.637	0.23	$0.283
Air-Cooled Chiller - Chilled Water Variable-Flow System	0.0%	0.0%	15	$0.07	0.211	2.74	$0.030
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	0.0%	0.0%	15	$2.51	0.526	0.18	$0.441
Air-Cooled Chiller - Maintenance	41.3%	90.0%	3	$0.19	0.514	0.37	$0.127
Air-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.071	1.51	$0.055
Water-Cooled Chiller - Condenser Water Temperature Reset	0.0%	0.0%	10	$0.86	0.167	0.11	$0.637
Water-Cooled Chiller - Economizer	37.4%	48.8%	10	$0.05	1.421	16.18	$0.004
Water-Cooled Chiller - Thermal Energy Storage	44.5%	48.8%	15	$0.15	-	0.03	$0.000
Water-Cooled Chiller - VSD on Fans	0.0%	0.0%	15	$1.17	0.222	0.17	$0.488
Water-Cooled Chiller - Chilled Water Reset	25.0%	75.0%	10	$1.45	0.725	0.26	$0.249
Water-Cooled Chiller - Chilled Water Variable-Flow System	0.0%	0.0%	15	$0.07	0.240	3.10	$0.026
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	0.0%	0.0%	15	$2.51	0.006	0.00	$39.913
Water-Cooled Chiller - Maintenance	41.3%	90.0%	3	$0.19	0.585	0.42	$0.112
Water-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.071	1.51	$0.055
RTU - Evaporative Precooler	0.0%	19.0%	20	$3.00	2.037	0.84	$0.114
RTU - Maintenance	41.3%	90.0%	18	$0.15	0.459	3.35	$0.027
Space Heating - Heat Recovery Ventilator	44.5%	48.8%	15	$1,150.00	0.550	0.00	$192.995
Heat Pump - Maintenance	1.6%	95.0%	4	$0.03	0.833	5.22	$0.010
Ventilation - ECM on VAV Boxes	0.0%	0.0%	18	$0.22	0.269	1.33	$0.067
Ventilation - Variable Speed Control	3.2%	81.0%	15	$0.32	0.297	0.82	$0.098
Water Heater - Drainwater Heat Recovery	0.0%	50.0%	5	$0.04	0.071	0.45	$0.124
Water Heater - Faucet Aerators/Low Flow Nozzles	25.4%	90.0%	10	$0.01	0.032	1.43	$0.054
Water Heater - High Efficiency	0.0%	0.0%	0	$0.00	-	1.00	$0.000

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Circulation Pump							
Water Heater - Desuperheater	0.0%	50.0%	5	$0.04	0.157	0.96	$0.056
Water Heater - Solar System	0.0%	50.0%	20	$0.73	0.394	0.67	$0.143
Water Heater - Install Timer	50.0%	50.0%	15	$0.28	0.157	0.50	$0.164
Water Heater - Pipe Insulation	50.0%	50.0%	13	$5.22	0.044	0.01	$12.021
Water Heater - Tank Blanket/Insulation	40.4%	50.0%	7	$0.02	0.037	0.63	$0.105
Interior Lighting - Daylighting Controls	75.0%	75.0%	8	$11.72	0.348	0.01	$4.983
Interior Lighting - LED Exit Lighting	85.5%	85.5%	16	$0.03	0.002	0.20	$1.312
Interior Lighting - Occupancy Sensors	56.3%	56.3%	8	$0.16	0.116	0.29	$0.208
Interior Lighting - Timeclocks and Timers	56.3%	56.3%	8	$0.18	0.058	0.14	$0.468
Interior Lighting - Task Lighting	14.3%	75.0%	5	$0.24	0.120	0.12	$0.440
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.50	0.224	0.18	$0.329
Interior Fluorescent - Delamp and Install Reflectors	14.3%	45.0%	11	$0.50	-	0.01	$0.000
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.009	0.03	$3.305
Exterior Lighting - Daylighting Controls	18.0%	37.5%	8	$0.02	0.045	1.02	$0.066
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.027	0.01	$7.554
Refrigerator - Anti-Sweat Heater	0.0%	75.0%	12	$0.58	-	0.01	$0.000
Refrigerator - Decommissioning	50.0%	51.7%	9	$0.08	-	0.03	$0.000
Refrigerator - Demand Defrost	0.0%	75.0%	16	$0.20	-	0.02	$0.000
Refrigerator - Door Gasket Replacement	5.0%	75.0%	4	$6.09	0.004	0.00	$419.015
Refrigerator - Evaporator Fan Controls	0.0%	7.5%	16	$0.10	-	0.05	$0.000
Refrigerator - Floating Head Pressure	17.9%	37.5%	15	$0.07	-	0.06	$0.000
Refrigerator - Strip Curtain	5.0%	56.3%	4	$2.16	-	0.00	$0.000
Refrigerator - High Efficiency Compressor	10.0%	37.5%	15	$0.29	-	0.01	$0.000
Refrigerator - Variable Speed Compressor	10.0%	37.5%	15	$0.17	-	0.02	$0.000
Refrigerator - eCube	5.0%	75.0%	12	$0.00	-	2.33	$0.000
Vending Machine - Controller	2.0%	10.0%	5	$0.27	0.020	0.02	$2.961
Office Equipment - ENERGY STAR Power Supplies	10.0%	95.0%	4	$0.00	0.009	27.71	$0.003
Office Equipment - Plug Load Occupancy Sensors	7.1%	56.3%	8	$0.20	0.095	0.20	$0.312
Pool Heater - Solar	0.0%	33.8%	20	$0.73	-	0.01	$0.000
Pool Pump - Timer	33.8%	33.8%	10	$0.44	-	0.01	$0.000
Ventilation - CO2 Controlled	11.5%	15.0%	15	$0.65	0.220	0.30	$0.273
Non-HVAC Motors - Variable Speed Control	1.6%	37.5%	10	$0.10	-	0.03	$0.000
Energy Management System	6.4%	50.0%	15	$0.35	1.019	2.50	$0.032
Thermostat - Clock/Programmable	78.0%	78.0%	11	$0.13	0.354	1.63	$0.042
HVAC - Occupancy Sensors	56.3%	56.3%	8	$0.14	0.595	1.71	$0.035
Commissioning - HVAC	0.0%	0.0%	25	$1.25	1.020	1.31	$0.084
Commissioning - Lighting	0.0%	0.0%	25	$0.20	0.120	1.02	$0.113
Retrocommissioning - HVAC	0.0%	0.0%	10	$0.75	-	0.01	$0.000
Retrocommissioning - Lighting	0.0%	0.0%	0	$0.00	-	2.00	$0.000
Advanced New Construction Designs	0.0%	0.0%	25	$2.00	4.415	3.52	$0.031
Custom Measures	10.0%	45.0%	15	$1.50	-	0.01	$0.000
PC Power Management Software	13.0%	90.0%	5	$0.05	0.666	4.11	$0.015
Pre-rinse Sprayer	25.0%	5.0%	5	$0.00	0.049	7.39	$0.008

Table C-29 Energy Efficiency Non-Equipment Data— Large Office, Existing Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	7.0%	12.5%	20	$0.26	0.199	0.89	$0.101
Insulation - Ducting	16.7%	50.0%	20	$0.77	0.220	0.33	$0.270
Insulation - Radiant Barrier	7.0%	12.5%	15	$0.00	0.069	3.00	$0.000
Insulation - Wall Cavity	16.7%	67.5%	20	$0.60	0.405	0.79	$0.114
HVAC - Duct Repair and Sealing	5.0%	25.0%	18	$0.50	0.142	0.29	$0.290
Doors - High Efficiency	0.0%	0.0%	0	$0.00	-	3.00	$0.000
Windows - High Efficiency	75.0%	80.0%	20	$7.08	1.034	0.17	$0.528
Roof - High Reflectivity	41.7%	75.0%	15	$0.16	0.084	0.42	$0.176
Air-Cooled Chiller - Condenser Water Temperature Reset	30.0%	75.0%	10	$0.18	0.488	1.31	$0.046
Air-Cooled Chiller - Economizer	25.0%	48.8%	10	$0.00	1.123	142.90	$0.000
Air-Cooled Chiller - Thermal Energy Storage	44.3%	48.8%	15	$0.15	-	0.01	$0.000
Air-Cooled Chiller - VSD on Fans	15.0%	66.2%	15	$1.17	1.169	0.79	$0.092
Air-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.12	0.768	3.10	$0.019
Air-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	15	$0.06	0.162	2.12	$0.035
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	15	$0.21	0.003	0.02	$6.152
Air-Cooled Chiller - Maintenance	41.7%	90.0%	3	$0.17	0.638	0.48	$0.091
Air-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.081	1.60	$0.048
Water-Cooled Chiller - Condenser Water Temperature Reset	30.0%	75.0%	10	$0.18	0.269	0.74	$0.083
Water-Cooled Chiller - Economizer	25.0%	48.8%	10	$0.00	1.384	178.83	$0.000
Water-Cooled Chiller - Thermal Energy Storage	44.3%	48.8%	15	$0.15	-	0.01	$0.000
Water-Cooled Chiller - VSD on Fans	15.0%	66.2%	15	$1.17	0.352	0.24	$0.307
Water-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.12	0.750	3.08	$0.020
Water-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	15	$0.06	0.156	2.07	$0.036
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	15	$0.21	0.002	0.02	$8.244
Water-Cooled Chiller - Maintenance	41.7%	90.0%	3	$0.17	0.612	0.47	$0.095
Water-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.081	1.60	$0.048
RTU - Evaporative Precooler	0.0%	3.0%	20	$3.00	2.535	0.93	$0.091
RTU - Maintenance	41.7%	90.0%	18	$0.04	0.727	18.78	$0.004
Space Heating - Heat Recovery Ventilator	44.3%	48.8%	15	$1,150.00	0.533	0.00	$199.186
Heat Pump - Maintenance	8.3%	95.0%	4	$0.06	2.342	6.70	$0.007
Ventilation - ECM on VAV Boxes	0.0%	0.0%	18	$0.22	0.394	1.74	$0.046
Ventilation - Variable Speed Control	0.0%	81.0%	15	$0.03	0.744	22.35	$0.003
Water Heater - Drainwater Heat Recovery	0.0%	50.0%	5	$0.04	0.081	0.48	$0.109
Water Heater - Faucet Aerators/Low Flow Nozzles	41.7%	90.0%	10	$0.00	0.036	17.39	$0.004
Water Heater - High Efficiency Circulation Pump	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Water Heater - Desuperheater	0.0%	50.0%	5	$0.04	0.180	1.04	$0.049
Water Heater - Solar System	0.0%	50.0%	20	$0.06	0.451	9.09	$0.010
Water Heater - Install Timer	33.3%	38.3%	15	$0.28	0.180	0.55	$0.144
Water Heater - Pipe Insulation	33.3%	38.3%	13	$5.22	0.051	0.01	$10.446
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	7	$0.00	0.045	8.32	$0.007
Interior Lighting - Daylighting Controls	8.3%	12.5%	8	$6.71	0.362	0.02	$2.740
Interior Lighting - LED Exit Lighting	50.0%	85.5%	16	$0.00	0.002	1.24	$0.103

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Interior Lighting - Occupancy Sensors	25.0%	56.3%	8	$0.01	0.121	3.27	$0.016
Interior Lighting - Timeclocks and Timers	8.3%	56.3%	8	$0.02	0.060	1.48	$0.037
Interior Lighting - Task Lighting	41.7%	75.0%	5	$0.24	0.125	0.09	$0.422
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.40	0.328	0.32	$0.180
Interior Fluorescent - Delamp and Install Reflectors	33.3%	67.5%	11	$0.50	0.279	0.32	$0.207
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.011	0.02	$2.609
Exterior Lighting - Daylighting Controls	18.0%	37.5%	8	$0.02	0.057	0.91	$0.052
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.034	0.01	$5.963
Refrigerator - Anti-Sweat Heater	0.0%	75.0%	12	$0.05	0.010	0.12	$0.533
Refrigerator - Decommissioning	50.0%	51.7%	9	$0.01	-	0.13	$0.000
Refrigerator - Demand Defrost	0.0%	75.0%	16	$0.20	-	0.01	$0.000
Refrigerator - Door Gasket Replacement	5.0%	75.0%	4	$3.49	0.009	0.00	$98.853
Refrigerator - Evaporator Fan Controls	0.0%	7.5%	16	$0.01	-	0.17	$0.000
Refrigerator - Floating Head Pressure	38.0%	45.0%	15	$0.01	-	0.21	$0.000
Refrigerator - Strip Curtain	5.0%	56.3%	4	$1.24	-	0.00	$0.000
Refrigerator - High Efficiency Compressor	10.0%	37.5%	15	$0.29	-	0.00	$0.000
Refrigerator - Variable Speed Compressor	10.0%	37.5%	15	$0.01	-	0.09	$0.000
Refrigerator - eCube	5.0%	75.0%	12	$0.00	-	0.52	$0.000
Vending Machine - Controller	2.0%	10.0%	5	$0.27	0.014	0.01	$4.228
Office Equipment - ENERGY STAR Power Supplies	10.0%	95.0%	4	$0.00	0.021	40.81	$0.001
Office Equipment - Plug Load Occupancy Sensors	12.6%	56.3%	8	$0.28	0.233	0.32	$0.178
Pool Heater - Solar	0.0%	33.8%	20	$0.06	-	0.04	$0.000
Pool Pump - Timer	8.3%	33.8%	10	$0.13	-	0.01	$0.000
Ventilation - CO2 Controlled	1.0%	11.3%	15	$0.65	0.338	0.40	$0.178
Non-HVAC Motors - Variable Speed Control	8.3%	37.5%	10	$0.10	-	0.01	$0.000
Energy Management System	8.3%	90.0%	15	$0.35	1.343	3.03	$0.024
Thermostat - Clock/Programmable	58.3%	63.3%	11	$0.13	0.414	1.77	$0.036
HVAC - Occupancy Sensors	14.3%	56.3%	8	$0.14	0.626	1.71	$0.033
Commissioning - HVAC	0.0%	0.0%	0	$0.00	-	3.00	$0.000
Commissioning - Lighting	0.0%	0.0%	0	$0.00	-	2.00	$0.000
Retrocommissioning - HVAC	9.0%	36.0%	10	$0.75	1.199	0.78	$0.077
Retrocommissioning - Lighting	66.7%	71.7%	5	$0.05	0.126	0.55	$0.087
Advanced New Construction Designs	0.0%	0.0%	0	$0.00	-	6.00	$0.000
Custom Measures	10.0%	45.0%	15	$0.90	-	0.01	$0.000
PC Power Management Software	13.0%	90.0%	5	$0.03	1.621	11.84	$0.004
Pre-rinse Sprayer	42.0%	5.0%	5	$0.00	0.018	7.25	$0.008

Table C-30 Energy Efficiency Non-Equipment Data— Large Office, New Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	7.0%	12.5%	20	$0.34	0.103	0.38	$0.255
Insulation - Ducting	0.0%	50.0%	20	$0.77	0.340	0.55	$0.175
Insulation - Radiant Barrier	7.0%	12.5%	15	$0.00	0.036	3.00	$0.000
Insulation - Wall Cavity	50.0%	67.5%	20	$0.36	0.205	0.68	$0.137
HVAC - Duct Repair and Sealing	25.0%	25.0%	18	$0.50	0.530	1.11	$0.078
Doors - High Efficiency	100.0%	100.0%	0	$0.00	-	3.00	$0.000
Windows - High Efficiency	100.0%	100.0%	20	$6.75	0.884	0.16	$0.589

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Roof - High Reflectivity	50.0%	95.0%	15	$0.16	0.256	1.40	$0.058
Air-Cooled Chiller - Condenser Water Temperature Reset	60.0%	75.0%	10	$0.18	0.265	0.78	$0.084
Air-Cooled Chiller - Economizer	53.8%	55.0%	10	$0.00	1.256	191.04	$0.000
Air-Cooled Chiller - Thermal Energy Storage	44.3%	48.8%	15	$0.15	-	0.01	$0.000
Air-Cooled Chiller - VSD on Fans	15.0%	66.2%	15	$1.17	0.760	0.56	$0.142
Air-Cooled Chiller - Chilled Water Reset	25.0%	75.0%	10	$0.11	0.452	2.19	$0.030
Air-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	15	$0.05	0.161	2.70	$0.030
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	15	$0.19	0.002	0.02	$11.123
Air-Cooled Chiller - Maintenance	50.0%	90.0%	3	$0.14	0.334	0.32	$0.149
Air-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.078	1.58	$0.050
Water-Cooled Chiller - Condenser Water Temperature Reset	60.0%	75.0%	10	$0.18	0.191	0.56	$0.117
Water-Cooled Chiller - Economizer	53.8%	55.0%	10	$0.00	0.877	133.81	$0.000
Water-Cooled Chiller - Thermal Energy Storage	44.3%	48.8%	15	$0.15	-	0.01	$0.000
Water-Cooled Chiller - VSD on Fans	15.0%	66.2%	15	$1.17	0.302	0.22	$0.358
Water-Cooled Chiller - Chilled Water Reset	25.0%	75.0%	10	$0.11	0.480	2.32	$0.028
Water-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	15	$0.05	0.205	3.44	$0.023
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	15	$0.19	0.004	0.03	$4.566
Water-Cooled Chiller - Maintenance	50.0%	90.0%	3	$0.14	0.357	0.34	$0.139
Water-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.078	1.58	$0.050
RTU - Evaporative Precooler	0.0%	1.0%	20	$3.00	1.945	0.80	$0.119
RTU - Maintenance	50.0%	90.0%	18	$0.04	0.411	11.94	$0.007
Space Heating - Heat Recovery Ventilator	44.3%	48.8%	15	$1,150.00	0.487	0.00	$218.190
Heat Pump - Maintenance	0.0%	95.0%	4	$0.06	0.768	2.36	$0.021
Ventilation - ECM on VAV Boxes	0.0%	0.0%	18	$0.22	0.296	1.47	$0.061
Ventilation - Variable Speed Control	0.0%	81.0%	15	$0.02	0.559	20.65	$0.004
Water Heater - Drainwater Heat Recovery	0.0%	50.0%	5	$0.04	0.078	0.47	$0.113
Water Heater - Faucet Aerators/Low Flow Nozzles	50.0%	90.0%	10	$0.00	0.035	18.86	$0.004
Water Heater - High Efficiency Circulation Pump	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Water Heater - Desuperheater	0.0%	50.0%	5	$0.04	0.173	1.02	$0.051
Water Heater - Solar System	0.0%	50.0%	20	$0.05	0.432	9.86	$0.010
Water Heater - Install Timer	100.0%	100.0%	15	$0.28	0.173	0.54	$0.150
Water Heater - Pipe Insulation	100.0%	100.0%	13	$5.22	0.049	0.01	$10.870
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	7	$0.00	0.040	8.40	$0.007
Interior Lighting - Daylighting Controls	18.8%	18.8%	8	$6.40	0.271	0.02	$3.497
Interior Lighting - LED Exit Lighting	85.5%	85.5%	16	$0.00	0.002	1.30	$0.126
Interior Lighting - Occupancy Sensors	56.3%	56.3%	8	$0.01	0.090	2.97	$0.020
Interior Lighting - Timeclocks and Timers	56.3%	56.3%	8	$0.01	0.045	1.35	$0.045
Interior Lighting - Task Lighting	50.0%	75.0%	5	$0.24	0.094	0.09	$0.565
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.40	0.296	0.29	$0.200
Interior Fluorescent - Delamp and Install Reflectors	100.0%	100.0%	11	$0.50	-	0.00	$0.000
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.007	0.02	$4.367
Exterior Lighting - Daylighting Controls	18.0%	37.5%	8	$0.02	0.034	0.72	$0.087

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.020	0.01	$9.982
Refrigerator - Anti-Sweat Heater	0.0%	75.0%	12	$0.04	0.010	0.18	$0.484
Refrigerator - Decommissioning	50.0%	51.7%	9	$0.01	-	0.17	$0.000
Refrigerator - Demand Defrost	0.0%	75.0%	16	$0.20	-	0.01	$0.000
Refrigerator - Door Gasket Replacement	5.0%	75.0%	4	$3.33	0.009	0.00	$103.588
Refrigerator - Evaporator Fan Controls	0.0%	7.5%	16	$0.01	-	0.23	$0.000
Refrigerator - Floating Head Pressure	38.0%	45.0%	15	$0.01	-	0.29	$0.000
Refrigerator - Strip Curtain	5.0%	56.3%	4	$1.18	-	0.00	$0.000
Refrigerator - High Efficiency Compressor	10.0%	37.5%	15	$0.29	-	0.01	$0.000
Refrigerator - Variable Speed Compressor	10.0%	37.5%	15	$0.01	-	0.12	$0.000
Refrigerator - eCube	5.0%	75.0%	12	$0.00	-	0.46	$0.000
Vending Machine - Controller	2.0%	10.0%	5	$0.27	0.010	0.01	$6.185
Office Equipment - ENERGY STAR Power Supplies	10.0%	95.0%	4	$0.00	0.021	41.72	$0.001
Office Equipment - Plug Load Occupancy Sensors	12.6%	56.3%	8	$0.25	0.231	0.37	$0.160
Pool Heater - Solar	0.0%	33.8%	20	$0.05	-	0.04	$0.000
Pool Pump - Timer	33.8%	33.8%	10	$0.13	-	0.01	$0.000
Ventilation - CO2 Controlled	8.7%	11.3%	15	$0.65	0.276	0.37	$0.218
Non-HVAC Motors - Variable Speed Control	50.0%	55.0%	10	$0.10	-	0.01	$0.000
Energy Management System	50.0%	90.0%	15	$0.35	0.907	2.20	$0.036
Thermostat - Clock/Programmable	50.0%	50.0%	11	$0.13	0.395	1.74	$0.038
HVAC - Occupancy Sensors	56.3%	56.3%	8	$0.14	0.550	1.56	$0.038
Commissioning - HVAC	0.0%	0.0%	25	$1.00	1.019	1.64	$0.067
Commissioning - Lighting	0.0%	0.0%	25	$0.15	0.094	1.03	$0.109
Retrocommissioning - HVAC	0.0%	0.0%	10	$0.75	-	0.00	$0.000
Retrocommissioning - Lighting	0.0%	0.0%	0	$0.00	-	2.00	$0.000
Advanced New Construction Designs	0.0%	0.0%	25	$2.00	4.108	3.28	$0.033
Custom Measures	10.0%	45.0%	15	$0.90	-	0.01	$0.000
PC Power Management Software	13.0%	90.0%	5	$0.03	1.621	12.08	$0.004
Pre-rinse Sprayer	50.0%	5.0%	5	$0.00	0.018	7.39	$0.008

Table C-31 Energy Efficiency Non-Equipment Data— Restaurant, Existing Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	7.0%	12.5%	20	$1.04	0.478	0.65	$0.168
Insulation - Ducting	10.7%	50.0%	20	$0.77	0.286	0.61	$0.207
Insulation - Radiant Barrier	4.0%	12.5%	15	$0.00	0.179	3.00	$0.000
Insulation - Wall Cavity	10.7%	67.5%	20	$0.96	1.098	1.41	$0.068
HVAC - Duct Repair and Sealing	5.0%	25.0%	18	$0.50	1.001	2.21	$0.041
Doors - High Efficiency	0.0%	0.0%	0	$0.00	-	3.00	$0.000
Windows - High Efficiency	53.6%	75.0%	20	$8.22	1.256	0.18	$0.505
Roof - High Reflectivity	35.7%	95.0%	15	$0.64	0.260	0.44	$0.227
Air-Cooled Chiller - Condenser Water Temperature Reset	0.0%	0.0%	10	$0.86	0.727	0.46	$0.147
Air-Cooled Chiller - Economizer	0.0%	48.8%	10	$0.03	2.853	54.21	$0.001
Air-Cooled Chiller - Thermal Energy Storage	44.5%	48.8%	15	$0.15	-	0.30	$0.000
Air-Cooled Chiller - VSD on Fans	0.0%	0.0%	15	$1.17	3.023	2.16	$0.036
Air-Cooled Chiller - Chilled Water Reset	0.0%	75.0%	10	$0.84	1.306	0.81	$0.080
Air-Cooled Chiller - Chilled Water	0.0%	0.0%	15	$0.09	0.194	2.29	$0.042

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Variable-Flow System							
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	0.0%	0.0%	15	$1.46	-	0.03	$0.000
Air-Cooled Chiller - Maintenance	64.3%	90.0%	3	$0.24	1.079	0.61	$0.079
Air-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.786	16.34	$0.005
Water-Cooled Chiller - Condenser Water Temperature Reset	0.0%	0.0%	10	$0.86	0.188	0.13	$0.566
Water-Cooled Chiller - Economizer	0.0%	48.8%	10	$0.03	2.353	42.09	$0.001
Water-Cooled Chiller - Thermal Energy Storage	44.5%	48.8%	15	$0.15	-	0.28	$0.000
Water-Cooled Chiller - VSD on Fans	0.0%	0.0%	15	$1.17	0.354	0.27	$0.305
Water-Cooled Chiller - Chilled Water Reset	0.0%	75.0%	10	$0.84	1.196	0.70	$0.087
Water-Cooled Chiller - Chilled Water Variable-Flow System	0.0%	0.0%	15	$0.09	-	0.46	$0.000
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	0.0%	0.0%	15	$1.46	0.004	0.03	$32.503
Water-Cooled Chiller - Maintenance	64.3%	90.0%	3	$0.24	1.090	0.58	$0.078
Water-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.786	16.34	$0.005
RTU - Evaporative Precooler	0.0%	13.0%	20	$3.00	3.836	1.40	$0.060
RTU - Maintenance	64.3%	90.0%	18	$0.15	1.093	7.27	$0.011
Space Heating - Heat Recovery Ventilator	44.5%	48.8%	15	$1,150.00	0.613	0.00	$173.313
Heat Pump - Maintenance	3.6%	95.0%	4	$0.03	2.851	18.90	$0.003
Ventilation - ECM on VAV Boxes	0.0%	0.0%	18	$0.22	0.429	2.05	$0.042
Ventilation - Variable Speed Control	0.0%	81.0%	15	$0.18	0.820	3.61	$0.021
Water Heater - Drainwater Heat Recovery	0.0%	50.0%	5	$0.04	0.786	4.90	$0.011
Water Heater - Faucet Aerators/Low Flow Nozzles	28.6%	90.0%	10	$0.01	0.349	26.53	$0.003
Water Heater - High Efficiency Circulation Pump	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Water Heater - Desuperheater	0.0%	50.0%	5	$0.04	1.746	10.41	$0.005
Water Heater - Solar System	0.0%	50.0%	20	$1.96	4.364	2.74	$0.035
Water Heater - Install Timer	10.7%	50.0%	15	$0.28	1.746	5.45	$0.015
Water Heater - Pipe Insulation	10.7%	50.0%	13	$5.22	0.494	0.07	$1.077
Water Heater - Tank Blanket/Insulation	40.4%	50.0%	7	$0.01	0.436	12.52	$0.005
Interior Lighting - Daylighting Controls	0.0%	50.0%	8	$7.80	1.830	0.05	$0.630
Interior Lighting - LED Exit Lighting	50.0%	85.5%	16	$0.02	0.012	1.42	$0.144
Interior Lighting - Occupancy Sensors	0.0%	56.3%	8	$0.09	0.610	1.38	$0.023
Interior Lighting - Timeclocks and Timers	3.6%	56.3%	8	$0.11	0.305	0.67	$0.052
Interior Lighting - Task Lighting	3.6%	75.0%	5	$0.24	0.633	0.28	$0.084
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.50	0.136	0.14	$0.544
Interior Fluorescent - Delamp and Install Reflectors	7.1%	37.5%	11	$0.50	0.115	0.18	$0.499
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.019	0.13	$1.526
Exterior Lighting - Daylighting Controls	19.0%	37.5%	8	$0.02	0.097	2.56	$0.031
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.058	0.03	$3.488
Refrigerator - Anti-Sweat Heater	0.0%	75.0%	12	$0.33	0.132	0.27	$0.273
Refrigerator - Decommissioning	50.0%	51.7%	9	$0.04	3.690	29.56	$0.002
Refrigerator - Demand Defrost	0.0%	75.0%	16	$0.20	0.205	0.86	$0.086
Refrigerator - Door Gasket Replacement	5.0%	75.0%	4	$5.61	0.295	0.01	$5.114
Refrigerator - Evaporator Fan Controls	0.0%	7.5%	16	$0.06	0.041	1.13	$0.120
Refrigerator - Floating Head Pressure	17.9%	37.5%	15	$0.04	0.287	5.13	$0.013

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Refrigerator - Strip Curtain	5.0%	56.3%	4	$1.43	0.164	0.02	$2.353
Refrigerator - High Efficiency Compressor	10.0%	37.5%	15	$0.29	0.287	0.73	$0.093
Refrigerator - Variable Speed Compressor	10.0%	37.5%	15	$0.10	0.287	2.13	$0.032
Refrigerator - eCube	5.0%	75.0%	12	$0.17	0.820	2.49	$0.022
Vending Machine - Controller	2.0%	10.0%	5	$0.27	0.097	0.11	$0.612
Office Equipment - ENERGY STAR Power Supplies	10.0%	95.0%	4	$0.00	0.002	123.72	$0.014
Office Equipment - Plug Load Occupancy Sensors	7.1%	56.3%	8	$0.30	0.021	0.11	$2.072
Pool Heater - Solar	0.0%	33.8%	20	$1.96	-	0.03	$0.000
Pool Pump - Timer	0.0%	33.8%	10	$0.44	-	0.07	$0.000
Ventilation - CO2 Controlled	1.0%	15.0%	15	$0.65	0.614	0.78	$0.098
Non-HVAC Motors - Variable Speed Control	0.0%	37.5%	10	$0.10	-	0.30	$0.000
Energy Management System	7.1%	50.0%	15	$0.35	2.985	6.37	$0.011
Thermostat - Clock/Programmable	50.0%	50.0%	11	$0.13	0.487	2.69	$0.031
HVAC - Occupancy Sensors	14.3%	56.3%	8	$0.14	0.793	2.57	$0.026
Commissioning - HVAC	0.0%	0.0%	0	$0.00	-	3.00	$0.000
Commissioning - Lighting	0.0%	0.0%	0	$0.00	-	2.00	$0.000
Retrocommissioning - HVAC	5.0%	24.0%	10	$0.75	1.585	1.11	$0.059
Retrocommissioning - Lighting	10.7%	15.7%	5	$0.10	0.620	0.94	$0.036
Advanced New Construction Designs	0.0%	0.0%	0	$0.00	-	6.00	$0.000
Custom Measures	10.0%	45.0%	15	$1.50	-	0.10	$0.000
PC Power Management Software	7.0%	90.0%	5	$0.01	0.146	4.98	$0.012
Pre-rinse Sprayer	29.0%	90.0%	5	$0.02	0.497	7.28	$0.008

Table C-32 Energy Efficiency Non-Equipment Data— Restaurant, New Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	7.0%	12.5%	20	$1.36	0.383	0.45	$0.274
Insulation - Ducting	0.0%	50.0%	20	$0.77	0.599	1.10	$0.099
Insulation - Radiant Barrier	4.0%	12.5%	15	$0.00	0.124	3.00	$0.000
Insulation - Wall Cavity	0.0%	67.5%	20	$0.55	0.816	2.13	$0.052
HVAC - Duct Repair and Sealing	25.0%	25.0%	18	$0.50	0.743	1.94	$0.055
Doors - High Efficiency	100.0%	100.0%	0	$0.00	-	3.00	$0.000
Windows - High Efficiency	0.0%	75.0%	20	$7.43	0.938	0.17	$0.611
Roof - High Reflectivity	50.0%	95.0%	15	$0.64	0.189	0.40	$0.312
Air-Cooled Chiller - Condenser Water Temperature Reset	0.0%	0.0%	10	$0.86	0.476	0.33	$0.224
Air-Cooled Chiller - Economizer	36.6%	48.8%	10	$0.02	0.887	22.77	$0.003
Air-Cooled Chiller - Thermal Energy Storage	44.5%	48.8%	15	$0.15	-	0.32	$0.000
Air-Cooled Chiller - VSD on Fans	0.0%	0.0%	15	$1.17	1.719	1.32	$0.063
Air-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.69	0.865	0.71	$0.099
Air-Cooled Chiller - Chilled Water Variable-Flow System	0.0%	0.0%	15	$0.08	0.217	2.81	$0.036
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	0.0%	0.0%	15	$1.19	-	0.04	$0.000
Air-Cooled Chiller - Maintenance	100.0%	100.0%	3	$0.23	0.606	0.40	$0.132
Air-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.754	16.03	$0.005
Water-Cooled Chiller - Condenser Water Temperature Reset	0.0%	0.0%	10	$0.86	0.092	0.09	$1.159
Water-Cooled Chiller - Economizer	36.6%	48.8%	10	$0.02	1.919	47.41	$0.001
Water-Cooled Chiller - Thermal	44.5%	48.8%	15	$0.15	-	0.32	$0.000

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Energy Storage							
Water-Cooled Chiller - VSD on Fans	0.0%	0.0%	15	$1.17	0.268	0.24	$0.403
Water-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.69	0.919	0.74	$0.093
Water-Cooled Chiller - Chilled Water Variable-Flow System	0.0%	0.0%	15	$0.08	-	0.55	$0.000
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	0.0%	0.0%	15	$1.19	0.007	0.04	$15.856
Water-Cooled Chiller - Maintenance	100.0%	100.0%	3	$0.23	0.620	0.40	$0.129
Water-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.754	16.03	$0.005
RTU - Evaporative Precooler	0.0%	13.0%	20	$3.00	2.944	1.24	$0.079
RTU - Maintenance	100.0%	100.0%	18	$0.15	0.590	4.63	$0.021
Space Heating - Heat Recovery Ventilator	44.5%	48.8%	15	$1,150.00	0.542	0.00	$196.099
Heat Pump - Maintenance	0.0%	95.0%	4	$0.03	0.500	4.75	$0.016
Ventilation - ECM on VAV Boxes	0.0%	0.0%	18	$0.22	0.232	1.39	$0.078
Ventilation - Variable Speed Control	0.0%	81.0%	15	$0.15	0.466	3.01	$0.030
Water Heater - Drainwater Heat Recovery	0.0%	50.0%	5	$0.04	0.754	4.79	$0.012
Water Heater - Faucet Aerators/Low Flow Nozzles	0.0%	90.0%	10	$0.01	0.335	31.94	$0.002
Water Heater - High Efficiency Circulation Pump	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Water Heater - Desuperheater	0.0%	50.0%	5	$0.04	1.676	10.16	$0.005
Water Heater - Solar System	0.0%	50.0%	20	$1.96	4.190	2.68	$0.036
Water Heater - Install Timer	50.0%	50.0%	15	$0.28	1.676	5.34	$0.015
Water Heater - Pipe Insulation	50.0%	50.0%	13	$5.22	0.474	0.07	$1.122
Water Heater - Tank Blanket/Insulation	40.4%	50.0%	7	$0.01	0.382	13.88	$0.005
Interior Lighting - Daylighting Controls	75.0%	75.0%	8	$7.05	0.717	0.04	$1.453
Interior Lighting - LED Exit Lighting	85.5%	85.5%	16	$0.02	0.005	3.10	$0.301
Interior Lighting - Occupancy Sensors	56.3%	56.3%	8	$0.08	0.239	1.49	$0.048
Interior Lighting - Timeclocks and Timers	56.3%	56.3%	8	$0.09	0.120	0.80	$0.107
Interior Lighting - Task Lighting	0.0%	75.0%	5	$0.24	0.248	0.29	$0.213
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.50	0.113	0.14	$0.654
Interior Fluorescent - Delamp and Install Reflectors	0.0%	37.5%	11	$0.50	-	0.07	$0.000
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.012	0.15	$2.368
Exterior Lighting - Daylighting Controls	19.0%	37.5%	8	$0.02	0.062	2.54	$0.047
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.037	0.03	$5.411
Refrigerator - Anti-Sweat Heater	0.0%	75.0%	12	$0.27	0.132	0.45	$0.223
Refrigerator - Decommissioning	50.0%	51.7%	9	$0.04	2.183	27.94	$0.002
Refrigerator - Demand Defrost	0.0%	75.0%	16	$0.20	0.121	0.80	$0.146
Refrigerator - Door Gasket Replacement	5.0%	75.0%	4	$5.07	0.216	0.02	$6.303
Refrigerator - Evaporator Fan Controls	0.0%	7.5%	16	$0.05	0.024	1.56	$0.166
Refrigerator - Floating Head Pressure	17.9%	37.5%	15	$0.03	0.170	5.65	$0.018
Refrigerator - Strip Curtain	5.0%	56.3%	4	$1.30	0.097	0.02	$3.595
Refrigerator - High Efficiency Compressor	10.0%	37.5%	15	$0.29	0.170	0.66	$0.158
Refrigerator - Variable Speed Compressor	10.0%	37.5%	15	$0.08	0.170	2.34	$0.044
Refrigerator - eCube	5.0%	75.0%	12	$0.24	0.485	1.48	$0.053
Vending Machine - Controller	2.0%	10.0%	5	$0.27	0.062	0.09	$0.958
Office Equipment - ENERGY STAR Power Supplies	10.0%	95.0%	4	$0.00	0.002	129.98	$0.014

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Office Equipment - Plug Load Occupancy Sensors	7.1%	56.3%	8	$0.25	0.021	0.13	$1.739
Pool Heater - Solar	0.0%	33.8%	20	$1.96	-	0.03	$0.000
Pool Pump - Timer	33.8%	33.8%	10	$0.44	-	0.07	$0.000
Ventilation - CO2 Controlled	11.5%	15.0%	15	$0.65	0.393	0.59	$0.153
Non-HVAC Motors - Variable Speed Control	0.0%	37.5%	10	$0.10	-	0.31	$0.000
Energy Management System	0.0%	50.0%	15	$0.35	1.856	4.97	$0.017
Thermostat - Clock/Programmable	50.0%	50.0%	11	$0.13	0.325	2.16	$0.046
HVAC - Occupancy Sensors	56.3%	56.3%	8	$0.14	0.656	2.34	$0.032
Commissioning - HVAC	0.0%	0.0%	25	$1.25	1.255	1.75	$0.068
Commissioning - Lighting	0.0%	0.0%	25	$0.20	0.245	2.60	$0.056
Retrocommissioning - HVAC	0.0%	0.0%	10	$0.75	-	0.13	$0.000
Retrocommissioning - Lighting	0.0%	0.0%	0	$0.00	-	2.00	$0.000
Advanced New Construction Designs	0.0%	0.0%	25	$2.00	7.015	5.77	$0.019
Custom Measures	10.0%	45.0%	15	$1.50	-	0.12	$0.000
PC Power Management Software	7.0%	90.0%	5	$0.01	0.146	5.08	$0.012
Pre-rinse Sprayer	0.0%	90.0%	5	$0.02	0.497	7.39	$0.008

Table C-33 Energy Efficiency Non-Equipment Data— Retail, Existing Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	7.0%	12.5%	20	$1.04	1.090	1.18	$0.074
Insulation - Ducting	20.5%	50.0%	20	$0.77	0.315	0.45	$0.189
Insulation - Radiant Barrier	7.0%	12.5%	15	$0.00	0.425	3.00	$0.000
Insulation - Wall Cavity	13.7%	67.5%	20	$0.73	1.041	1.57	$0.054
HVAC - Duct Repair and Sealing	5.0%	25.0%	18	$0.50	0.661	1.31	$0.062
Doors - High Efficiency	0.0%	0.0%	0	$0.00	-	3.00	$0.000
Windows - High Efficiency	45.2%	75.0%	20	$3.45	0.943	0.30	$0.282
Roof - High Reflectivity	57.5%	95.0%	15	$0.64	0.345	0.40	$0.171
Air-Cooled Chiller - Condenser Water Temperature Reset	0.0%	0.0%	10	$0.86	0.293	0.17	$0.364
Air-Cooled Chiller - Economizer	4.1%	48.8%	10	$0.02	0.232	5.20	$0.012
Air-Cooled Chiller - Thermal Energy Storage	44.5%	48.8%	15	$0.15	-	0.00	$0.000
Air-Cooled Chiller - VSD on Fans	0.0%	0.0%	15	$1.17	1.073	0.76	$0.101
Air-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.70	0.491	0.35	$0.178
Air-Cooled Chiller - Chilled Water Variable-Flow System	0.0%	0.0%	15	$0.35	0.079	0.19	$0.413
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	0.0%	0.0%	15	$1.22	-	0.00	$0.000
Air-Cooled Chiller - Maintenance	45.2%	90.0%	3	$0.97	0.437	0.06	$0.773
Air-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.080	1.57	$0.048
Water-Cooled Chiller - Condenser Water Temperature Reset	0.0%	0.0%	10	$0.86	0.072	0.04	$1.479
Water-Cooled Chiller - Economizer	4.1%	48.8%	10	$0.02	0.767	15.95	$0.004
Water-Cooled Chiller - Thermal Energy Storage	44.5%	48.8%	15	$0.15	-	0.00	$0.000
Water-Cooled Chiller - VSD on Fans	0.0%	0.0%	15	$1.17	-	0.00	$0.000
Water-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.70	0.729	0.48	$0.120
Water-Cooled Chiller - Chilled Water Variable-Flow System	0.0%	0.0%	15	$0.35	-	0.00	$0.000
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	0.0%	0.0%	15	$1.22	0.002	0.00	$71.064

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Water-Cooled Chiller - Maintenance	45.2%	90.0%	3	$0.97	0.419	0.05	$0.806
Water-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.080	1.57	$0.048
RTU - Evaporative Precooler	0.0%	13.0%	20	$3.00	2.347	0.86	$0.099
RTU - Maintenance	45.2%	90.0%	18	$0.15	0.673	4.34	$0.018
Space Heating - Heat Recovery Ventilator	44.5%	48.8%	15	$1,150.00	0.644	0.00	$164.853
Heat Pump - Maintenance	4.1%	95.0%	4	$0.03	2.405	13.57	$0.003
Ventilation - ECM on VAV Boxes	0.0%	0.0%	18	$0.22	0.387	1.69	$0.047
Ventilation - Variable Speed Control	0.0%	81.0%	15	$0.15	0.259	1.30	$0.054
Water Heater - Drainwater Heat Recovery	0.0%	50.0%	5	$0.04	0.080	0.47	$0.110
Water Heater - Faucet Aerators/Low Flow Nozzles	23.3%	90.0%	10	$0.01	0.036	2.81	$0.023
Water Heater - High Efficiency Circulation Pump	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Water Heater - Desuperheater	0.0%	50.0%	5	$0.04	0.179	1.03	$0.049
Water Heater - Solar System	0.0%	50.0%	20	$0.24	0.447	2.22	$0.042
Water Heater - Install Timer	9.6%	50.0%	15	$0.28	0.179	0.54	$0.145
Water Heater - Pipe Insulation	9.6%	50.0%	13	$5.22	0.050	0.01	$10.554
Water Heater - Tank Blanket/Insulation	40.4%	50.0%	7	$0.01	0.045	1.35	$0.042
Interior Lighting - Daylighting Controls	13.7%	50.0%	8	$3.27	0.873	0.08	$0.553
Interior Lighting - LED Exit Lighting	50.0%	85.5%	16	$0.02	0.006	0.25	$0.253
Interior Lighting - Occupancy Sensors	4.1%	56.3%	8	$0.08	0.291	1.04	$0.040
Interior Lighting - Timeclocks and Timers	4.1%	56.3%	8	$0.09	0.146	0.46	$0.090
Interior Lighting - Task Lighting	12.3%	75.0%	5	$0.24	0.302	0.15	$0.175
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.50	0.234	0.18	$0.316
Interior Fluorescent - Delamp and Install Reflectors	9.6%	30.0%	11	$0.50	0.199	0.23	$0.290
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.058	0.11	$0.514
Exterior Lighting - Daylighting Controls	17.0%	37.5%	8	$0.02	0.288	5.67	$0.010
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.173	0.04	$1.175
Refrigerator - Anti-Sweat Heater	0.0%	75.0%	12	$0.28	0.016	0.03	$1.932
Refrigerator - Decommissioning	50.0%	51.7%	9	$0.04	0.435	4.12	$0.012
Refrigerator - Demand Defrost	0.0%	75.0%	16	$0.20	0.024	0.08	$0.732
Refrigerator - Door Gasket Replacement	5.0%	75.0%	4	$4.24	0.035	0.00	$32.754
Refrigerator - Evaporator Fan Controls	0.0%	7.5%	16	$0.05	0.005	0.08	$0.853
Refrigerator - Floating Head Pressure	17.9%	37.5%	15	$0.03	0.034	0.62	$0.094
Refrigerator - Strip Curtain	5.0%	56.3%	4	$0.60	0.019	0.00	$8.358
Refrigerator - High Efficiency Compressor	10.0%	37.5%	15	$0.29	0.034	0.07	$0.791
Refrigerator - Variable Speed Compressor	10.0%	37.5%	15	$0.08	0.034	0.26	$0.227
Refrigerator - eCube	5.0%	75.0%	12	$0.01	0.097	3.51	$0.015
Vending Machine - Controller	2.0%	10.0%	5	$0.27	0.023	0.02	$2.595
Office Equipment - ENERGY STAR Power Supplies	10.0%	95.0%	4	$0.00	0.001	3.53	$0.020
Office Equipment - Plug Load Occupancy Sensors	7.1%	56.3%	8	$0.30	0.015	0.02	$2.939
Pool Heater - Solar	0.0%	33.8%	20	$0.24	-	0.00	$0.000
Pool Pump - Timer	0.0%	33.8%	10	$0.44	-	0.00	$0.000
Ventilation - CO2 Controlled	1.0%	15.0%	15	$0.65	0.276	0.33	$0.217
Non-HVAC Motors - Variable Speed Control	0.0%	37.5%	10	$0.10	-	0.00	$0.000
Energy Management System	8.2%	75.0%	15	$0.35	2.099	4.52	$0.015

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Thermostat - Clock/Programmable	43.8%	50.0%	11	$0.13	0.661	2.74	$0.023
HVAC - Occupancy Sensors	14.3%	56.3%	8	$0.14	0.701	1.88	$0.030
Commissioning - HVAC	0.0%	0.0%	0	$0.00	-	3.00	$0.000
Commissioning - Lighting	0.0%	0.0%	0	$0.00	-	2.00	$0.000
Retrocommissioning - HVAC	5.0%	36.0%	10	$0.75	1.194	0.76	$0.078
Retrocommissioning - Lighting	31.5%	36.5%	5	$0.10	0.320	0.56	$0.069
Advanced New Construction Designs	0.0%	0.0%	0	$0.00	-	6.00	$0.000
Custom Measures	10.0%	45.0%	15	$1.50	-	0.00	$0.000
PC Power Management Software	7.0%	90.0%	5	$0.02	0.105	1.84	$0.046
Pre-rinse Sprayer	23.0%	0.0%	5	$0.00	0.005	7.28	$0.008

Table C-34 Energy Efficiency Non-Equipment Data— Retail, New Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	7.0%	12.5%	20	$1.36	0.690	0.60	$0.152
Insulation - Ducting	0.0%	50.0%	20	$0.77	0.366	0.57	$0.162
Insulation - Radiant Barrier	7.0%	12.5%	15	$0.00	0.166	3.00	$0.000
Insulation - Wall Cavity	0.0%	67.5%	20	$0.40	0.318	0.94	$0.097
HVAC - Duct Repair and Sealing	25.0%	25.0%	18	$0.50	0.052	0.11	$0.786
Doors - High Efficiency	100.0%	100.0%	0	$0.00	-	3.00	$0.000
Windows - High Efficiency	72.7%	75.0%	20	$2.97	0.576	0.23	$0.398
Roof - High Reflectivity	63.6%	95.0%	15	$0.64	0.183	0.24	$0.323
Air-Cooled Chiller - Condenser Water Temperature Reset	0.0%	0.0%	10	$0.86	0.190	0.12	$0.561
Air-Cooled Chiller - Economizer	36.6%	48.8%	10	$0.02	0.353	11.15	$0.006
Air-Cooled Chiller - Thermal Energy Storage	44.5%	48.8%	15	$0.15	-	0.00	$0.000
Air-Cooled Chiller - VSD on Fans	0.0%	0.0%	15	$1.17	0.800	0.59	$0.135
Air-Cooled Chiller - Chilled Water Reset	10.0%	75.0%	10	$0.52	0.327	0.33	$0.199
Air-Cooled Chiller - Chilled Water Variable-Flow System	0.0%	0.0%	15	$0.23	0.111	0.41	$0.195
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	0.0%	0.0%	15	$0.91	-	0.00	$0.000
Air-Cooled Chiller - Maintenance	45.4%	90.0%	3	$0.64	0.264	0.06	$0.849
Air-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.077	1.57	$0.050
Water-Cooled Chiller - Condenser Water Temperature Reset	0.0%	0.0%	10	$0.86	0.036	0.02	$2.979
Water-Cooled Chiller - Economizer	36.6%	48.8%	10	$0.02	0.302	9.49	$0.007
Water-Cooled Chiller - Thermal Energy Storage	44.5%	48.8%	15	$0.15	-	0.00	$0.000
Water-Cooled Chiller - VSD on Fans	0.0%	0.0%	15	$1.17	-	0.00	$0.000
Water-Cooled Chiller - Chilled Water Reset	10.0%	75.0%	10	$0.52	0.449	0.45	$0.145
Water-Cooled Chiller - Chilled Water Variable-Flow System	0.0%	0.0%	15	$0.23	-	0.00	$0.000
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	0.0%	0.0%	15	$0.91	0.003	0.00	$31.064
Water-Cooled Chiller - Maintenance	45.4%	90.0%	3	$0.64	0.264	0.06	$0.851
Water-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.077	1.57	$0.050
RTU - Evaporative Precooler	0.0%	13.0%	20	$3.00	1.851	0.76	$0.125
RTU - Maintenance	45.4%	90.0%	18	$0.15	0.405	2.93	$0.030
Space Heating - Heat Recovery Ventilator	44.5%	48.8%	15	$1,150.00	0.590	0.00	$180.017
Heat Pump - Maintenance	0.0%	95.0%	4	$0.03	0.410	2.53	$0.020
Ventilation - ECM on VAV Boxes	0.0%	0.0%	18	$0.22	0.319	1.57	$0.057

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Ventilation - Variable Speed Control	0.0%	81.0%	15	$0.11	0.188	1.42	$0.056
Water Heater - Drainwater Heat Recovery	0.0%	50.0%	5	$0.04	0.077	0.46	$0.114
Water Heater - Faucet Aerators/Low Flow Nozzles	36.4%	90.0%	10	$0.00	0.034	3.75	$0.018
Water Heater - High Efficiency Circulation Pump	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Water Heater - Desuperheater	0.0%	50.0%	5	$0.04	0.171	1.02	$0.052
Water Heater - Solar System	0.0%	50.0%	20	$0.24	0.428	2.22	$0.044
Water Heater - Install Timer	50.0%	50.0%	15	$0.28	0.171	0.54	$0.151
Water Heater - Pipe Insulation	50.0%	50.0%	13	$5.22	0.048	0.01	$11.007
Water Heater - Tank Blanket/Insulation	40.4%	50.0%	7	$0.01	0.039	1.63	$0.036
Interior Lighting - Daylighting Controls	75.0%	75.0%	8	$2.82	0.447	0.06	$0.932
Interior Lighting - LED Exit Lighting	85.5%	85.5%	16	$0.01	0.003	0.26	$0.368
Interior Lighting - Occupancy Sensors	56.3%	56.3%	8	$0.06	0.149	1.00	$0.058
Interior Lighting - Timeclocks and Timers	56.3%	56.3%	8	$0.07	0.075	0.45	$0.131
Interior Lighting - Task Lighting	18.2%	75.0%	5	$0.24	0.155	0.14	$0.342
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.50	0.209	0.17	$0.354
Interior Fluorescent - Delamp and Install Reflectors	9.1%	30.0%	11	$0.50	-	0.00	$0.000
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.070	0.13	$0.425
Exterior Lighting - Daylighting Controls	17.0%	37.5%	8	$0.02	0.348	6.56	$0.008
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.209	0.05	$0.970
Refrigerator - Anti-Sweat Heater	0.0%	75.0%	12	$0.21	0.016	0.05	$1.439
Refrigerator - Decommissioning	50.0%	51.7%	9	$0.03	0.258	4.11	$0.015
Refrigerator - Demand Defrost	0.0%	75.0%	16	$0.20	0.014	0.07	$1.237
Refrigerator - Door Gasket Replacement	5.0%	75.0%	4	$3.66	0.026	0.00	$38.546
Refrigerator - Evaporator Fan Controls	0.0%	7.5%	16	$0.03	0.003	0.09	$1.074
Refrigerator - Floating Head Pressure	17.9%	37.5%	15	$0.03	0.020	0.66	$0.119
Refrigerator - Strip Curtain	5.0%	56.3%	4	$0.52	0.011	0.00	$12.191
Refrigerator - High Efficiency Compressor	10.0%	37.5%	15	$0.29	0.020	0.06	$1.337
Refrigerator - Variable Speed Compressor	10.0%	37.5%	15	$0.06	0.020	0.28	$0.286
Refrigerator - eCube	5.0%	75.0%	12	$0.01	0.057	2.47	$0.028
Vending Machine - Controller	2.0%	10.0%	5	$0.27	0.016	0.01	$3.655
Office Equipment - ENERGY STAR Power Supplies	10.0%	95.0%	4	$0.00	0.001	3.74	$0.020
Office Equipment - Plug Load Occupancy Sensors	7.1%	56.3%	8	$0.25	0.015	0.02	$2.467
Pool Heater - Solar	0.0%	33.8%	20	$0.24	-	0.00	$0.000
Pool Pump - Timer	33.8%	33.8%	10	$0.44	-	0.00	$0.000
Ventilation - CO2 Controlled	11.5%	15.0%	15	$0.65	0.223	0.30	$0.269
Non-HVAC Motors - Variable Speed Control	0.0%	37.5%	10	$0.10	-	0.00	$0.000
Energy Management System	0.0%	75.0%	15	$0.35	1.463	3.45	$0.022
Thermostat - Clock/Programmable	50.0%	50.0%	11	$0.13	0.711	3.09	$0.021
HVAC - Occupancy Sensors	56.3%	56.3%	8	$0.14	0.616	1.72	$0.034
Commissioning - HVAC	0.0%	0.0%	25	$1.25	1.023	1.28	$0.083
Commissioning - Lighting	0.0%	0.0%	25	$0.20	0.184	1.46	$0.074
Retrocommissioning - HVAC	0.0%	0.0%	10	$0.75	-	0.00	$0.000
Retrocommissioning - Lighting	0.0%	0.0%	0	$0.00	-	2.00	$0.000
Advanced New Construction Designs	0.0%	0.0%	25	$2.00	4.628	3.63	$0.030
Custom Measures	10.0%	45.0%	15	$1.50	-	0.00	$0.000
PC Power Management Software	7.0%	90.0%	5	$0.02	0.105	1.87	$0.046

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Pre-rinse Sprayer	36.0%	0.0%	5	$0.00	0.005	7.51	$0.008

Table C-35 Energy Efficiency Non-Equipment Data— Grocery, Existing Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	7.0%	12.5%	20	$0.85	1.567	2.06	$0.042
Insulation - Ducting	33.3%	50.0%	20	$0.77	0.124	0.25	$0.477
Insulation - Radiant Barrier	0.0%	12.5%	15	$0.00	0.615	3.00	$0.000
Insulation - Wall Cavity	11.1%	67.5%	20	$0.86	8.468	11.00	$0.008
HVAC - Duct Repair and Sealing	5.0%	25.0%	18	$0.50	0.046	0.20	$0.895
Doors - High Efficiency	0.0%	0.0%	0	$0.00	-	3.00	$0.000
Windows - High Efficiency	33.3%	75.0%	20	$2.24	0.643	0.33	$0.269
Roof - High Reflectivity	66.7%	95.0%	15	$0.64	1.344	1.59	$0.044
Air-Cooled Chiller - Condenser Water Temperature Reset	0.0%	0.0%	10	$0.86	0.527	0.31	$0.202
Air-Cooled Chiller - Economizer	0.0%	48.8%	10	$0.01	0.794	59.26	$0.001
Air-Cooled Chiller - Thermal Energy Storage	44.5%	48.8%	15	$0.15	-	0.11	$0.000
Air-Cooled Chiller - VSD on Fans	0.0%	0.0%	15	$1.17	1.931	1.31	$0.056
Air-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.21	0.884	2.09	$0.029
Air-Cooled Chiller - Chilled Water Variable-Flow System	0.0%	0.0%	15	$0.10	0.142	1.22	$0.068
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	0.0%	0.0%	15	$0.36	-	0.04	$0.000
Air-Cooled Chiller - Maintenance	33.3%	90.0%	3	$0.28	0.783	0.36	$0.127
Air-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.219	4.63	$0.018
Water-Cooled Chiller - Condenser Water Temperature Reset	0.0%	0.0%	10	$0.86	0.130	0.08	$0.822
Water-Cooled Chiller - Economizer	0.0%	48.8%	10	$0.01	1.620	117.34	$0.001
Water-Cooled Chiller - Thermal Energy Storage	44.5%	48.8%	15	$0.15	-	0.11	$0.000
Water-Cooled Chiller - VSD on Fans	0.0%	0.0%	15	$1.17	-	0.01	$0.000
Water-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.21	1.313	3.03	$0.020
Water-Cooled Chiller - Chilled Water Variable-Flow System	0.0%	0.0%	15	$0.10	-	0.15	$0.000
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	0.0%	0.0%	15	$0.36	0.003	0.05	$11.652
Water-Cooled Chiller - Maintenance	33.3%	90.0%	3	$0.28	0.751	0.34	$0.133
Water-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.219	4.63	$0.018
RTU - Evaporative Precooler	0.0%	18.0%	20	$3.00	4.224	1.53	$0.055
RTU - Maintenance	33.3%	90.0%	18	$0.15	1.204	7.76	$0.010
Space Heating - Heat Recovery Ventilator	44.5%	48.8%	15	$1,150.00	0.771	0.00	$137.868
Heat Pump - Maintenance	0.0%	95.0%	4	$0.03	1.710	10.19	$0.005
Ventilation - ECM on VAV Boxes	0.0%	0.0%	18	$0.22	0.058	0.34	$0.309
Ventilation - Variable Speed Control	0.0%	81.0%	15	$0.05	0.950	16.46	$0.004
Water Heater - Drainwater Heat Recovery	0.0%	50.0%	5	$0.04	0.219	1.40	$0.040
Water Heater - Faucet Aerators/Low Flow Nozzles	22.2%	90.0%	10	$0.00	0.097	31.29	$0.002
Water Heater - High Efficiency Circulation Pump	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Water Heater - Desuperheater	0.0%	50.0%	5	$0.04	0.486	2.93	$0.018
Water Heater - Solar System	0.0%	50.0%	20	$0.19	1.214	7.79	$0.012

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Water Heater - Install Timer	22.2%	50.0%	15	$0.28	0.486	1.53	$0.053
Water Heater - Pipe Insulation	22.2%	50.0%	13	$5.22	0.137	0.02	$3.872
Water Heater - Tank Blanket/Insulation	40.4%	50.0%	7	$0.00	0.121	14.69	$0.005
Interior Lighting - Daylighting Controls	22.2%	50.0%	8	$2.13	0.926	0.14	$0.340
Interior Lighting - LED Exit Lighting	50.0%	85.5%	16	$0.00	0.006	3.85	$0.070
Interior Lighting - Occupancy Sensors	0.0%	56.3%	8	$0.02	0.309	4.58	$0.011
Interior Lighting - Timeclocks and Timers	11.1%	56.3%	8	$0.03	0.154	2.18	$0.025
Interior Lighting - Task Lighting	0.0%	75.0%	5	$0.24	0.320	0.17	$0.165
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.50	0.621	0.50	$0.119
Interior Fluorescent - Delamp and Install Reflectors	44.4%	49.4%	11	$0.55	0.527	0.56	$0.120
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.028	0.08	$1.075
Exterior Lighting - Daylighting Controls	31.0%	37.5%	8	$0.02	0.138	2.44	$0.021
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.083	0.02	$2.456
Refrigerator - Anti-Sweat Heater	0.0%	75.0%	12	$0.08	0.635	3.82	$0.014
Refrigerator - Decommissioning	50.0%	51.7%	9	$0.01	6.194	206.04	$0.000
Refrigerator - Demand Defrost	0.0%	75.0%	16	$0.20	0.344	1.26	$0.051
Refrigerator - Door Gasket Replacement	5.0%	75.0%	4	$5.01	0.795	0.03	$1.694
Refrigerator - Evaporator Fan Controls	0.0%	7.5%	16	$0.01	0.069	4.46	$0.018
Refrigerator - Floating Head Pressure	17.9%	37.5%	15	$0.01	0.482	31.69	$0.002
Refrigerator - Strip Curtain	5.0%	56.3%	4	$0.39	0.275	0.11	$0.382
Refrigerator - High Efficiency Compressor	10.0%	37.5%	15	$0.29	0.482	1.11	$0.056
Refrigerator - Variable Speed Compressor	10.0%	37.5%	15	$0.02	0.482	13.13	$0.005
Refrigerator - eCube	5.0%	75.0%	12	$0.17	1.376	4.08	$0.013
Vending Machine - Controller	2.0%	10.0%	5	$0.27	0.047	0.05	$1.277
Office Equipment - ENERGY STAR Power Supplies	10.0%	95.0%	4	$0.00	0.001	46.08	$0.021
Office Equipment - Plug Load Occupancy Sensors	7.1%	56.3%	8	$0.30	0.014	0.05	$3.079
Pool Heater - Solar	0.0%	33.8%	20	$0.19	-	0.12	$0.000
Pool Pump - Timer	0.0%	33.8%	10	$0.44	-	0.03	$0.000
Ventilation - CO2 Controlled	1.0%	15.0%	15	$0.65	0.579	0.70	$0.104
Non-HVAC Motors - Variable Speed Control	0.0%	37.5%	10	$0.10	-	0.11	$0.000
Energy Management System	0.0%	50.0%	15	$0.35	3.263	7.21	$0.010
Thermostat - Clock/Programmable	33.3%	50.0%	11	$0.13	1.236	5.29	$0.012
HVAC - Occupancy Sensors	14.3%	56.3%	8	$0.14	0.945	2.69	$0.022
Commissioning - HVAC	0.0%	0.0%	0	$0.00	-	3.00	$0.000
Commissioning - Lighting	0.0%	0.0%	0	$0.00	-	2.00	$0.000
Retrocommissioning - HVAC	5.0%	24.0%	10	$0.75	1.801	1.17	$0.052
Retrocommissioning - Lighting	55.6%	60.6%	5	$0.10	0.322	0.70	$0.068
Advanced New Construction Designs	0.0%	0.0%	0	$0.00	-	6.00	$0.000
Custom Measures	10.0%	45.0%	15	$1.50	-	0.04	$0.000
PC Power Management Software	7.0%	90.0%	5	$0.02	0.100	1.93	$0.042
Pre-rinse Sprayer	22.0%	10.0%	5	$0.01	0.184	7.27	$0.008

Table C-36 Energy Efficiency Non-Equipment Data— Grocery, New Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	7.0%	12.5%	20	$0.85	1.503	2.15	$0.044
Insulation - Ducting	33.3%	50.0%	20	$0.77	0.776	1.26	$0.077
Insulation - Radiant Barrier	0.0%	12.5%	15	$0.00	0.511	3.00	$0.000
Insulation - Wall Cavity	11.1%	67.5%	20	$0.97	2.828	3.47	$0.026
HVAC - Duct Repair and Sealing	25.0%	25.0%	18	$0.50	0.026	0.17	$1.607
Doors - High Efficiency	100.0%	100.0%	0	$0.00	-	3.00	$0.000
Windows - High Efficiency	33.3%	75.0%	20	$2.24	1.142	0.63	$0.151
Roof - High Reflectivity	66.7%	95.0%	15	$0.64	0.832	1.13	$0.071
Air-Cooled Chiller - Condenser Water Temperature Reset	0.0%	0.0%	10	$0.86	0.331	0.22	$0.322
Air-Cooled Chiller - Economizer	36.6%	48.8%	10	$0.01	0.625	51.45	$0.001
Air-Cooled Chiller - Thermal Energy Storage	44.5%	48.8%	15	$0.15	-	0.12	$0.000
Air-Cooled Chiller - VSD on Fans	0.0%	0.0%	15	$1.17	1.395	1.05	$0.077
Air-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.21	0.570	1.49	$0.045
Air-Cooled Chiller - Chilled Water Variable-Flow System	0.0%	0.0%	15	$0.09	0.194	2.00	$0.044
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	0.0%	0.0%	15	$0.36	-	0.05	$0.000
Air-Cooled Chiller - Maintenance	33.3%	90.0%	3	$0.25	0.450	0.25	$0.198
Air-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.210	4.56	$0.018
Water-Cooled Chiller - Condenser Water Temperature Reset	0.0%	0.0%	10	$0.86	0.064	0.05	$1.655
Water-Cooled Chiller - Economizer	36.6%	48.8%	10	$0.01	1.345	108.37	$0.001
Water-Cooled Chiller - Thermal Energy Storage	44.5%	48.8%	15	$0.15	-	0.12	$0.000
Water-Cooled Chiller - VSD on Fans	0.0%	0.0%	15	$1.17	-	0.01	$0.000
Water-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.21	0.808	2.09	$0.032
Water-Cooled Chiller - Chilled Water Variable-Flow System	0.0%	0.0%	15	$0.09	-	0.18	$0.000
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	0.0%	0.0%	15	$0.36	0.005	0.06	$6.838
Water-Cooled Chiller - Maintenance	33.3%	90.0%	3	$0.25	0.463	0.26	$0.192
Water-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.210	4.56	$0.018
RTU - Evaporative Precooler	0.0%	14.0%	20	$3.00	3.272	1.36	$0.071
RTU - Maintenance	33.3%	90.0%	18	$0.15	0.699	5.19	$0.018
Space Heating - Heat Recovery Ventilator	44.5%	48.8%	15	$1,150.00	0.676	0.00	$157.086
Heat Pump - Maintenance	0.0%	95.0%	4	$0.03	1.499	9.74	$0.005
Ventilation - ECM on VAV Boxes	0.0%	0.0%	18	$0.22	0.004	0.11	$4.933
Ventilation - Variable Speed Control	0.0%	81.0%	15	$0.05	0.651	12.85	$0.006
Water Heater - Drainwater Heat Recovery	0.0%	50.0%	5	$0.04	0.210	1.37	$0.042
Water Heater - Faucet Aerators/Low Flow Nozzles	22.2%	90.0%	10	$0.00	0.093	30.90	$0.003
Water Heater - High Efficiency Circulation Pump	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Water Heater - Desuperheater	0.0%	50.0%	5	$0.04	0.466	2.86	$0.019
Water Heater - Solar System	0.0%	50.0%	20	$0.19	1.166	7.65	$0.013
Water Heater - Install Timer	50.0%	50.0%	15	$0.28	0.466	1.50	$0.055
Water Heater - Pipe Insulation	50.0%	50.0%	13	$5.22	0.132	0.02	$4.034
Water Heater - Tank Blanket/Insulation	40.4%	50.0%	7	$0.00	0.105	13.25	$0.005
Interior Lighting - Daylighting Controls	75.0%	75.0%	8	$2.13	0.429	0.08	$0.732
Interior Lighting - LED Exit Lighting	85.5%	85.5%	16	$0.00	0.003	4.05	$0.152
Interior Lighting - Occupancy Sensors	56.3%	56.3%	8	$0.02	0.143	2.74	$0.024
Interior Lighting - Timeclocks and	56.3%	56.3%	8	$0.03	0.072	1.39	$0.054

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Timers							
Interior Lighting - Task Lighting	0.0%	75.0%	5	$0.24	0.148	0.16	$0.356
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.50	0.578	0.46	$0.128
Interior Fluorescent - Delamp and Install Reflectors	44.4%	49.4%	11	$0.55	-	0.02	$0.000
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.014	0.08	$2.090
Exterior Lighting - Daylighting Controls	31.0%	37.5%	8	$0.02	0.071	1.89	$0.042
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.042	0.02	$4.777
Refrigerator - Anti-Sweat Heater	0.0%	75.0%	12	$0.08	0.635	5.20	$0.014
Refrigerator - Decommissioning	50.0%	51.7%	9	$0.01	3.665	153.88	$0.000
Refrigerator - Demand Defrost	0.0%	75.0%	16	$0.20	0.204	1.05	$0.087
Refrigerator - Door Gasket Replacement	5.0%	75.0%	4	$5.01	0.677	0.03	$1.989
Refrigerator - Evaporator Fan Controls	0.0%	7.5%	16	$0.01	0.041	4.10	$0.030
Refrigerator - Floating Head Pressure	17.9%	37.5%	15	$0.01	0.285	25.91	$0.003
Refrigerator - Strip Curtain	5.0%	56.3%	4	$0.39	0.163	0.09	$0.646
Refrigerator - High Efficiency Compressor	10.0%	37.5%	15	$0.29	0.285	0.91	$0.094
Refrigerator - Variable Speed Compressor	10.0%	37.5%	15	$0.02	0.285	10.74	$0.008
Refrigerator - eCube	5.0%	75.0%	12	$0.24	0.814	2.29	$0.032
Vending Machine - Controller	2.0%	10.0%	5	$0.27	0.022	0.04	$2.663
Office Equipment - ENERGY STAR Power Supplies	10.0%	95.0%	4	$0.00	0.001	48.99	$0.021
Office Equipment - Plug Load Occupancy Sensors	7.1%	56.3%	8	$0.25	0.014	0.06	$2.584
Pool Heater - Solar	0.0%	33.8%	20	$0.19	-	0.12	$0.000
Pool Pump - Timer	33.8%	33.8%	10	$0.44	-	0.03	$0.000
Ventilation - CO2 Controlled	11.5%	15.0%	15	$0.65	0.427	0.59	$0.141
Non-HVAC Motors - Variable Speed Control	0.0%	37.5%	10	$0.10	-	0.12	$0.000
Energy Management System	0.0%	50.0%	15	$0.35	2.273	5.60	$0.014
Thermostat - Clock/Programmable	50.0%	50.0%	11	$0.13	0.638	3.07	$0.023
HVAC - Occupancy Sensors	56.3%	56.3%	8	$0.14	0.793	2.40	$0.026
Commissioning - HVAC	0.0%	0.0%	25	$1.25	1.464	1.90	$0.058
Commissioning - Lighting	0.0%	0.0%	25	$0.20	0.150	1.44	$0.091
Retrocommissioning - HVAC	0.0%	0.0%	10	$0.75	-	0.05	$0.000
Retrocommissioning - Lighting	0.0%	0.0%	0	$0.00	-	2.00	$0.000
Advanced New Construction Designs	0.0%	0.0%	25	$2.00	6.445	5.14	$0.021
Custom Measures	10.0%	45.0%	15	$1.50	-	0.04	$0.000
PC Power Management Software	7.0%	90.0%	5	$0.02	0.100	1.97	$0.042
Pre-rinse Sprayer	22.0%	10.0%	5	$0.01	0.184	7.39	$0.008

Table C-37 Energy Efficiency Non-Equipment Data— College, Existing Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	2.0%	12.5%	20	$1.04	0.377	0.42	$0.212
Insulation - Ducting	55.5%	60.5%	20	$0.77	0.520	0.77	$0.114
Insulation - Radiant Barrier	2.0%	12.5%	15	$0.00	0.140	3.00	$0.000
Insulation - Wall Cavity	44.5%	67.5%	20	$0.53	0.587	1.26	$0.069
HVAC - Duct Repair and Sealing	5.0%	25.0%	18	$0.50	0.940	1.84	$0.044
Doors - High Efficiency	0.0%	0.0%	0	$0.00	-	3.00	$0.000
Windows - High Efficiency	44.5%	100.0%	20	$3.39	0.622	0.21	$0.420
Roof - High Reflectivity	22.2%	95.0%	15	$0.64	0.231	0.30	$0.256
Air-Cooled Chiller - Condenser Water	30.0%	75.0%	10	$0.09	0.357	1.98	$0.031

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Temperature Reset							
Air-Cooled Chiller - Economizer	11.1%	81.0%	10	$0.01	0.065	6.86	$0.010
Air-Cooled Chiller - Thermal Energy Storage	73.4%	81.0%	15	$0.15	-	0.06	$0.000
Air-Cooled Chiller - VSD on Fans	3.0%	75.0%	15	$1.17	1.717	1.16	$0.063
Air-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.17	0.468	1.35	$0.046
Air-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	15	$0.07	0.098	1.22	$0.067
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	25.0%	36.9%	15	$0.30	0.087	0.26	$0.317
Air-Cooled Chiller - Maintenance	44.5%	90.0%	3	$0.19	0.700	0.47	$0.096
Air-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.160	3.32	$0.024
Water-Cooled Chiller - Condenser Water Temperature Reset	30.0%	75.0%	10	$0.09	0.288	1.63	$0.039
Water-Cooled Chiller - Economizer	11.1%	81.0%	10	$0.01	0.190	18.13	$0.004
Water-Cooled Chiller - Thermal Energy Storage	73.4%	81.0%	15	$0.15	-	0.06	$0.000
Water-Cooled Chiller - VSD on Fans	3.0%	75.0%	15	$1.17	0.320	0.23	$0.338
Water-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.17	0.449	1.31	$0.047
Water-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	15	$0.07	0.094	1.19	$0.069
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	25.0%	36.9%	15	$0.30	0.003	0.04	$10.828
Water-Cooled Chiller - Maintenance	44.5%	90.0%	3	$0.19	0.672	0.46	$0.100
Water-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.160	3.32	$0.024
RTU - Evaporative Precooler	0.0%	5.4%	20	$3.00	2.054	0.76	$0.113
RTU - Maintenance	44.5%	90.0%	18	$0.15	0.589	3.86	$0.021
Space Heating - Heat Recovery Ventilator	73.4%	81.0%	15	$1,150.00	0.884	0.00	$120.173
Heat Pump - Maintenance	33.3%	95.0%	4	$0.06	2.432	6.88	$0.007
Ventilation - ECM on VAV Boxes	0.0%	0.0%	18	$0.22	0.397	1.80	$0.046
Ventilation - Variable Speed Control	0.0%	81.0%	15	$0.04	0.521	11.08	$0.007
Water Heater - Drainwater Heat Recovery	0.0%	50.0%	5	$0.04	0.160	1.00	$0.055
Water Heater - Faucet Aerators/Low Flow Nozzles	55.5%	90.0%	10	$0.00	0.071	26.44	$0.003
Water Heater - High Efficiency Circulation Pump	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Water Heater - Desuperheater	0.0%	50.0%	5	$0.04	0.356	2.12	$0.025
Water Heater - Solar System	0.0%	50.0%	20	$0.06	0.890	17.13	$0.006
Water Heater - Install Timer	44.5%	49.5%	15	$0.28	0.356	1.11	$0.073
Water Heater - Pipe Insulation	44.5%	49.5%	13	$5.22	0.101	0.02	$5.285
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	7	$0.00	0.089	12.48	$0.005
Interior Lighting - Daylighting Controls	0.0%	10.0%	8	$3.22	0.502	0.06	$0.947
Interior Lighting - LED Exit Lighting	50.0%	85.5%	16	$0.00	0.003	2.94	$0.108
Interior Lighting - Occupancy Sensors	11.1%	56.3%	8	$0.02	0.167	3.44	$0.017
Interior Lighting - Timeclocks and Timers	0.0%	56.3%	8	$0.02	0.084	1.64	$0.038
Interior Lighting - Task Lighting	11.1%	75.0%	5	$0.24	0.174	0.15	$0.305
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.20	0.277	0.57	$0.107
Interior Fluorescent - Delamp and Install Reflectors	55.5%	60.5%	11	$0.50	0.235	0.29	$0.245
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.012	0.04	$2.373
Exterior Lighting - Daylighting Controls	6.0%	37.5%	8	$0.02	0.062	1.12	$0.047
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.037	0.01	$5.423

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Refrigerator - Anti-Sweat Heater	0.0%	75.0%	12	$0.07	0.006	0.12	$1.305
Refrigerator - Decommissioning	50.0%	51.7%	9	$0.01	0.157	6.56	$0.008
Refrigerator - Demand Defrost	0.0%	75.0%	16	$0.20	0.009	0.07	$2.023
Refrigerator - Door Gasket Replacement	5.0%	75.0%	4	$3.07	0.014	0.00	$60.457
Refrigerator - Evaporator Fan Controls	0.0%	7.5%	16	$0.01	0.002	0.74	$0.576
Refrigerator - Floating Head Pressure	38.0%	45.0%	15	$0.01	0.012	1.72	$0.064
Refrigerator - Strip Curtain	5.0%	56.3%	4	$0.59	0.007	0.01	$22.746
Refrigerator - High Efficiency Compressor	10.0%	37.5%	15	$0.29	0.012	0.05	$2.187
Refrigerator - Variable Speed Compressor	10.0%	37.5%	15	$0.02	0.012	0.71	$0.153
Refrigerator - eCube	5.0%	75.0%	12	$0.00	0.035	8.68	$0.008
Vending Machine - Controller	2.0%	10.0%	5	$0.27	0.008	0.02	$7.174
Office Equipment - ENERGY STAR Power Supplies	10.0%	95.0%	4	$0.00	0.004	31.08	$0.008
Office Equipment - Plug Load Occupancy Sensors	41.7%	56.3%	8	$0.28	0.039	0.07	$1.048
Pool Heater - Solar	0.0%	33.8%	20	$0.06	0.003	0.25	$1.883
Pool Pump - Timer	11.1%	33.8%	10	$0.44	0.003	0.02	$17.453
Ventilation - CO2 Controlled	1.0%	7.5%	15	$0.65	0.163	0.21	$0.368
Non-HVAC Motors - Variable Speed Control	11.1%	37.5%	10	$0.10	-	0.06	$0.000
Energy Management System	44.5%	90.0%	15	$0.35	1.396	3.15	$0.023
Thermostat - Clock/Programmable	44.5%	50.0%	11	$0.13	0.447	1.95	$0.034
HVAC - Occupancy Sensors	14.3%	56.3%	8	$0.14	0.881	2.40	$0.024
Commissioning - HVAC	0.0%	0.0%	0	$0.00	-	3.00	$0.000
Commissioning - Lighting	0.0%	0.0%	0	$0.00	-	2.00	$0.000
Retrocommissioning - HVAC	5.0%	36.0%	10	$0.75	1.390	0.89	$0.067
Retrocommissioning - Lighting	66.7%	71.7%	5	$0.05	0.174	0.86	$0.063
Advanced New Construction Designs	0.0%	0.0%	0	$0.00	-	6.00	$0.000
Custom Measures	10.0%	45.0%	15	$0.67	-	0.05	$0.000
PC Power Management Software	42.0%	90.0%	5	$0.13	0.275	1.24	$0.102
Pre-rinse Sprayer	56.0%	10.0%	5	$0.00	0.102	7.27	$0.008

Table C-38 Energy Efficiency Non-Equipment Data— College, New Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	2.0%	12.5%	20	$1.36	0.259	0.24	$0.405
Insulation - Ducting	55.5%	60.5%	20	$0.77	0.909	1.38	$0.065
Insulation - Radiant Barrier	2.0%	12.5%	15	$0.00	0.084	3.00	$0.000
Insulation - Wall Cavity	44.5%	67.5%	20	$0.34	0.385	1.47	$0.067
HVAC - Duct Repair and Sealing	25.0%	25.0%	18	$0.50	0.830	1.70	$0.049
Doors - High Efficiency	100.0%	100.0%	0	$0.00	-	3.00	$0.000
Windows - High Efficiency	44.5%	100.0%	20	$3.39	0.945	0.33	$0.277
Roof - High Reflectivity	22.2%	95.0%	15	$0.64	0.158	0.24	$0.373
Air-Cooled Chiller - Condenser Water Temperature Reset	60.0%	75.0%	10	$0.09	0.226	1.39	$0.049
Air-Cooled Chiller - Economizer	63.5%	81.0%	10	$0.01	0.566	55.45	$0.001
Air-Cooled Chiller - Thermal Energy Storage	73.4%	81.0%	15	$0.15	-	0.06	$0.000
Air-Cooled Chiller - VSD on Fans	3.0%	75.0%	15	$1.17	1.284	0.96	$0.084
Air-Cooled Chiller - Chilled Water Reset	25.0%	75.0%	10	$0.17	0.297	0.94	$0.072
Air-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	15	$0.15	0.099	0.65	$0.137
Air-Cooled Chiller - High Efficiency	25.0%	36.9%	15	$0.30	0.175	0.54	$0.157

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Cooling Tower Fans							
Air-Cooled Chiller - Maintenance	44.5%	90.0%	3	$0.40	0.440	0.15	$0.318
Air-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.154	3.27	$0.025
Water-Cooled Chiller - Condenser Water Temperature Reset	60.0%	75.0%	10	$0.09	0.130	0.82	$0.086
Water-Cooled Chiller - Economizer	63.5%	81.0%	10	$0.01	0.127	13.38	$0.005
Water-Cooled Chiller - Thermal Energy Storage	73.4%	81.0%	15	$0.15	-	0.06	$0.000
Water-Cooled Chiller - VSD on Fans	3.0%	75.0%	15	$1.17	0.276	0.21	$0.391
Water-Cooled Chiller - Chilled Water Reset	25.0%	75.0%	10	$0.17	0.374	1.17	$0.057
Water-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	15	$0.15	0.095	0.63	$0.142
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	25.0%	36.9%	15	$0.30	0.004	0.04	$6.584
Water-Cooled Chiller - Maintenance	44.5%	90.0%	3	$0.40	0.423	0.15	$0.331
Water-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.154	3.27	$0.025
RTU - Evaporative Precooler	0.0%	3.2%	20	$3.00	1.641	0.68	$0.141
RTU - Maintenance	44.5%	90.0%	18	$0.15	0.373	2.77	$0.033
Space Heating - Heat Recovery Ventilator	73.4%	81.0%	15	$1,150.00	0.802	0.00	$132.535
Heat Pump - Maintenance	33.3%	95.0%	4	$0.06	0.799	2.60	$0.020
Ventilation - ECM on VAV Boxes	0.0%	0.0%	18	$0.22	0.274	1.40	$0.066
Ventilation - Variable Speed Control	0.0%	81.0%	15	$0.04	0.366	8.74	$0.009
Water Heater - Drainwater Heat Recovery	0.0%	50.0%	5	$0.04	0.154	0.98	$0.057
Water Heater - Faucet Aerators/Low Flow Nozzles	55.5%	90.0%	10	$0.00	0.068	26.05	$0.003
Water Heater - High Efficiency Circulation Pump	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Water Heater - Desuperheater	0.0%	50.0%	5	$0.04	0.342	2.07	$0.026
Water Heater - Solar System	0.0%	50.0%	20	$0.06	0.854	16.84	$0.006
Water Heater - Install Timer	49.5%	49.5%	15	$0.28	0.342	1.09	$0.076
Water Heater - Pipe Insulation	49.5%	49.5%	13	$5.22	0.097	0.01	$5.506
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	7	$0.00	0.079	11.53	$0.006
Interior Lighting - Daylighting Controls	15.0%	15.0%	8	$3.22	0.444	0.06	$1.071
Interior Lighting - LED Exit Lighting	85.5%	85.5%	16	$0.00	0.003	3.04	$0.122
Interior Lighting - Occupancy Sensors	56.3%	56.3%	8	$0.02	0.148	3.24	$0.019
Interior Lighting - Timeclocks and Timers	56.3%	56.3%	8	$0.02	0.074	1.56	$0.043
Interior Lighting - Task Lighting	11.1%	75.0%	5	$0.24	0.154	0.15	$0.345
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.20	0.252	0.52	$0.118
Interior Fluorescent - Delamp and Install Reflectors	55.5%	60.5%	11	$0.50	-	0.01	$0.000
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.005	0.04	$5.747
Exterior Lighting - Daylighting Controls	6.0%	37.5%	8	$0.02	0.026	0.78	$0.115
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.015	0.01	$13.135
Refrigerator - Anti-Sweat Heater	0.0%	75.0%	12	$0.07	0.006	0.17	$1.305
Refrigerator - Decommissioning	50.0%	51.7%	9	$0.01	0.093	5.15	$0.013
Refrigerator - Demand Defrost	0.0%	75.0%	16	$0.20	0.005	0.07	$3.420
Refrigerator - Door Gasket Replacement	5.0%	75.0%	4	$3.07	0.010	0.00	$84.296
Refrigerator - Evaporator Fan Controls	0.0%	7.5%	16	$0.01	0.001	0.93	$0.974
Refrigerator - Floating Head Pressure	38.0%	45.0%	15	$0.01	0.007	1.80	$0.107
Refrigerator - Strip Curtain	5.0%	56.3%	4	$0.59	0.004	0.01	$38.442

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Refrigerator - High Efficiency Compressor	10.0%	37.5%	15	$0.29	0.007	0.05	$3.697
Refrigerator - Variable Speed Compressor	10.0%	37.5%	15	$0.02	0.007	0.75	$0.259
Refrigerator - eCube	5.0%	75.0%	12	$0.00	0.021	7.16	$0.015
Vending Machine - Controller	2.0%	10.0%	5	$0.27	0.006	0.01	$10.130
Office Equipment - ENERGY STAR Power Supplies	10.0%	95.0%	4	$0.00	0.004	32.13	$0.008
Office Equipment - Plug Load Occupancy Sensors	41.7%	56.3%	8	$0.25	0.039	0.08	$0.943
Pool Heater - Solar	0.0%	33.8%	20	$0.06	0.003	0.25	$1.826
Pool Pump - Timer	33.8%	33.8%	10	$0.44	0.003	0.02	$16.930
Ventilation - CO2 Controlled	5.9%	7.5%	15	$0.65	0.132	0.19	$0.453
Non-HVAC Motors - Variable Speed Control	11.1%	37.5%	10	$0.10	-	0.06	$0.000
Energy Management System	44.5%	90.0%	15	$0.35	1.256	3.06	$0.026
Thermostat - Clock/Programmable	50.0%	50.0%	11	$0.13	0.380	1.77	$0.039
HVAC - Occupancy Sensors	56.3%	56.3%	8	$0.14	0.775	2.21	$0.027
Commissioning - HVAC	0.0%	0.0%	25	$0.80	1.205	2.34	$0.045
Commissioning - Lighting	0.0%	0.0%	25	$0.10	0.151	2.68	$0.045
Retrocommissioning - HVAC	0.0%	0.0%	10	$0.75	-	0.03	$0.000
Retrocommissioning - Lighting	0.0%	0.0%	0	$0.00	-	2.00	$0.000
Advanced New Construction Designs	0.0%	0.0%	25	$2.00	5.379	4.15	$0.025
Custom Measures	10.0%	45.0%	15	$0.67	-	0.06	$0.000
PC Power Management Software	42.0%	90.0%	5	$0.13	0.275	1.26	$0.102
Pre-rinse Sprayer	56.0%	10.0%	5	$0.00	0.102	7.39	$0.008

Table C-39 Energy Efficiency Non-Equipment Data— School, Existing Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	7.0%	12.5%	20	$1.04	0.257	0.27	$0.312
Insulation - Ducting	26.9%	50.0%	20	$0.77	0.348	0.48	$0.170
Insulation - Radiant Barrier	2.0%	12.5%	15	$0.00	0.096	3.00	$0.000
Insulation - Wall Cavity	19.2%	67.5%	20	$0.53	0.376	0.77	$0.108
HVAC - Duct Repair and Sealing	5.0%	25.0%	18	$0.50	0.652	1.18	$0.063
Doors - High Efficiency	0.0%	0.0%	0	$0.00	-	3.00	$0.000
Windows - High Efficiency	73.1%	75.0%	20	$3.39	0.407	0.13	$0.643
Roof - High Reflectivity	50.0%	75.0%	15	$0.64	0.141	0.18	$0.418
Air-Cooled Chiller - Condenser Water Temperature Reset	30.0%	75.0%	10	$0.18	0.219	0.61	$0.102
Air-Cooled Chiller - Economizer	3.9%	48.8%	10	$0.01	0.040	4.13	$0.017
Air-Cooled Chiller - Thermal Energy Storage	44.3%	48.8%	15	$0.15	-	0.03	$0.000
Air-Cooled Chiller - VSD on Fans	15.0%	66.2%	15	$1.17	0.572	0.39	$0.189
Air-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.17	0.287	0.83	$0.074
Air-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	15	$0.07	0.060	0.74	$0.109
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	15	$0.30	0.053	0.16	$0.517
Air-Cooled Chiller - Maintenance	73.1%	90.0%	3	$0.19	0.429	0.29	$0.157
Air-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.100	2.05	$0.039
Water-Cooled Chiller - Condenser Water Temperature Reset	30.0%	75.0%	10	$0.18	0.176	0.49	$0.127
Water-Cooled Chiller - Economizer	3.9%	48.8%	10	$0.01	0.126	11.73	$0.005
Water-Cooled Chiller - Thermal Energy Storage	44.3%	48.8%	15	$0.15	-	0.03	$0.000

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Water-Cooled Chiller - VSD on Fans	15.0%	66.2%	15	$1.17	0.196	0.14	$0.551
Water-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.17	0.275	0.79	$0.077
Water-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	15	$0.07	0.057	0.71	$0.113
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	15	$0.30	0.002	0.02	$17.669
Water-Cooled Chiller - Maintenance	73.1%	90.0%	3	$0.19	0.412	0.28	$0.163
Water-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.100	2.05	$0.039
RTU - Evaporative Precooler	0.0%	7.5%	20	$3.00	1.259	0.46	$0.184
RTU - Maintenance	73.1%	90.0%	18	$0.15	0.361	2.35	$0.034
Space Heating - Heat Recovery Ventilator	44.3%	48.8%	15	$1,150.00	0.622	0.00	$170.915
Heat Pump - Maintenance	0.0%	95.0%	4	$0.06	1.631	4.56	$0.010
Ventilation - ECM on VAV Boxes	0.0%	0.0%	18	$0.22	0.279	1.26	$0.065
Ventilation - Variable Speed Control	0.0%	81.0%	15	$0.04	0.319	6.76	$0.011
Water Heater - Drainwater Heat Recovery	0.0%	50.0%	5	$0.04	0.100	0.61	$0.088
Water Heater - Faucet Aerators/Low Flow Nozzles	30.8%	90.0%	10	$0.00	0.044	16.02	$0.005
Water Heater - High Efficiency Circulation Pump	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Water Heater - Desuperheater	0.0%	50.0%	5	$0.04	0.222	1.31	$0.040
Water Heater - Solar System	0.0%	50.0%	20	$0.06	0.555	10.67	$0.009
Water Heater - Install Timer	15.4%	20.4%	15	$0.28	0.222	0.69	$0.116
Water Heater - Pipe Insulation	15.4%	20.4%	13	$5.22	0.063	0.01	$8.468
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	7	$0.00	0.056	7.59	$0.008
Interior Lighting - Daylighting Controls	11.5%	12.5%	8	$3.22	0.605	0.07	$0.787
Interior Lighting - LED Exit Lighting	50.0%	85.5%	16	$0.00	0.004	1.86	$0.089
Interior Lighting - Occupancy Sensors	15.4%	56.3%	8	$0.02	0.202	3.78	$0.014
Interior Lighting - Timeclocks and Timers	3.9%	56.3%	8	$0.02	0.101	1.73	$0.032
Interior Lighting - Task Lighting	3.9%	75.0%	5	$0.24	0.209	0.18	$0.253
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.40	0.149	0.15	$0.398
Interior Fluorescent - Delamp and Install Reflectors	19.2%	56.3%	11	$0.50	0.126	0.15	$0.456
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.007	0.02	$3.986
Exterior Lighting - Daylighting Controls	6.0%	37.5%	8	$0.02	0.037	0.66	$0.080
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.022	0.01	$9.110
Refrigerator - Anti-Sweat Heater	0.0%	75.0%	12	$0.07	0.007	0.09	$1.111
Refrigerator - Decommissioning	50.0%	51.7%	9	$0.01	0.185	7.37	$0.007
Refrigerator - Demand Defrost	0.0%	75.0%	16	$0.20	0.010	0.05	$1.724
Refrigerator - Door Gasket Replacement	5.0%	75.0%	4	$3.07	0.016	0.00	$51.505
Refrigerator - Evaporator Fan Controls	0.0%	7.5%	16	$0.01	0.002	0.44	$0.491
Refrigerator - Floating Head Pressure	38.0%	45.0%	15	$0.01	0.014	1.47	$0.054
Refrigerator - Strip Curtain	5.0%	56.3%	4	$0.59	0.008	0.00	$19.378
Refrigerator - High Efficiency Compressor	10.0%	37.5%	15	$0.29	0.014	0.04	$1.863
Refrigerator - Variable Speed Compressor	10.0%	37.5%	15	$0.02	0.014	0.61	$0.131
Refrigerator - eCube	5.0%	75.0%	12	$0.01	0.041	3.40	$0.017
Vending Machine - Controller	2.0%	10.0%	5	$0.27	0.010	0.01	$6.112
Office Equipment - ENERGY STAR Power Supplies	10.0%	95.0%	4	$0.00	0.002	15.49	$0.015
Office Equipment - Plug Load Occupancy Sensors	12.6%	56.3%	8	$0.28	0.020	0.04	$2.082

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Pool Heater - Solar	0.0%	33.8%	20	$0.06	0.001	0.11	$8.003
Pool Pump - Timer	0.0%	33.8%	10	$0.13	0.001	0.03	$21.921
Ventilation - CO2 Controlled	1.0%	11.3%	15	$0.65	0.100	0.13	$0.602
Non-HVAC Motors - Variable Speed Control	3.9%	37.5%	10	$0.10	-	0.03	$0.000
Energy Management System	19.2%	75.0%	15	$0.35	1.029	2.18	$0.031
Thermostat - Clock/Programmable	50.0%	50.0%	11	$0.13	0.301	1.23	$0.050
HVAC - Occupancy Sensors	14.3%	56.3%	8	$0.14	0.606	1.54	$0.034
Commissioning - HVAC	0.0%	0.0%	0	$0.00	-	3.00	$0.000
Commissioning - Lighting	0.0%	0.0%	0	$0.00	-	2.00	$0.000
Retrocommissioning - HVAC	9.0%	36.0%	10	$0.75	0.929	0.57	$0.100
Retrocommissioning - Lighting	30.8%	35.8%	5	$0.05	0.205	0.90	$0.054
Advanced New Construction Designs	0.0%	0.0%	0	$0.00	-	6.00	$0.000
Custom Measures	10.0%	45.0%	15	$0.90	-	0.02	$0.000
PC Power Management Software	13.0%	90.0%	5	$0.05	0.133	1.38	$0.079
Pre-rinse Sprayer	31.0%	10.0%	5	$0.00	0.051	7.27	$0.008

Table C-40 Energy Efficiency Non-Equipment Data— School, New Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	7.0%	12.5%	20	$1.36	0.176	0.15	$0.595
Insulation - Ducting	33.5%	50.0%	20	$0.77	0.626	0.90	$0.095
Insulation - Radiant Barrier	2.0%	12.5%	15	$0.00	0.057	3.00	$0.000
Insulation - Wall Cavity	33.5%	67.5%	20	$0.34	0.241	0.89	$0.107
HVAC - Duct Repair and Sealing	25.0%	25.0%	18	$0.50	0.577	1.12	$0.071
Doors - High Efficiency	100.0%	100.0%	0	$0.00	-	3.00	$0.000
Windows - High Efficiency	66.5%	75.0%	20	$3.39	0.648	0.21	$0.403
Roof - High Reflectivity	33.5%	95.0%	15	$0.64	0.097	0.14	$0.609
Air-Cooled Chiller - Condenser Water Temperature Reset	60.0%	75.0%	10	$0.18	0.139	0.42	$0.161
Air-Cooled Chiller - Economizer	36.6%	48.8%	10	$0.01	0.347	33.85	$0.002
Air-Cooled Chiller - Thermal Energy Storage	44.3%	48.8%	15	$0.15	-	0.03	$0.000
Air-Cooled Chiller - VSD on Fans	15.0%	66.2%	15	$1.17	0.787	0.59	$0.137
Air-Cooled Chiller - Chilled Water Reset	25.0%	75.0%	10	$0.17	0.182	0.57	$0.117
Air-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	15	$0.15	0.061	0.39	$0.223
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	15	$0.30	0.107	0.33	$0.256
Air-Cooled Chiller - Maintenance	66.5%	90.0%	3	$0.40	0.270	0.09	$0.519
Air-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.096	2.01	$0.040
Water-Cooled Chiller - Condenser Water Temperature Reset	60.0%	75.0%	10	$0.18	0.079	0.25	$0.281
Water-Cooled Chiller - Economizer	36.6%	48.8%	10	$0.01	0.086	8.86	$0.008
Water-Cooled Chiller - Thermal Energy Storage	44.3%	48.8%	15	$0.15	-	0.03	$0.000
Water-Cooled Chiller - VSD on Fans	15.0%	66.2%	15	$1.17	0.029	0.03	$3.781
Water-Cooled Chiller - Chilled Water Reset	25.0%	75.0%	10	$0.17	0.229	0.71	$0.093
Water-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	15	$0.15	0.058	0.38	$0.232
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	15	$0.30	0.003	0.02	$10.744
Water-Cooled Chiller - Maintenance	66.5%	90.0%	3	$0.40	0.259	0.09	$0.540
Water-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.096	2.01	$0.040

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
RTU - Evaporative Precooler	0.0%	2.6%	20	$3.00	1.006	0.42	$0.230
RTU - Maintenance	66.5%	90.0%	18	$0.15	0.228	1.69	$0.054
Space Heating - Heat Recovery Ventilator	44.3%	48.8%	15	$1,150.00	0.564	0.00	$188.496
Heat Pump - Maintenance	0.0%	95.0%	4	$0.06	0.535	1.71	$0.030
Ventilation - ECM on VAV Boxes	0.0%	0.0%	18	$0.22	0.227	1.14	$0.080
Ventilation - Variable Speed Control	0.0%	81.0%	15	$0.04	0.224	5.32	$0.015
Water Heater - Drainwater Heat Recovery	0.0%	50.0%	5	$0.04	0.096	0.60	$0.092
Water Heater - Faucet Aerators/Low Flow Nozzles	33.5%	90.0%	10	$0.00	0.043	15.76	$0.005
Water Heater - High Efficiency Circulation Pump	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Water Heater - Desuperheater	0.0%	50.0%	5	$0.04	0.213	1.28	$0.041
Water Heater - Solar System	0.0%	50.0%	20	$0.06	0.533	10.48	$0.009
Water Heater - Install Timer	0.0%	0.0%	15	$0.28	0.213	0.68	$0.121
Water Heater - Pipe Insulation	0.0%	0.0%	13	$5.22	0.060	0.01	$8.824
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	7	$0.00	0.050	6.99	$0.009
Interior Lighting - Daylighting Controls	18.8%	18.8%	8	$3.22	0.535	0.06	$0.889
Interior Lighting - LED Exit Lighting	85.5%	85.5%	16	$0.00	0.004	1.96	$0.101
Interior Lighting - Occupancy Sensors	56.3%	56.3%	8	$0.02	0.178	3.69	$0.016
Interior Lighting - Timeclocks and Timers	56.3%	56.3%	8	$0.02	0.089	1.70	$0.036
Interior Lighting - Task Lighting	0.0%	75.0%	5	$0.24	0.185	0.18	$0.286
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.40	0.135	0.14	$0.438
Interior Fluorescent - Delamp and Install Reflectors	66.5%	71.5%	11	$0.50	-	0.01	$0.000
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.003	0.02	$9.654
Exterior Lighting - Daylighting Controls	6.0%	37.5%	8	$0.02	0.015	0.44	$0.193
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.009	0.00	$22.064
Refrigerator - Anti-Sweat Heater	0.0%	75.0%	12	$0.07	0.007	0.12	$1.111
Refrigerator - Decommissioning	50.0%	51.7%	9	$0.01	0.109	5.68	$0.011
Refrigerator - Demand Defrost	0.0%	75.0%	16	$0.20	0.006	0.05	$2.913
Refrigerator - Door Gasket Replacement	5.0%	75.0%	4	$3.07	0.012	0.00	$71.814
Refrigerator - Evaporator Fan Controls	0.0%	7.5%	16	$0.01	0.001	0.53	$0.830
Refrigerator - Floating Head Pressure	38.0%	45.0%	15	$0.01	0.009	1.39	$0.092
Refrigerator - Strip Curtain	5.0%	56.3%	4	$0.59	0.005	0.00	$32.750
Refrigerator - High Efficiency Compressor	10.0%	37.5%	15	$0.29	0.009	0.04	$3.149
Refrigerator - Variable Speed Compressor	10.0%	37.5%	15	$0.02	0.009	0.58	$0.221
Refrigerator - eCube	5.0%	75.0%	12	$0.01	0.024	2.06	$0.041
Vending Machine - Controller	2.0%	10.0%	5	$0.27	0.007	0.01	$8.630
Office Equipment - ENERGY STAR Power Supplies	10.0%	95.0%	4	$0.00	0.002	16.07	$0.015
Office Equipment - Plug Load Occupancy Sensors	12.6%	56.3%	8	$0.25	0.020	0.04	$1.873
Pool Heater - Solar	0.0%	33.8%	20	$0.06	0.001	0.11	$7.763
Pool Pump - Timer	33.8%	33.8%	10	$0.13	0.001	0.03	$21.264
Ventilation - CO2 Controlled	8.7%	11.3%	15	$0.65	0.081	0.12	$0.741
Non-HVAC Motors - Variable Speed Control	0.0%	37.5%	10	$0.10	-	0.03	$0.000
Energy Management System	0.0%	75.0%	15	$0.35	0.905	2.13	$0.036
Thermostat - Clock/Programmable	71.5%	71.5%	11	$0.13	0.257	1.13	$0.058
HVAC - Occupancy Sensors	56.3%	56.3%	8	$0.14	0.534	1.45	$0.039
Commissioning - HVAC	0.0%	0.0%	25	$1.00	0.809	1.20	$0.084

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Commissioning - Lighting	0.0%	0.0%	25	$0.15	0.180	1.97	$0.057
Retrocommissioning - HVAC	0.0%	0.0%	10	$0.75	-	0.01	$0.000
Retrocommissioning - Lighting	0.0%	0.0%	0	$0.00	-	2.00	$0.000
Advanced New Construction Designs	0.0%	0.0%	25	$2.00	3.765	2.80	$0.036
Custom Measures	10.0%	45.0%	15	$0.90	-	0.02	$0.000
PC Power Management Software	13.0%	90.0%	5	$0.05	0.133	1.41	$0.079
Pre-rinse Sprayer	34.0%	10.0%	5	$0.00	0.051	7.39	$0.008

Table C-41 Energy Efficiency Non-Equipment Data— Health, Existing Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	2.0%	12.5%	20	$0.52	0.371	0.83	$0.108
Insulation - Ducting	9.8%	50.0%	20	$0.77	0.581	0.86	$0.102
Insulation - Radiant Barrier	5.0%	12.5%	15	$0.00	0.132	3.00	$0.000
Insulation - Wall Cavity	14.6%	67.5%	20	$0.84	1.436	1.90	$0.045
HVAC - Duct Repair and Sealing	5.0%	25.0%	18	$0.50	1.238	2.45	$0.033
Doors - High Efficiency	0.0%	0.0%	0	$0.00	-	3.00	$0.000
Windows - High Efficiency	65.9%	100.0%	20	$0.89	1.249	1.57	$0.055
Roof - High Reflectivity	39.0%	95.0%	15	$0.32	0.259	0.67	$0.114
Air-Cooled Chiller - Condenser Water Temperature Reset	30.0%	75.0%	10	$0.09	0.510	2.83	$0.022
Air-Cooled Chiller - Economizer	2.4%	81.0%	10	$0.01	0.141	10.43	$0.006
Air-Cooled Chiller - Thermal Energy Storage	73.4%	81.0%	15	$0.15	-	0.04	$0.000
Air-Cooled Chiller - VSD on Fans	3.0%	75.0%	15	$1.17	1.986	1.37	$0.054
Air-Cooled Chiller - Chilled Water Reset	25.0%	75.0%	10	$0.22	0.784	1.75	$0.035
Air-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	15	$0.07	0.177	2.11	$0.037
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	25.0%	36.9%	15	$0.38	0.084	0.19	$0.422
Air-Cooled Chiller - Maintenance	48.8%	90.0%	3	$0.19	0.921	0.63	$0.073
Air-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.277	5.50	$0.014
Water-Cooled Chiller - Condenser Water Temperature Reset	30.0%	75.0%	10	$0.09	0.114	0.66	$0.098
Water-Cooled Chiller - Economizer	2.4%	81.0%	10	$0.01	0.766	53.38	$0.001
Water-Cooled Chiller - Thermal Energy Storage	73.4%	81.0%	15	$0.15	-	0.04	$0.000
Water-Cooled Chiller - VSD on Fans	3.0%	75.0%	15	$1.17	0.223	0.16	$0.484
Water-Cooled Chiller - Chilled Water Reset	25.0%	75.0%	10	$0.22	0.752	1.66	$0.037
Water-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	15	$0.07	0.170	2.00	$0.038
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	25.0%	36.9%	15	$0.38	0.003	0.02	$10.645
Water-Cooled Chiller - Maintenance	48.8%	90.0%	3	$0.19	0.883	0.59	$0.076
Water-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.277	5.50	$0.014
RTU - Evaporative Precooler	0.0%	2.0%	20	$3.00	4.510	1.71	$0.051
RTU - Maintenance	48.8%	90.0%	18	$0.08	1.293	17.22	$0.005
Space Heating - Heat Recovery Ventilator	73.4%	81.0%	15	$1,150.00	1.124	0.00	$94.549
Heat Pump - Maintenance	4.9%	95.0%	4	$0.06	3.994	11.33	$0.004
Ventilation - ECM on VAV Boxes	0.0%	0.0%	18	$0.22	0.353	1.57	$0.051
Ventilation - Variable Speed Control	2.4%	81.0%	15	$0.05	1.483	23.81	$0.003
Water Heater - Drainwater Heat Recovery	0.0%	50.0%	5	$0.04	0.277	1.63	$0.032

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Water Heater - Faucet Aerators/Low Flow Nozzles	19.5%	90.0%	10	$0.00	0.123	32.06	$0.002
Water Heater - High Efficiency Circulation Pump	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Water Heater - Desuperheater	0.0%	50.0%	5	$0.04	0.615	3.57	$0.014
Water Heater - Solar System	0.0%	50.0%	20	$0.13	1.537	13.90	$0.007
Water Heater - Install Timer	14.6%	19.6%	15	$0.28	0.615	1.88	$0.042
Water Heater - Pipe Insulation	14.6%	19.6%	13	$5.22	0.174	0.02	$3.061
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	7	$0.00	0.154	15.32	$0.004
Interior Lighting - Daylighting Controls	14.6%	19.6%	8	$0.85	0.515	0.23	$0.243
Interior Lighting - LED Exit Lighting	50.0%	85.5%	16	$0.01	0.003	1.69	$0.135
Interior Lighting - Occupancy Sensors	4.9%	56.3%	8	$0.02	0.172	2.69	$0.021
Interior Lighting - Timeclocks and Timers	7.3%	56.3%	8	$0.03	0.086	1.25	$0.048
Interior Lighting - Task Lighting	9.8%	75.0%	5	$0.24	0.178	0.15	$0.297
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.20	0.388	0.77	$0.076
Interior Fluorescent - Delamp and Install Reflectors	12.2%	25.0%	11	$0.50	0.330	0.38	$0.175
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.004	0.02	$8.171
Exterior Lighting - Daylighting Controls	11.0%	37.5%	8	$0.02	0.018	0.42	$0.163
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.011	0.00	$18.675
Refrigerator - Anti-Sweat Heater	0.0%	75.0%	12	$0.09	0.009	0.09	$1.093
Refrigerator - Decommissioning	50.0%	51.7%	9	$0.01	0.243	7.53	$0.007
Refrigerator - Demand Defrost	0.0%	75.0%	16	$0.20	0.013	0.07	$1.313
Refrigerator - Door Gasket Replacement	5.0%	75.0%	4	$4.91	0.019	0.00	$68.019
Refrigerator - Evaporator Fan Controls	0.0%	7.5%	16	$0.01	0.003	0.45	$0.483
Refrigerator - Floating Head Pressure	38.0%	45.0%	15	$0.01	0.019	1.50	$0.053
Refrigerator - Strip Curtain	5.0%	56.3%	4	$0.16	0.011	0.02	$3.881
Refrigerator - High Efficiency Compressor	10.0%	37.5%	15	$0.29	0.019	0.06	$1.419
Refrigerator - Variable Speed Compressor	10.0%	37.5%	15	$0.03	0.019	0.62	$0.129
Refrigerator - eCube	5.0%	75.0%	12	$0.01	0.054	3.39	$0.018
Vending Machine - Controller	2.0%	10.0%	5	$0.27	0.013	0.01	$4.655
Office Equipment - ENERGY STAR Power Supplies	10.0%	95.0%	4	$0.00	0.004	23.64	$0.006
Office Equipment - Plug Load Occupancy Sensors	41.7%	56.3%	8	$0.28	0.049	0.08	$0.852
Pool Heater - Solar	0.0%	33.8%	20	$0.13	0.006	0.12	$1.658
Pool Pump - Timer	2.4%	33.8%	10	$0.44	0.007	0.02	$7.273
Ventilation - CO2 Controlled	1.0%	7.5%	15	$0.65	0.444	0.53	$0.135
Non-HVAC Motors - Variable Speed Control	2.4%	37.5%	10	$0.10	-	0.04	$0.000
Energy Management System	0.0%	90.0%	15	$0.35	3.897	8.74	$0.008
Thermostat - Clock/Programmable	63.4%	68.4%	11	$0.13	1.157	4.84	$0.013
HVAC - Occupancy Sensors	14.3%	56.3%	8	$0.14	1.283	3.47	$0.016
Commissioning - HVAC	0.0%	0.0%	0	$0.00	-	3.00	$0.000
Commissioning - Lighting	0.0%	0.0%	0	$0.00	-	2.00	$0.000
Retrocommissioning - HVAC	5.0%	36.0%	10	$0.75	2.321	1.50	$0.040
Retrocommissioning - Lighting	12.2%	17.2%	5	$0.05	0.173	0.83	$0.064
Advanced New Construction Designs	0.0%	0.0%	0	$0.00	-	6.00	$0.000
Custom Measures	10.0%	45.0%	15	$0.67	-	0.03	$0.000
PC Power Management Software	42.0%	90.0%	5	$0.16	0.339	1.21	$0.107
Pre-rinse Sprayer	20.0%	10.0%	5	$0.00	0.066	7.26	$0.008

Table C-42 Energy Efficiency Non-Equipment Data— Health, New Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	2.0%	12.5%	20	$0.68	0.902	1.56	$0.058
Insulation - Ducting	9.1%	50.0%	20	$0.77	0.756	1.20	$0.079
Insulation - Radiant Barrier	5.0%	12.5%	15	$0.00	0.272	3.00	$0.000
Insulation - Wall Cavity	9.1%	67.5%	20	$0.42	1.958	5.33	$0.017
HVAC - Duct Repair and Sealing	25.0%	25.0%	18	$0.50	1.392	2.85	$0.030
Doors - High Efficiency	100.0%	100.0%	0	$0.00	-	3.00	$0.000
Windows - High Efficiency	90.9%	100.0%	20	$0.71	1.366	2.26	$0.040
Roof - High Reflectivity	45.5%	95.0%	15	$0.32	0.458	1.27	$0.065
Air-Cooled Chiller - Condenser Water Temperature Reset	60.0%	75.0%	10	$0.09	0.330	1.94	$0.034
Air-Cooled Chiller - Economizer	60.8%	81.0%	10	$0.00	0.211	25.62	$0.003
Air-Cooled Chiller - Thermal Energy Storage	73.4%	81.0%	15	$0.15	-	0.04	$0.000
Air-Cooled Chiller - VSD on Fans	3.0%	75.0%	15	$1.17	1.534	1.12	$0.070
Air-Cooled Chiller - Chilled Water Reset	50.0%	75.0%	10	$0.14	0.564	2.12	$0.031
Air-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	15	$0.05	0.157	2.73	$0.030
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	25.0%	36.9%	15	$0.24	0.003	0.03	$8.680
Air-Cooled Chiller - Maintenance	72.7%	90.0%	3	$0.14	0.581	0.56	$0.084
Air-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.266	5.41	$0.015
Water-Cooled Chiller - Condenser Water Temperature Reset	60.0%	75.0%	10	$0.09	0.086	0.55	$0.129
Water-Cooled Chiller - Economizer	60.8%	81.0%	10	$0.00	0.428	51.72	$0.001
Water-Cooled Chiller - Thermal Energy Storage	73.4%	81.0%	15	$0.15	-	0.04	$0.000
Water-Cooled Chiller - VSD on Fans	3.0%	75.0%	15	$1.17	0.174	0.13	$0.622
Water-Cooled Chiller - Chilled Water Reset	50.0%	75.0%	10	$0.14	0.505	1.93	$0.034
Water-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	15	$0.05	0.177	3.11	$0.027
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	25.0%	36.9%	15	$0.24	0.005	0.05	$4.070
Water-Cooled Chiller - Maintenance	72.7%	90.0%	3	$0.14	0.552	0.54	$0.089
Water-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.266	5.41	$0.015
RTU - Evaporative Precooler	0.0%	1.0%	20	$3.00	3.796	1.57	$0.061
RTU - Maintenance	72.7%	90.0%	18	$0.08	0.862	12.56	$0.007
Space Heating - Heat Recovery Ventilator	73.4%	81.0%	15	$1,150.00	0.998	0.00	$106.474
Heat Pump - Maintenance	9.1%	95.0%	4	$0.06	1.064	3.34	$0.015
Ventilation - ECM on VAV Boxes	0.0%	0.0%	18	$0.22	0.229	1.16	$0.079
Ventilation - Variable Speed Control	0.0%	81.0%	15	$0.03	0.889	25.65	$0.003
Water Heater - Drainwater Heat Recovery	0.0%	50.0%	5	$0.04	0.266	1.60	$0.033
Water Heater - Faucet Aerators/Low Flow Nozzles	27.3%	90.0%	10	$0.00	0.118	50.45	$0.001
Water Heater - High Efficiency Circulation Pump	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Water Heater - Desuperheater	0.0%	50.0%	5	$0.04	0.590	3.49	$0.015
Water Heater - Solar System	0.0%	50.0%	20	$0.08	1.475	21.85	$0.004
Water Heater - Install Timer	14.1%	14.1%	15	$0.28	0.590	1.84	$0.044
Water Heater - Pipe Insulation	14.1%	14.1%	13	$5.22	0.167	0.02	$3.188
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	7	$0.00	0.136	22.25	$0.003
Interior Lighting - Daylighting Controls	32.3%	32.3%	8	$0.67	0.449	0.27	$0.220
Interior Lighting - LED Exit Lighting	85.5%	85.5%	16	$0.00	0.003	2.73	$0.097

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Interior Lighting - Occupancy Sensors	56.3%	56.3%	8	$0.02	0.150	3.95	$0.015
Interior Lighting - Timeclocks and Timers	56.3%	56.3%	8	$0.02	0.075	1.85	$0.035
Interior Lighting - Task Lighting	27.3%	75.0%	5	$0.24	0.155	0.15	$0.341
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.20	0.361	0.73	$0.082
Interior Fluorescent - Delamp and Install Reflectors	18.2%	25.0%	11	$0.50	-	0.01	$0.000
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.002	0.02	$17.381
Exterior Lighting - Daylighting Controls	11.0%	37.5%	8	$0.02	0.009	0.34	$0.348
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.005	0.00	$39.727
Refrigerator - Anti-Sweat Heater	0.0%	75.0%	12	$0.06	0.009	0.19	$0.683
Refrigerator - Decommissioning	50.0%	51.7%	9	$0.01	0.144	8.94	$0.007
Refrigerator - Demand Defrost	0.0%	75.0%	16	$0.20	0.008	0.07	$2.219
Refrigerator - Door Gasket Replacement	5.0%	75.0%	4	$3.88	0.014	0.00	$73.356
Refrigerator - Evaporator Fan Controls	0.0%	7.5%	16	$0.01	0.002	0.82	$0.510
Refrigerator - Floating Head Pressure	38.0%	45.0%	15	$0.01	0.011	2.18	$0.056
Refrigerator - Strip Curtain	5.0%	56.3%	4	$0.12	0.006	0.02	$5.186
Refrigerator - High Efficiency Compressor	10.0%	37.5%	15	$0.29	0.011	0.05	$2.399
Refrigerator - Variable Speed Compressor	10.0%	37.5%	15	$0.02	0.011	0.90	$0.136
Refrigerator - eCube	5.0%	75.0%	12	$0.01	0.032	2.13	$0.039
Vending Machine - Controller	2.0%	10.0%	5	$0.27	0.011	0.01	$5.340
Office Equipment - ENERGY STAR Power Supplies	10.0%	95.0%	4	$0.00	0.004	24.42	$0.006
Office Equipment - Plug Load Occupancy Sensors	41.7%	56.3%	8	$0.25	0.048	0.09	$0.766
Pool Heater - Solar	0.0%	33.8%	20	$0.08	0.006	0.19	$1.005
Pool Pump - Timer	33.8%	33.8%	10	$0.44	0.008	0.02	$7.055
Ventilation - CO2 Controlled	5.9%	7.5%	15	$0.65	0.339	0.46	$0.177
Non-HVAC Motors - Variable Speed Control	0.0%	37.5%	10	$0.10	-	0.04	$0.000
Energy Management System	0.0%	90.0%	15	$0.35	2.961	7.07	$0.011
Thermostat - Clock/Programmable	86.8%	86.8%	11	$0.13	1.313	5.78	$0.011
HVAC - Occupancy Sensors	56.3%	56.3%	8	$0.14	1.112	3.13	$0.019
Commissioning - HVAC	0.0%	0.0%	25	$0.80	1.977	3.92	$0.028
Commissioning - Lighting	0.0%	0.0%	25	$0.10	0.151	2.58	$0.045
Retrocommissioning - HVAC	0.0%	0.0%	10	$0.75	-	0.02	$0.000
Retrocommissioning - Lighting	0.0%	0.0%	0	$0.00	-	2.00	$0.000
Advanced New Construction Designs	0.0%	0.0%	25	$2.00	8.463	6.68	$0.016
Custom Measures	10.0%	45.0%	15	$0.67	-	0.04	$0.000
PC Power Management Software	42.0%	90.0%	5	$0.16	0.339	1.24	$0.107
Pre-rinse Sprayer	27.0%	10.0%	5	$0.00	0.066	7.39	$0.008

Table C-43 Energy Efficiency Non-Equipment Data— Lodging, Existing Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	7.0%	12.5%	20	$0.31	0.136	0.51	$0.173
Insulation - Ducting	4.8%	50.0%	20	$0.77	0.210	0.32	$0.283
Insulation - Radiant Barrier	5.0%	12.5%	15	$0.00	0.067	3.00	$0.000
Insulation - Wall Cavity	9.5%	67.5%	20	$0.44	0.253	0.67	$0.134
HVAC - Duct Repair and Sealing	5.0%	25.0%	18	$0.50	0.710	1.45	$0.058
Doors - High Efficiency	0.0%	0.0%	0	$0.00	-	3.00	$0.000
Windows - High Efficiency	61.9%	75.0%	20	$5.74	0.177	0.03	$2.496

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Roof - High Reflectivity	33.3%	75.0%	15	$0.23	-	0.00	$0.000
Air-Cooled Chiller - Condenser Water Temperature Reset	30.0%	75.0%	10	$0.18	0.141	0.38	$0.158
Air-Cooled Chiller - Economizer	0.0%	48.8%	10	$0.00	0.039	24.38	$0.002
Air-Cooled Chiller - Thermal Energy Storage	44.3%	48.8%	15	$0.15	-	0.00	$0.000
Air-Cooled Chiller - VSD on Fans	15.0%	66.2%	15	$1.17	0.665	0.45	$0.162
Air-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.02	0.291	5.72	$0.010
Air-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	15	$0.02	0.053	1.88	$0.039
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	15	$0.04	0.271	5.10	$0.014
Air-Cooled Chiller - Maintenance	14.3%	90.0%	3	$0.06	0.103	0.21	$0.210
Air-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.371	7.20	$0.010
Water-Cooled Chiller - Condenser Water Temperature Reset	30.0%	75.0%	10	$0.18	0.032	0.08	$0.707
Water-Cooled Chiller - Economizer	0.0%	48.8%	10	$0.00	0.073	44.84	$0.001
Water-Cooled Chiller - Thermal Energy Storage	44.3%	48.8%	15	$0.15	-	0.00	$0.000
Water-Cooled Chiller - VSD on Fans	15.0%	66.2%	15	$1.17	0.503	0.33	$0.215
Water-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.02	0.265	5.17	$0.011
Water-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	15	$0.02	0.058	2.01	$0.036
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	15	$0.04	0.003	0.05	$1.516
Water-Cooled Chiller - Maintenance	14.3%	90.0%	3	$0.06	0.099	0.20	$0.220
Water-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.371	7.20	$0.010
RTU - Evaporative Precooler	0.0%	8.0%	20	$3.00	2.145	0.81	$0.108
RTU - Maintenance	14.3%	90.0%	18	$0.05	0.248	4.56	$0.018
Space Heating - Heat Recovery Ventilator	44.3%	48.8%	15	$1,150.00	0.425	0.00	$250.214
Heat Pump - Maintenance	4.8%	95.0%	4	$0.06	0.465	1.33	$0.035
Ventilation - ECM on VAV Boxes	0.0%	0.0%	18	$0.22	0.050	0.22	$0.358
Ventilation - Variable Speed Control	0.0%	81.0%	15	$0.01	0.208	30.43	$0.002
Water Heater - Drainwater Heat Recovery	0.0%	50.0%	5	$0.04	0.371	2.13	$0.024
Water Heater - Faucet Aerators/Low Flow Nozzles	33.3%	90.0%	10	$0.00	0.165	368.72	$0.000
Water Heater - High Efficiency Circulation Pump	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Water Heater - Desuperheater	0.0%	50.0%	5	$0.04	0.824	4.72	$0.011
Water Heater - Solar System	0.0%	50.0%	20	$0.02	2.060	110.92	$0.001
Water Heater - Install Timer	23.8%	28.8%	15	$0.28	0.824	2.49	$0.031
Water Heater - Pipe Insulation	23.8%	28.8%	13	$5.22	0.233	0.03	$2.283
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	7	$0.00	0.206	177.57	$0.000
Interior Lighting - Daylighting Controls	9.5%	12.5%	8	$5.45	1.340	0.06	$0.601
Interior Lighting - LED Exit Lighting	50.0%	85.5%	16	$0.00	0.009	9.29	$0.006
Interior Lighting - Occupancy Sensors	14.3%	56.3%	8	$0.00	0.447	41.42	$0.001
Interior Lighting - Timeclocks and Timers	4.8%	56.3%	8	$0.00	0.223	18.41	$0.002
Interior Lighting - Task Lighting	9.5%	75.0%	5	$0.24	0.463	0.28	$0.114
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.50	0.057	0.04	$1.301
Interior Fluorescent - Delamp and Install Reflectors	0.0%	56.3%	11	$0.50	0.048	0.05	$1.194
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.024	0.03	$1.247
Exterior Lighting - Daylighting Controls	20.0%	37.5%	8	$0.02	0.119	1.69	$0.025

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.071	0.01	$2.849
Refrigerator - Anti-Sweat Heater	0.0%	75.0%	12	$0.01	0.014	0.71	$0.075
Refrigerator - Decommissioning	50.0%	51.7%	9	$0.00	0.387	104.70	$0.000
Refrigerator - Demand Defrost	0.0%	75.0%	16	$0.20	0.021	0.07	$0.823
Refrigerator - Door Gasket Replacement	5.0%	75.0%	4	$2.57	0.031	0.00	$22.320
Refrigerator - Evaporator Fan Controls	0.0%	7.5%	16	$0.00	0.004	1.92	$0.033
Refrigerator - Floating Head Pressure	38.0%	45.0%	15	$0.00	0.030	15.66	$0.004
Refrigerator - Strip Curtain	5.0%	56.3%	4	$1.00	0.017	0.00	$15.675
Refrigerator - High Efficiency Compressor	10.0%	37.5%	15	$0.29	0.030	0.06	$0.890
Refrigerator - Variable Speed Compressor	10.0%	37.5%	15	$0.00	0.030	6.49	$0.009
Refrigerator - eCube	5.0%	75.0%	12	$0.01	0.086	4.86	$0.011
Vending Machine - Controller	2.0%	10.0%	5	$0.27	0.020	0.01	$2.919
Office Equipment - ENERGY STAR Power Supplies	10.0%	95.0%	4	$0.00	0.001	2.12	$0.038
Office Equipment - Plug Load Occupancy Sensors	12.6%	56.3%	8	$0.28	0.008	0.01	$5.245
Pool Heater - Solar	0.0%	47.8%	20	$0.02	0.007	0.39	$0.265
Pool Pump - Timer	42.8%	47.8%	10	$0.13	0.008	0.03	$2.051
Ventilation - CO2 Controlled	1.0%	15.0%	15	$0.65	0.304	0.36	$0.198
Non-HVAC Motors - Variable Speed Control	0.0%	37.5%	10	$0.10	-	0.00	$0.000
Energy Management System	9.5%	90.0%	15	$0.35	1.859	3.90	$0.017
Thermostat - Clock/Programmable	52.4%	57.4%	11	$0.13	0.426	1.83	$0.035
HVAC - Occupancy Sensors	56.3%	56.3%	8	$0.14	0.463	1.27	$0.045
Commissioning - HVAC	0.0%	0.0%	0	$0.00	-	3.00	$0.000
Commissioning - Lighting	0.0%	0.0%	0	$0.00	-	2.00	$0.000
Retrocommissioning - HVAC	9.0%	24.0%	10	$0.75	0.809	0.53	$0.115
Retrocommissioning - Lighting	42.8%	47.8%	5	$0.05	0.459	1.40	$0.024
Advanced New Construction Designs	0.0%	0.0%	0	$0.00	-	6.00	$0.000
Custom Measures	10.0%	45.0%	15	$1.50	-	0.00	$0.000
PC Power Management Software	13.0%	90.0%	5	$0.00	0.055	19.10	$0.003
Pre-rinse Sprayer	33.0%	5.0%	5	$0.00	0.004	7.28	$0.008

Table C-44 Energy Efficiency Non-Equipment Data— Lodging, New Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	7.0%	12.5%	20	$0.31	0.388	1.52	$0.061
Insulation - Ducting	0.0%	50.0%	20	$0.77	0.470	0.73	$0.126
Insulation - Radiant Barrier	5.0%	12.5%	15	$0.00	0.254	3.00	$0.000
Insulation - Wall Cavity	0.0%	67.5%	20	$0.50	0.286	0.70	$0.134
HVAC - Duct Repair and Sealing	25.0%	25.0%	18	$0.50	0.546	1.15	$0.075
Doors - High Efficiency	100.0%	100.0%	0	$0.00	-	3.00	$0.000
Windows - High Efficiency	74.9%	75.0%	20	$5.74	0.084	0.02	$5.257
Roof - High Reflectivity	50.0%	95.0%	15	$0.23	-	0.00	$0.000
Air-Cooled Chiller - Condenser Water Temperature Reset	60.0%	75.0%	10	$0.18	0.096	0.28	$0.232
Air-Cooled Chiller - Economizer	36.6%	48.8%	10	$0.00	0.056	38.67	$0.002
Air-Cooled Chiller - Thermal Energy Storage	44.3%	48.8%	15	$0.15	-	0.00	$0.000
Air-Cooled Chiller - VSD on Fans	15.0%	66.2%	15	$1.17	0.549	0.41	$0.197
Air-Cooled Chiller - Chilled Water Reset	10.0%	75.0%	10	$0.02	0.220	4.75	$0.014
Air-Cooled Chiller - Chilled Water	30.0%	75.0%	15	$0.02	0.052	2.58	$0.031

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Variable-Flow System							
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	15	$0.04	0.344	7.11	$0.011
Air-Cooled Chiller - Maintenance	25.1%	90.0%	3	$0.05	0.063	0.18	$0.267
Air-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.356	7.06	$0.011
Water-Cooled Chiller - Condenser Water Temperature Reset	60.0%	75.0%	10	$0.18	0.024	0.07	$0.921
Water-Cooled Chiller - Economizer	36.6%	48.8%	10	$0.00	0.035	23.79	$0.003
Water-Cooled Chiller - Thermal Energy Storage	44.3%	48.8%	15	$0.15	-	0.00	$0.000
Water-Cooled Chiller - VSD on Fans	15.0%	66.2%	15	$1.17	0.401	0.30	$0.269
Water-Cooled Chiller - Chilled Water Reset	10.0%	75.0%	10	$0.02	0.189	4.05	$0.016
Water-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	15	$0.02	0.064	3.18	$0.025
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	15	$0.04	0.003	0.06	$1.509
Water-Cooled Chiller - Maintenance	25.1%	90.0%	3	$0.05	0.057	0.16	$0.292
Water-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.356	7.06	$0.011
RTU - Evaporative Precooler	0.0%	8.0%	20	$3.00	1.728	0.71	$0.134
RTU - Maintenance	25.1%	90.0%	18	$0.05	0.146	2.93	$0.030
Space Heating - Heat Recovery Ventilator	44.3%	48.8%	15	$1,150.00	0.377	0.00	$281.773
Heat Pump - Maintenance	0.0%	95.0%	4	$0.06	0.411	1.24	$0.039
Ventilation - ECM on VAV Boxes	0.0%	0.0%	18	$0.22	0.321	1.58	$0.056
Ventilation - Variable Speed Control	0.0%	81.0%	15	$0.01	0.143	23.34	$0.003
Water Heater - Drainwater Heat Recovery	0.0%	50.0%	5	$0.04	0.356	2.08	$0.025
Water Heater - Faucet Aerators/Low Flow Nozzles	0.0%	90.0%	10	$0.00	0.158	360.93	$0.000
Water Heater - High Efficiency Circulation Pump	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Water Heater - Desuperheater	0.0%	50.0%	5	$0.04	0.791	4.61	$0.011
Water Heater - Solar System	0.0%	50.0%	20	$0.02	1.978	108.84	$0.001
Water Heater - Install Timer	30.1%	30.1%	15	$0.28	0.791	2.44	$0.033
Water Heater - Pipe Insulation	30.1%	30.1%	13	$5.22	0.224	0.03	$2.378
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	7	$0.00	0.182	159.82	$0.000
Interior Lighting - Daylighting Controls	18.8%	18.8%	8	$5.45	0.834	0.06	$0.965
Interior Lighting - LED Exit Lighting	85.5%	85.5%	16	$0.00	0.006	9.00	$0.009
Interior Lighting - Occupancy Sensors	56.3%	56.3%	8	$0.00	0.278	38.63	$0.001
Interior Lighting - Timeclocks and Timers	56.3%	56.3%	8	$0.00	0.139	17.18	$0.003
Interior Lighting - Task Lighting	0.0%	75.0%	5	$0.24	0.288	0.27	$0.183
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.50	0.047	0.04	$1.560
Interior Fluorescent - Delamp and Install Reflectors	0.0%	56.3%	11	$0.50	-	0.00	$0.000
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.013	0.03	$2.350
Exterior Lighting - Daylighting Controls	20.0%	37.5%	8	$0.02	0.063	1.26	$0.047
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.038	0.01	$5.372
Refrigerator - Anti-Sweat Heater	0.0%	75.0%	12	$0.01	0.014	0.96	$0.075
Refrigerator - Decommissioning	50.0%	51.7%	9	$0.00	0.229	75.62	$0.001
Refrigerator - Demand Defrost	0.0%	75.0%	16	$0.20	0.013	0.06	$1.392
Refrigerator - Door Gasket Replacement	5.0%	75.0%	4	$2.57	0.023	0.00	$30.447
Refrigerator - Evaporator Fan Controls	0.0%	7.5%	16	$0.00	0.003	1.56	$0.056
Refrigerator - Floating Head Pressure	38.0%	45.0%	15	$0.00	0.018	12.11	$0.006

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Refrigerator - Strip Curtain	5.0%	56.3%	4	$1.00	0.010	0.00	$26.492
Refrigerator - High Efficiency Compressor	10.0%	37.5%	15	$0.29	0.018	0.05	$1.504
Refrigerator - Variable Speed Compressor	10.0%	37.5%	15	$0.00	0.018	5.02	$0.015
Refrigerator - eCube	5.0%	75.0%	12	$0.01	0.051	3.05	$0.022
Vending Machine - Controller	2.0%	10.0%	5	$0.27	0.013	0.01	$4.566
Office Equipment - ENERGY STAR Power Supplies	10.0%	95.0%	4	$0.00	0.001	2.19	$0.038
Office Equipment - Plug Load Occupancy Sensors	12.6%	56.3%	8	$0.25	0.008	0.01	$4.717
Pool Heater - Solar	0.0%	55.0%	20	$0.02	0.007	0.39	$0.257
Pool Pump - Timer	55.0%	55.0%	10	$0.13	0.008	0.03	$1.990
Ventilation - CO2 Controlled	11.5%	15.0%	15	$0.65	0.245	0.33	$0.245
Non-HVAC Motors - Variable Speed Control	0.0%	37.5%	10	$0.10	-	0.00	$0.000
Energy Management System	0.0%	90.0%	15	$0.35	1.491	3.55	$0.022
Thermostat - Clock/Programmable	100.0%	100.0%	11	$0.13	0.482	2.13	$0.031
HVAC - Occupancy Sensors	56.3%	56.3%	8	$0.14	0.406	1.14	$0.051
Commissioning - HVAC	0.0%	0.0%	25	$1.00	0.710	1.13	$0.096
Commissioning - Lighting	0.0%	0.0%	25	$0.15	0.284	2.91	$0.036
Retrocommissioning - HVAC	0.0%	0.0%	10	$0.75	-	0.00	$0.000
Retrocommissioning - Lighting	0.0%	0.0%	0	$0.00	-	2.00	$0.000
Advanced New Construction Designs	0.0%	0.0%	25	$2.00	4.087	3.26	$0.033
Custom Measures	10.0%	45.0%	15	$1.50	-	0.00	$0.000
PC Power Management Software	13.0%	90.0%	5	$0.00	0.055	19.49	$0.003
Pre-rinse Sprayer	0.0%	5.0%	5	$0.00	0.004	7.39	$0.008

Table C-45 Energy Efficiency Non-Equipment Data— Warehouse, Existing Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	7.0%	12.5%	20	$0.52	3.563	6.84	$0.011
Insulation - Ducting	15.3%	50.0%	20	$0.77	0.443	0.58	$0.134
Insulation - Radiant Barrier	7.0%	12.5%	15	$0.00	1.418	3.00	$0.000
Insulation - Wall Cavity	10.3%	67.5%	20	$0.49	2.560	5.26	$0.015
HVAC - Duct Repair and Sealing	5.0%	25.0%	18	$0.50	1.030	1.81	$0.040
Doors - High Efficiency	0.0%	0.0%	0	$0.00	-	3.00	$0.000
Windows - High Efficiency	46.9%	75.0%	20	$0.00	0.506	3.00	$0.000
Roof - High Reflectivity	50.0%	75.0%	15	$0.32	0.373	0.81	$0.079
Air-Cooled Chiller - Condenser Water Temperature Reset	30.0%	75.0%	10	$0.18	0.207	0.59	$0.108
Air-Cooled Chiller - Economizer	0.0%	48.8%	10	$0.00	0.571	155.07	$0.000
Air-Cooled Chiller - Thermal Energy Storage	44.3%	48.8%	15	$0.15	-	0.01	$0.000
Air-Cooled Chiller - VSD on Fans	15.0%	66.2%	15	$1.17	0.808	0.58	$0.134
Air-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.06	0.375	3.24	$0.020
Air-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	15	$0.01	0.070	4.30	$0.018
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	15	$0.10	0.680	5.60	$0.014
Air-Cooled Chiller - Maintenance	62.2%	90.0%	3	$0.04	0.334	1.15	$0.040
Air-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.030	0.62	$0.129
Water-Cooled Chiller - Condenser Water Temperature Reset	30.0%	75.0%	10	$0.18	0.043	0.11	$0.523
Water-Cooled Chiller - Economizer	0.0%	48.8%	10	$0.00	0.565	138.48	$0.000
Water-Cooled Chiller - Thermal	44.3%	48.8%	15	$0.15	-	0.01	$0.000

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Energy Storage							
Water-Cooled Chiller - VSD on Fans	15.0%	66.2%	15	$1.17	0.193	0.13	$0.559
Water-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.06	0.467	3.64	$0.016
Water-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	15	$0.01	0.080	4.45	$0.016
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	15	$0.10	0.001	0.02	$6.616
Water-Cooled Chiller - Maintenance	62.2%	90.0%	3	$0.04	0.321	1.00	$0.042
Water-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.030	0.62	$0.129
RTU - Evaporative Precooler	0.0%	6.0%	20	$3.00	1.794	0.66	$0.129
RTU - Maintenance	62.2%	90.0%	18	$0.08	0.514	6.65	$0.012
Space Heating - Heat Recovery Ventilator	44.3%	48.8%	15	$1,150.00	0.995	0.00	$106.726
Heat Pump - Maintenance	3.1%	95.0%	4	$0.06	0.257	0.72	$0.063
Ventilation - ECM on VAV Boxes	0.0%	0.0%	18	$0.22	0.127	0.57	$0.142
Ventilation - Variable Speed Control	4.2%	81.0%	15	$0.01	0.177	10.88	$0.007
Water Heater - Drainwater Heat Recovery	0.0%	50.0%	5	$0.04	0.030	0.19	$0.294
Water Heater - Faucet Aerators/Low Flow Nozzles	19.5%	90.0%	10	$0.00	0.013	14.22	$0.005
Water Heater - High Efficiency Circulation Pump	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Water Heater - Desuperheater	0.0%	50.0%	5	$0.04	0.067	0.40	$0.132
Water Heater - Solar System	0.0%	50.0%	20	$0.24	0.167	0.83	$0.113
Water Heater - Install Timer	6.1%	11.1%	15	$0.28	0.067	0.21	$0.388
Water Heater - Pipe Insulation	6.1%	11.1%	13	$5.22	0.019	0.00	$28.234
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	7	$0.00	0.017	6.72	$0.009
Interior Lighting - Daylighting Controls	15.3%	20.3%	8	$0.00	0.228	1.00	$0.000
Interior Lighting - LED Exit Lighting	50.0%	85.5%	16	$0.00	0.002	1.99	$0.081
Interior Lighting - Occupancy Sensors	6.1%	56.3%	8	$0.01	0.305	16.57	$0.003
Interior Lighting - Timeclocks and Timers	3.1%	56.3%	8	$0.01	0.038	1.93	$0.029
Interior Lighting - Task Lighting	6.1%	75.0%	5	$0.24	0.079	0.05	$0.670
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.20	0.222	0.45	$0.133
Interior Fluorescent - Delamp and Install Reflectors	18.3%	56.3%	11	$0.50	0.188	0.22	$0.306
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.000	0.00	$207.804
Exterior Lighting - Daylighting Controls	18.0%	37.5%	8	$0.02	0.001	0.05	$4.156
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.000	0.00	$474.955
Refrigerator - Anti-Sweat Heater	0.0%	75.0%	12	$0.02	-	0.06	$0.000
Refrigerator - Decommissioning	50.0%	51.7%	9	$0.00	1.217	134.67	$0.000
Refrigerator - Demand Defrost	0.0%	75.0%	16	$0.20	0.068	0.23	$0.262
Refrigerator - Door Gasket Replacement	5.0%	75.0%	4	$2.84	0.054	0.00	$14.101
Refrigerator - Evaporator Fan Controls	0.0%	7.5%	16	$0.00	0.014	2.59	$0.026
Refrigerator - Floating Head Pressure	38.0%	45.0%	15	$0.00	0.095	20.38	$0.003
Refrigerator - Strip Curtain	5.0%	56.3%	4	$0.00	0.054	1.00	$0.000
Refrigerator - High Efficiency Compressor	10.0%	37.5%	15	$0.29	0.095	0.20	$0.283
Refrigerator - Variable Speed Compressor	10.0%	37.5%	15	$0.01	0.095	8.45	$0.007
Refrigerator - eCube	5.0%	75.0%	12	$0.00	0.271	1.00	$0.000
Vending Machine - Controller	2.0%	10.0%	5	$0.27	0.128	0.09	$0.464
Office Equipment - ENERGY STAR Power Supplies	10.0%	95.0%	4	$0.00	0.001	5.69	$0.033

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Office Equipment - Plug Load Occupancy Sensors	12.6%	56.3%	8	$0.28	0.009	0.02	$4.577
Pool Heater - Solar	0.0%	33.8%	20	$0.24	-	0.01	$0.000
Pool Pump - Timer	0.0%	33.8%	10	$0.13	-	0.01	$0.000
Ventilation - CO2 Controlled	1.0%	7.5%	15	$0.65	0.045	0.06	$1.321
Non-HVAC Motors - Variable Speed Control	0.0%	37.5%	10	$0.10	-	0.01	$0.000
Energy Management System	7.2%	75.0%	15	$0.35	2.398	4.82	$0.013
Thermostat - Clock/Programmable	31.7%	50.0%	11	$0.13	0.221	0.85	$0.068
HVAC - Occupancy Sensors	14.3%	56.3%	8	$0.14	0.946	2.30	$0.022
Commissioning - HVAC	0.0%	0.0%	0	$0.00	-	3.00	$0.000
Commissioning - Lighting	0.0%	0.0%	0	$0.00	-	2.00	$0.000
Retrocommissioning - HVAC	9.0%	24.0%	10	$0.75	1.356	0.79	$0.069
Retrocommissioning - Lighting	25.6%	30.6%	5	$0.05	0.076	0.34	$0.145
Advanced New Construction Designs	0.0%	0.0%	0	$0.00	-	6.00	$0.000
Custom Measures	10.0%	45.0%	15	$0.67	-	0.01	$0.000
PC Power Management Software	13.0%	90.0%	5	$0.02	0.062	1.60	$0.058
Pre-rinse Sprayer	19.0%	5.0%	5	$0.00	0.017	7.27	$0.008

Table C-46 Energy Efficiency Non-Equipment Data— Warehouse, New Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	7.0%	12.5%	20	$0.68	1.325	2.06	$0.040
Insulation - Ducting	0.0%	50.0%	20	$0.77	0.488	0.68	$0.122
Insulation - Radiant Barrier	7.0%	12.5%	15	$0.00	0.418	3.00	$0.000
Insulation - Wall Cavity	25.5%	67.5%	20	$0.32	0.554	1.83	$0.045
HVAC - Duct Repair and Sealing	25.0%	25.0%	18	$0.50	0.434	0.82	$0.095
Doors - High Efficiency	100.0%	100.0%	0	$0.00	-	3.00	$0.000
Windows - High Efficiency	78.0%	100.0%	20	$0.00	0.466	3.00	$0.000
Roof - High Reflectivity	55.9%	95.0%	15	$0.32	0.245	0.62	$0.121
Air-Cooled Chiller - Condenser Water Temperature Reset	60.0%	75.0%	10	$0.18	0.147	0.43	$0.152
Air-Cooled Chiller - Economizer	36.6%	48.8%	10	$0.00	0.355	92.86	$0.001
Air-Cooled Chiller - Thermal Energy Storage	44.3%	48.8%	15	$0.15	-	0.01	$0.000
Air-Cooled Chiller - VSD on Fans	15.0%	66.2%	15	$1.17	0.598	0.44	$0.181
Air-Cooled Chiller - Chilled Water Reset	25.0%	75.0%	10	$0.06	0.248	2.06	$0.032
Air-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	15	$0.01	0.079	5.33	$0.015
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	15	$0.11	0.520	4.13	$0.019
Air-Cooled Chiller - Maintenance	62.8%	90.0%	3	$0.04	0.210	0.79	$0.060
Air-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.029	0.61	$0.135
Water-Cooled Chiller - Condenser Water Temperature Reset	60.0%	75.0%	10	$0.18	0.011	0.04	$2.054
Water-Cooled Chiller - Economizer	36.6%	48.8%	10	$0.00	0.244	63.89	$0.001
Water-Cooled Chiller - Thermal Energy Storage	44.3%	48.8%	15	$0.15	-	0.01	$0.000
Water-Cooled Chiller - VSD on Fans	15.0%	66.2%	15	$1.17	0.086	0.06	$1.260
Water-Cooled Chiller - Chilled Water Reset	25.0%	75.0%	10	$0.06	0.288	2.39	$0.027
Water-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	15	$0.01	0.107	7.10	$0.011
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	15	$0.11	0.002	0.03	$4.498
Water-Cooled Chiller - Maintenance	62.8%	90.0%	3	$0.04	0.222	0.83	$0.057

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Water-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.029	0.61	$0.135
RTU - Evaporative Precooler	0.0%	7.0%	20	$3.00	1.429	0.59	$0.162
RTU - Maintenance	62.8%	90.0%	18	$0.08	0.328	4.77	$0.019
Space Heating - Heat Recovery Ventilator	44.3%	48.8%	15	$1,150.00	0.919	0.00	$115.586
Heat Pump - Maintenance	0.0%	95.0%	4	$0.06	0.207	0.66	$0.078
Ventilation - ECM on VAV Boxes	0.0%	0.0%	18	$0.22	0.102	0.51	$0.178
Ventilation - Variable Speed Control	0.0%	81.0%	15	$0.01	0.136	8.69	$0.009
Water Heater - Drainwater Heat Recovery	0.0%	50.0%	5	$0.04	0.029	0.18	$0.306
Water Heater - Faucet Aerators/Low Flow Nozzles	0.0%	90.0%	10	$0.00	0.013	13.04	$0.006
Water Heater - High Efficiency Circulation Pump	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Water Heater - Desuperheater	0.0%	50.0%	5	$0.04	0.064	0.39	$0.138
Water Heater - Solar System	0.0%	50.0%	20	$0.24	0.160	0.82	$0.118
Water Heater - Install Timer	0.0%	0.0%	15	$0.28	0.064	0.20	$0.405
Water Heater - Pipe Insulation	0.0%	0.0%	13	$5.22	0.018	0.00	$29.422
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	7	$0.00	0.015	5.72	$0.011
Interior Lighting - Daylighting Controls	42.2%	42.2%	8	$0.00	0.157	1.00	$0.000
Interior Lighting - LED Exit Lighting	85.5%	85.5%	16	$0.00	0.001	1.75	$0.127
Interior Lighting - Occupancy Sensors	56.3%	56.3%	8	$0.01	0.210	11.64	$0.005
Interior Lighting - Timeclocks and Timers	56.3%	56.3%	8	$0.01	0.026	1.39	$0.045
Interior Lighting - Task Lighting	0.0%	75.0%	5	$0.24	0.054	0.05	$0.972
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.20	0.208	0.41	$0.142
Interior Fluorescent - Delamp and Install Reflectors	18.7%	56.3%	11	$0.50	-	0.00	$0.000
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.000	0.00	$363.410
Exterior Lighting - Daylighting Controls	18.0%	37.5%	8	$0.02	0.000	0.05	$7.268
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.000	0.00	$830.607
Refrigerator - Anti-Sweat Heater	0.0%	75.0%	12	$0.03	-	0.05	$0.000
Refrigerator - Decommissioning	50.0%	51.7%	9	$0.00	0.720	90.81	$0.001
Refrigerator - Demand Defrost	0.0%	75.0%	16	$0.20	0.040	0.18	$0.442
Refrigerator - Door Gasket Replacement	5.0%	75.0%	4	$2.94	0.032	0.00	$24.699
Refrigerator - Evaporator Fan Controls	0.0%	7.5%	16	$0.00	0.008	2.00	$0.046
Refrigerator - Floating Head Pressure	38.0%	45.0%	15	$0.00	0.056	14.64	$0.005
Refrigerator - Strip Curtain	5.0%	56.3%	4	$0.00	0.032	1.00	$0.000
Refrigerator - High Efficiency Compressor	10.0%	37.5%	15	$0.29	0.056	0.16	$0.478
Refrigerator - Variable Speed Compressor	10.0%	37.5%	15	$0.01	0.056	6.07	$0.012
Refrigerator - eCube	5.0%	75.0%	12	$0.00	0.160	1.00	$0.000
Vending Machine - Controller	2.0%	10.0%	5	$0.27	0.091	0.06	$0.655
Office Equipment - ENERGY STAR Power Supplies	10.0%	95.0%	4	$0.00	0.001	5.89	$0.033
Office Equipment - Plug Load Occupancy Sensors	12.6%	56.3%	8	$0.25	0.009	0.02	$4.117
Pool Heater - Solar	0.0%	33.8%	20	$0.24	-	0.01	$0.000
Pool Pump - Timer	33.8%	33.8%	10	$0.13	-	0.01	$0.000
Ventilation - CO2 Controlled	5.9%	7.5%	15	$0.65	0.036	0.05	$1.653
Non-HVAC Motors - Variable Speed Control	0.0%	37.5%	10	$0.10	-	0.01	$0.000
Energy Management System	0.0%	75.0%	15	$0.35	1.834	3.99	$0.018
Thermostat - Clock/Programmable	86.3%	86.3%	11	$0.13	1.095	4.40	$0.014

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
HVAC - Occupancy Sensors	56.3%	56.3%	8	$0.14	0.848	2.19	$0.024
Commissioning - HVAC	0.0%	0.0%	25	$1.00	1.203	1.71	$0.057
Commissioning - Lighting	0.0%	0.0%	25	$0.15	0.053	0.59	$0.195
Retrocommissioning - HVAC	0.0%	0.0%	10	$0.75	-	0.00	$0.000
Retrocommissioning - Lighting	0.0%	0.0%	0	$0.00	-	2.00	$0.000
Advanced New Construction Designs	0.0%	0.0%	25	$2.00	5.047	3.60	$0.027
Custom Measures	10.0%	45.0%	15	$0.67	-	0.01	$0.000
PC Power Management Software	13.0%	90.0%	5	$0.02	0.062	1.63	$0.058
Pre-rinse Sprayer	0.0%	5.0%	5	$0.00	0.017	7.39	$0.008

Table C-47 Energy Efficiency Non-Equipment Data— Miscellaneous Commercial, Existing Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	7.0%	12.5%	20	$0.52	2.046	4.24	$0.020
Insulation - Ducting	17.8%	50.0%	20	$0.77	0.082	0.12	$0.728
Insulation - Radiant Barrier	7.0%	12.5%	15	$0.00	1.073	3.00	$0.000
Insulation - Wall Cavity	22.6%	67.5%	20	$0.49	2.121	4.70	$0.018
HVAC - Duct Repair and Sealing	5.0%	25.0%	18	$0.50	0.433	0.83	$0.095
Doors - High Efficiency	0.0%	0.0%	0	$0.00	-	3.00	$0.000
Windows - High Efficiency	63.0%	75.0%	20	$0.00	0.633	3.00	$0.000
Roof - High Reflectivity	36.3%	75.0%	15	$0.32	0.120	0.29	$0.246
Air-Cooled Chiller - Condenser Water Temperature Reset	30.0%	75.0%	10	$0.18	0.168	0.44	$0.133
Air-Cooled Chiller - Economizer	2.1%	48.8%	10	$0.00	0.472	118.82	$0.000
Air-Cooled Chiller - Thermal Energy Storage	44.3%	48.8%	15	$0.15	-	0.00	$0.000
Air-Cooled Chiller - VSD on Fans	15.0%	66.2%	15	$1.17	0.587	0.39	$0.184
Air-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.06	0.302	2.41	$0.024
Air-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	15	$0.03	0.045	1.21	$0.060
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	15	$0.10	0.525	3.99	$0.018
Air-Cooled Chiller - Maintenance	44.5%	90.0%	3	$0.08	0.251	0.38	$0.113
Air-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.094	1.84	$0.041
Water-Cooled Chiller - Condenser Water Temperature Reset	30.0%	75.0%	10	$0.18	0.041	0.11	$0.540
Water-Cooled Chiller - Economizer	2.1%	48.8%	10	$0.00	0.514	133.13	$0.000
Water-Cooled Chiller - Thermal Energy Storage	44.3%	48.8%	15	$0.15	-	0.00	$0.000
Water-Cooled Chiller - VSD on Fans	15.0%	66.2%	15	$1.17	0.144	0.10	$0.753
Water-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.06	0.418	3.44	$0.018
Water-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	15	$0.03	0.041	1.11	$0.067
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	15	$0.10	0.001	0.01	$10.401
Water-Cooled Chiller - Maintenance	44.5%	90.0%	3	$0.08	0.240	0.38	$0.118
Water-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.094	1.84	$0.041
RTU - Evaporative Precooler	0.0%	10.0%	20	$3.00	1.345	0.50	$0.172
RTU - Maintenance	44.5%	90.0%	18	$0.07	0.386	5.01	$0.016
Space Heating - Heat Recovery Ventilator	44.3%	48.8%	15	$1,150.00	0.421	0.00	$252.429
Heat Pump - Maintenance	6.2%	95.0%	4	$0.06	0.712	2.05	$0.023
Ventilation - ECM on VAV Boxes	0.0%	0.0%	18	$0.22	0.193	0.87	$0.094

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Ventilation - Variable Speed Control	1.4%	81.0%	15	$0.01	0.244	15.06	$0.005
Water Heater - Drainwater Heat Recovery	0.0%	50.0%	5	$0.04	0.094	0.55	$0.094
Water Heater - Faucet Aerators/Low Flow Nozzles	27.4%	90.0%	10	$0.00	0.042	39.56	$0.002
Water Heater - High Efficiency Circulation Pump	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Water Heater - Desuperheater	0.0%	50.0%	5	$0.04	0.209	1.21	$0.042
Water Heater - Solar System	0.0%	50.0%	20	$0.24	0.523	2.60	$0.036
Water Heater - Install Timer	24.0%	29.0%	15	$0.28	0.209	0.63	$0.124
Water Heater - Pipe Insulation	24.0%	29.0%	13	$5.22	0.059	0.01	$8.981
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	7	$0.00	0.052	18.99	$0.003
Interior Lighting - Daylighting Controls	7.5%	12.5%	8	$0.00	0.283	1.00	$0.000
Interior Lighting - LED Exit Lighting	50.0%	85.5%	16	$0.00	0.002	1.28	$0.066
Interior Lighting - Occupancy Sensors	6.8%	56.3%	8	$0.01	0.094	4.09	$0.010
Interior Lighting - Timeclocks and Timers	4.8%	56.3%	8	$0.01	0.047	1.84	$0.023
Interior Lighting - Task Lighting	17.8%	75.0%	5	$0.24	0.098	0.06	$0.540
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.50	0.058	0.05	$1.282
Interior Fluorescent - Delamp and Install Reflectors	15.1%	67.5%	11	$0.50	0.049	0.06	$1.176
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.024	0.04	$1.237
Exterior Lighting - Daylighting Controls	18.0%	37.5%	8	$0.02	0.120	2.12	$0.025
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.072	0.02	$2.828
Refrigerator - Anti-Sweat Heater	0.0%	75.0%	12	$0.02	0.010	0.23	$0.252
Refrigerator - Decommissioning	50.0%	51.7%	9	$0.00	0.281	31.19	$0.002
Refrigerator - Demand Defrost	0.0%	75.0%	16	$0.20	0.016	0.05	$1.136
Refrigerator - Door Gasket Replacement	5.0%	75.0%	4	$2.84	0.022	0.00	$33.999
Refrigerator - Evaporator Fan Controls	0.0%	7.5%	16	$0.00	0.003	0.68	$0.111
Refrigerator - Floating Head Pressure	38.0%	45.0%	15	$0.00	0.022	4.78	$0.012
Refrigerator - Strip Curtain	5.0%	56.3%	4	$0.00	0.012	1.00	$0.000
Refrigerator - High Efficiency Compressor	10.0%	37.5%	15	$0.29	0.022	0.05	$1.227
Refrigerator - Variable Speed Compressor	10.0%	37.5%	15	$0.01	0.022	1.98	$0.030
Refrigerator - eCube	5.0%	75.0%	12	$0.00	0.062	10.21	$0.005
Vending Machine - Controller	2.0%	10.0%	5	$0.27	0.015	0.01	$4.026
Office Equipment - ENERGY STAR Power Supplies	10.0%	95.0%	4	$0.00	0.001	4.52	$0.019
Office Equipment - Plug Load Occupancy Sensors	12.6%	56.3%	8	$0.28	0.016	0.02	$2.640
Pool Heater - Solar	0.0%	33.8%	20	$0.24	0.001	0.01	$20.650
Pool Pump - Timer	0.7%	33.8%	10	$0.13	0.001	0.01	$14.745
Ventilation - CO2 Controlled	1.0%	15.0%	15	$0.65	0.138	0.17	$0.436
Non-HVAC Motors - Variable Speed Control	0.7%	37.5%	10	$0.10	-	0.01	$0.000
Energy Management System	9.6%	75.0%	15	$0.35	1.339	2.86	$0.024
Thermostat - Clock/Programmable	44.5%	50.0%	11	$0.13	0.158	0.65	$0.095
HVAC - Occupancy Sensors	14.3%	56.3%	8	$0.14	0.443	1.16	$0.047
Commissioning - HVAC	0.0%	0.0%	0	$0.00	-	3.00	$0.000
Commissioning - Lighting	0.0%	0.0%	0	$0.00	-	2.00	$0.000
Retrocommissioning - HVAC	9.0%	24.0%	10	$0.75	0.726	0.46	$0.128
Retrocommissioning - Lighting	34.2%	39.2%	5	$0.10	0.106	0.19	$0.207
Advanced New Construction Designs	0.0%	0.0%	0	$0.00	-	6.00	$0.000
Custom Measures	10.0%	45.0%	15	$1.50	-	0.00	$0.000
PC Power Management Software	13.0%	90.0%	5	$0.01	0.109	5.27	$0.011

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Pre-rinse Sprayer	27.0%	5.0%	5	$0.00	0.009	7.27	$0.008

Table C-48 Energy Efficiency Non-Equipment Data— Miscellaneous Commercial, New Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	7.0%	12.5%	20	$0.68	1.152	1.92	$0.046
Insulation - Ducting	8.3%	50.0%	20	$0.77	0.226	0.34	$0.262
Insulation - Radiant Barrier	7.0%	12.5%	15	$0.00	0.464	3.00	$0.000
Insulation - Wall Cavity	19.5%	67.5%	20	$0.32	0.698	2.47	$0.035
HVAC - Duct Repair and Sealing	25.0%	25.0%	18	$0.50	0.153	0.31	$0.269
Doors - High Efficiency	100.0%	100.0%	0	$0.00	-	3.00	$0.000
Windows - High Efficiency	77.8%	82.8%	20	$0.00	0.802	3.00	$0.000
Roof - High Reflectivity	33.3%	95.0%	15	$0.32	0.067	0.18	$0.442
Air-Cooled Chiller - Condenser Water Temperature Reset	60.0%	75.0%	10	$0.18	0.110	0.32	$0.204
Air-Cooled Chiller - Economizer	37.9%	48.8%	10	$0.00	0.135	35.30	$0.002
Air-Cooled Chiller - Thermal Energy Storage	44.3%	48.8%	15	$0.15	-	0.01	$0.000
Air-Cooled Chiller - VSD on Fans	15.0%	66.2%	15	$1.17	0.439	0.33	$0.246
Air-Cooled Chiller - Chilled Water Reset	25.0%	75.0%	10	$0.06	0.199	1.65	$0.040
Air-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	15	$0.03	0.064	1.99	$0.041
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	15	$0.11	0.406	3.22	$0.025
Air-Cooled Chiller - Maintenance	36.1%	90.0%	3	$0.08	0.154	0.27	$0.176
Air-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.090	1.81	$0.043
Water-Cooled Chiller - Condenser Water Temperature Reset	60.0%	75.0%	10	$0.18	0.020	0.06	$1.115
Water-Cooled Chiller - Economizer	37.9%	48.8%	10	$0.00	0.369	95.99	$0.001
Water-Cooled Chiller - Thermal Energy Storage	44.3%	48.8%	15	$0.15	-	0.01	$0.000
Water-Cooled Chiller - VSD on Fans	15.0%	66.2%	15	$1.17	0.034	0.03	$3.179
Water-Cooled Chiller - Chilled Water Reset	25.0%	75.0%	10	$0.06	0.251	2.08	$0.031
Water-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	15	$0.03	0.067	2.06	$0.039
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	15	$0.11	0.002	0.02	$6.724
Water-Cooled Chiller - Maintenance	36.1%	90.0%	3	$0.08	0.149	0.26	$0.182
Water-Cooled Chiller - Chiller Heat Recovery	0.0%	50.0%	14	$0.04	0.090	1.81	$0.043
RTU - Evaporative Precooler	0.0%	7.0%	20	$3.00	1.039	0.43	$0.223
RTU - Maintenance	36.1%	90.0%	18	$0.08	0.230	3.34	$0.027
Space Heating - Heat Recovery Ventilator	44.3%	48.8%	15	$1,150.00	0.385	0.00	$275.785
Heat Pump - Maintenance	8.3%	95.0%	4	$0.06	0.630	1.93	$0.026
Ventilation - ECM on VAV Boxes	0.0%	0.0%	18	$0.22	0.154	0.76	$0.117
Ventilation - Variable Speed Control	2.8%	81.0%	15	$0.01	0.189	11.89	$0.007
Water Heater - Drainwater Heat Recovery	0.0%	50.0%	5	$0.04	0.090	0.53	$0.097
Water Heater - Faucet Aerators/Low Flow Nozzles	30.6%	90.0%	10	$0.00	0.040	36.10	$0.002
Water Heater - High Efficiency Circulation Pump	0.0%	0.0%	0	$0.00	-	1.00	$0.000
Water Heater - Desuperheater	0.0%	50.0%	5	$0.04	0.201	1.18	$0.044
Water Heater - Solar System	0.0%	50.0%	20	$0.24	0.503	2.56	$0.037

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/SqFt)	Savings (kWh/SqFt)	BC Ratio	Levelized Cost of Energy ($/kWh)
Water Heater - Install Timer	30.0%	30.0%	15	$0.28	0.201	0.62	$0.129
Water Heater - Pipe Insulation	30.0%	30.0%	13	$5.22	0.057	0.01	$9.359
Water Heater - Tank Blanket/Insulation	0.0%	0.0%	7	$0.00	0.047	16.13	$0.004
Interior Lighting - Daylighting Controls	18.8%	18.8%	8	$0.00	0.197	1.00	$0.000
Interior Lighting - LED Exit Lighting	85.5%	85.5%	16	$0.00	0.001	1.36	$0.101
Interior Lighting - Occupancy Sensors	56.3%	56.3%	8	$0.01	0.066	3.68	$0.016
Interior Lighting - Timeclocks and Timers	56.3%	56.3%	8	$0.01	0.033	1.66	$0.036
Interior Lighting - Task Lighting	16.7%	75.0%	5	$0.24	0.068	0.06	$0.776
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.50	0.052	0.04	$1.435
Interior Fluorescent - Delamp and Install Reflectors	11.1%	67.5%	11	$0.50	-	0.00	$0.000
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.021	0.04	$1.402
Exterior Lighting - Daylighting Controls	18.0%	37.5%	8	$0.02	0.106	2.11	$0.028
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.063	0.02	$3.204
Refrigerator - Anti-Sweat Heater	0.0%	75.0%	12	$0.03	0.010	0.29	$0.270
Refrigerator - Decommissioning	50.0%	51.7%	9	$0.00	0.166	21.95	$0.003
Refrigerator - Demand Defrost	0.0%	75.0%	16	$0.20	0.009	0.05	$1.919
Refrigerator - Door Gasket Replacement	5.0%	75.0%	4	$2.94	0.016	0.00	$48.030
Refrigerator - Evaporator Fan Controls	0.0%	7.5%	16	$0.00	0.002	0.59	$0.202
Refrigerator - Floating Head Pressure	38.0%	45.0%	15	$0.00	0.013	3.68	$0.022
Refrigerator - Strip Curtain	5.0%	56.3%	4	$0.00	0.007	1.00	$0.000
Refrigerator - High Efficiency Compressor	10.0%	37.5%	15	$0.29	0.013	0.04	$2.074
Refrigerator - Variable Speed Compressor	10.0%	37.5%	15	$0.01	0.013	1.53	$0.054
Refrigerator - eCube	5.0%	75.0%	12	$0.00	0.037	6.75	$0.010
Vending Machine - Controller	2.0%	10.0%	5	$0.27	0.010	0.01	$5.685
Office Equipment - ENERGY STAR Power Supplies	10.0%	95.0%	4	$0.00	0.001	4.72	$0.019
Office Equipment - Plug Load Occupancy Sensors	12.6%	56.3%	8	$0.25	0.016	0.03	$2.374
Pool Heater - Solar	0.0%	33.8%	20	$0.24	0.001	0.01	$20.026
Pool Pump - Timer	33.8%	33.8%	10	$0.13	0.001	0.01	$14.303
Ventilation - CO2 Controlled	11.5%	15.0%	15	$0.65	0.110	0.15	$0.546
Non-HVAC Motors - Variable Speed Control	0.0%	37.5%	10	$0.10	-	0.01	$0.000
Energy Management System	13.9%	75.0%	15	$0.35	1.002	2.34	$0.032
Thermostat - Clock/Programmable	50.0%	50.0%	11	$0.13	0.551	2.32	$0.027
HVAC - Occupancy Sensors	56.3%	56.3%	8	$0.14	0.389	1.06	$0.053
Commissioning - HVAC	0.0%	0.0%	25	$1.00	0.621	0.96	$0.110
Commissioning - Lighting	0.0%	0.0%	25	$0.15	0.076	0.83	$0.134
Retrocommissioning - HVAC	0.0%	0.0%	10	$0.75	-	0.00	$0.000
Retrocommissioning - Lighting	0.0%	0.0%	0	$0.00	-	2.00	$0.000
Advanced New Construction Designs	0.0%	0.0%	25	$2.00	2.835	2.19	$0.048
Custom Measures	10.0%	45.0%	15	$1.50	-	0.00	$0.000
PC Power Management Software	13.0%	90.0%	5	$0.01	0.109	5.38	$0.011
Pre-rinse Sprayer	31.0%	5.0%	5	$0.00	0.009	7.39	$0.008

INDUSTRIAL ENERGY EFFICIENCY EQUIPMENT AND MEASURE DATA

This appendix presents detailed information for industrial energy-efficiency measures (*equipment* and *other* measures per the LoadMAP taxonomy) that were evaluated in this study.

Table D-1 and Table D-2 provide brief narrative descriptions for the measures.[2]

Table D-3 through Table D-10 list the detailed unit-level data (including economic screen results) for industrial energy-efficiency equipment measures in existing and new buildings. The column headings and units are the same as described for the corresponding residential sector tables above.

Table D-11 through Table D-18 list the detailed unit-level data (including economic screen results) for industrial energy-efficiency non-equipment measures in existing and new buildings. The column headings and units are the same as described for the corresponding residential sector tables above.

[2] Measure Description Sources: EnerNOC internal databases.

Table D-1 Industrial Energy Efficiency Equipment Measure Descriptions

End Use	Technology	Measure Description
Cooling	Air-Cooled Chiller	A central chiller plant creates chilled water for distribution throughout the facility. Because of the wide variety of system types and sizes, savings and cost values for efficiency improvements represent an average over screw, reciprocating, and centrifugal technologies. Under this simplified approach, each central system is characterized by an aggregate efficiency value (inclusive of chiller, pumps, and motors), in kW/ton with a further efficiency upgrade through the application of variable refrigerant flow technology.
Cooling	Water-Cooled Chiller	A central chiller plant creates chilled water for distribution throughout the facility. Water source chillers include heat rejection via a condenser loop and cooling tower. Because of the wide variety of system types and sizes, savings and cost values for efficiency improvements represent an average over screw, reciprocating, and centrifugal technologies. Under this simplified approach, each central system is characterized by an aggregate efficiency value (inclusive of chiller, pumps, motors, and condenser loop equipment), in kW/ton with a further efficiency upgrade through the application of variable refrigerant flow technology.
Cooling	Roof Top AC	Packaged cooling systems, such as rooftop units (RTUs), are simple to install and maintain, and are commonly used in small and medium-sized commercial buildings. Applications range from a single supply system with air intake filters, supply fan, and cooling coil, or can become more complex with the addition of a return air duct, return air fan, and various controls to optimize performance. For packaged RTUs, varying Energy Efficiency Ratios (EER) are modeled, as well as a ductless mini-split system.
Cooling / Heating	Air-Source Heat Pump	For heat pumps, units with increasing EER and COP levels are evaluated, as well as a ductless mini-split system.
Cooling / Heating	Geothermal Heat Pump	For heat pumps, units with increasing EER and COP levels are evaluated.
Heating	Electric Furnace	Resistive heating elements are used to convert electricity directly to heat. The heat is then delivered by a supply fan and duct system to the regions that require heating.
Heating	Electric Room Heat	Resistive heating elements are used to convert electricity directly to heat. Conductive fins surrounding the element or another mechanism is used to deliver the heat directly to the surrounding room or area. These are typically either baseboard or wall-mounted units.
Ventilation	Ventilation	A variable air volume ventilation system modulates the air flow rate as needed based on the interior conditions of the building to reduce fan load, improve dehumidification, and reduce energy usage.
Interior Lighting	Screw-in	This measure evaluates higher-efficiency alternatives for screw-in interior lamps including halogen, CFL, and LED.
Interior Lighting	High-Bay Fixtures	With the exception of screw-in lighting, industrial lighting efficiency changes typically require more than the simple purchase and installation of an alternative lamp Restrictions regarding ballasts, fixtures, and circuitry limit the potential for direct substitution of one lamp type for another. Also, during the buildout for a leased office space, management could decide to replace all lamps, ballasts, and fixtures with different configurations. This type of decision-making is modeled on a stock turnover basis because of the time between opportunities for upgrades. For High-Bay fixtures, alternatives include mercury vapor, metal halides, T5 fluorescent high output, and high-pressure sodium.
Interior Lighting	Linear Fluorescent	With the exception of screw-in lighting, industrial lighting efficiency changes typically require more than the simple purchase and installation of an alternative lamp Restrictions regarding ballasts, fixtures, and circuitry limit the potential for direct substitution of one lamp type for another. Also, during the buildout for a leased office space, management could decide to replace all lamps, ballasts, and fixtures with different configurations. This type of decision-

End Use	Technology	Measure Description
		making is modeled on a stock turnover basis because of the time between opportunities for upgrades. For linear fluorescent fixtures, alternatives include T12, T8, Super T8, T5, and LED.
Exterior Lighting	Screw-in	This measure evaluates higher-efficiency alternatives for screw-in interior lamps including halogen, CFL, and LED.
Exterior Lighting	HID	Alternatives modeled include metal halides, T8 and T5 high output, high pressure sodium, and LEDs
Exterior Lighting	Linear Fluorescent	For linear fluorescent fixtures, alternatives include T12, T8, Super T8, T5, and LED.
Process	Process Electrochemical	Electrochemical processes deal with chemical reactions in solution driven by electricity applied at a cathode and anode.
Process	Other Process	This category is a "catch all" for the many unique process applications in the broader industrial sector.
Process	Process Cooling	Industrial process where cooling is applied
Process	Process Refrigeration	Industrial refrigeration process
Process	Process Heating	Industrial process where heating is applied
Process	Other Process	This category is a "catch all" for the many unique process applications in the broader industrial sector.
Motors	Pumps, Fans & Blowers, Compressed Air, Conveyors, Material Handling, Material Processing	Premium efficiency motors reduce the amount of lost energy going into heat rather than power. Since less heat is generated, less energy is needed to cool the motor with a fan. The initial cost of energy efficient motors is generally higher than for standard motors, however their life-cycle costs can make them far more economical because of savings they generate in operating expense. The fact that energy efficient motors run cooler than their standard counterparts also results in an increase in the life of the motor insulation and bearing. High efficiency units use copper instead of aluminum in the windings and increased conductor cross-sectional area to lower a motor’s I2R losses.
Miscellaneous	Miscellaneous	Improvement of miscellaneous electric uses.

Table D-2 Industrial Energy Efficiency Non-Equipment Measure Descriptions

End Use	Measure	Description
HVAC (All)	Insulation - Ceiling	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation can conserve energy by reducing the heat loss or gain of a building. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose; loose-fill (blown) fiberglass; and rigid polystyrene.
HVAC (All)	Insulation - Ducting	Air distribution ducts can be insulated to reduce heating or cooling losses. Best results can be achieved by covering the entire surface area with insulation. Insulation material inhibits the transfer of heat through the air-supply duct. Several types of ducts and duct insulation are available, including flexible duct, pre-insulated duct, duct board, duct wrap, tacked, or glued rigid insulation, and waterproof hard shell materials for exterior ducts.
HVAC (All)	Insulation - Wall Cavity	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation can conserve energy by reducing the heat loss or gain of a building. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose; loose-fill (blown) fiberglass; and rigid polystyrene.
HVAC (All)	HVAC - Duct Repair and Sealing	Leakage in unsealed ducts varies considerably because of the differences in fabricating machinery used, the methods for assembly, installation workmanship, and age of the ductwork. Air leaks from the system to the outdoors result in a direct loss proportional to the amount of leakage and the difference in enthalpy between the outdoor air and the conditioned air. To seal ducts, a wide variety of sealing methods and products exist. Each has a relatively short shelf life, and no documented research has identified the aging characteristics of sealant applications.
Air-Cooled Chiller	Air-Cooled Chiller - Economizer	Economizers allow outside air (when it is cool and dry enough) to be brought into the building space to meet cooling loads instead of using mechanically cooled interior air. A dual enthalpy economizer consists of indoor and outdoor temperature and humidity sensors, dampers, motors, and motor controls. Economizers are most applicable to temperate climates and savings will be smaller in extremely hot or humid areas.
Air-Cooled Chiller	Air-Cooled Chiller - Efficient Mechanical Layout	Improvements to layout and placement of chiller equipment, for example to enable unobstructed access to cooling tower airflow or minimize the length of refrigerant run between cooling tower and chiller head unit.
Air-Cooled Chiller	Air-Cooled Chiller - Maintenance	Filters, coils, and fins require regular cleaning and maintenance for the heat pump or roof top unit to function effectively and efficiently throughout its years of service. Neglecting necessary maintenance leads to a steady decline in performance while energy use increases.
Air-Cooled Chiller	Air-Cooled Chiller - Chilled Water Reset	Chilled water reset controls save energy by improving chiller performance through increasing the supply chilled water temperature, which allows increased suction pressure during low load periods. Raising the chilled water temperature also reduces chilled water piping losses. However, the primary savings from the chilled water reset measure results from chiller efficiency improvement. This is due partly to the smaller temperature difference between chilled water and ambient air, and partly due to the sensitivity of chiller performance to suction temperature.
Air-Cooled Chiller	Air-Cooled Chiller - Chilled Water Variable-Flow System	The part-load efficiency of chilled water loops can be improved substantially by varying the flow speed of the delivered water with the building demand for cooling.
Air-Cooled Chiller	Air-Cooled Chiller - Condenser Water Temperature Reset	Resetting the condenser water temperature to the lowest possible setting allows the cooling tower to generate cooler water whenever possible and decreases the temperature lift between the condenser and the evaporator. This will generally increase chiller part-load efficiency, though it may require

End Use	Measure	Description
		increased tower fan energy use.
Air-Cooled Chiller	Air-Cooled Chiller - High Efficiency Cooling Tower Fans	High-efficiency cooling fans utilize efficient components and variable frequency drives that improve fan performance by adjusting fan speed and rotation as conditions change.
Air-Cooled Chiller	Air-Cooled Chiller - VSD on Fans	Variable speed drives, which reduce chiller energy use under part load, are modeled for both air-cooled and water-cooled chillers.
Water-Cooled Chiller	Water-Cooled Chiller Economizer	Economizers allow outside air (when it is cool and dry enough) to be brought into the building space to meet cooling loads instead of using mechanically cooled interior air. A dual enthalpy economizer consists of indoor and outdoor temperature and humidity sensors, dampers, motors, and motor controls. Economizers are most applicable to temperate climates and savings will be smaller in extremely hot or humid areas.
Water-Cooled Chiller	Water Cooled Chiller-Efficient Mechanical Layout	Improvements to layout and placement of chiller equipment, for example to enable unobstructed access to cooling tower airflow or minimize the length of refrigerant run between cooling tower and chiller head unit.
Water-Cooled Chiller	Water Cooled Chiller Maintenance	Filters, coils, and fins require regular cleaning and maintenance for the heat pump or roof top unit to function effectively and efficiently throughout its years of service. Neglecting necessary maintenance leads to a steady decline in performance while energy use increases.
Water-Cooled Chiller	Water Cooled Chiller-Chilled Water Reset	Chilled water reset controls save energy by improving chiller performance through increasing the supply chilled water temperature, which allows increased suction pressure during low load periods. Raising the chilled water temperature also reduces chilled water piping losses. However, the primary savings from the chilled water reset measure results from chiller efficiency improvement. This is due partly to the smaller temperature difference between chilled water and ambient air, and partly due to the sensitivity of chiller performance to suction temperature.
Water-Cooled Chiller	Water Cooled Chiller-Variable Flow System	The part-load efficiency of chilled water loops can be improved substantially by varying the flow speed of the delivered water with the building demand for cooling.
Water-Cooled Chiller	Water Cooled Chiller Condenser Water Temperature Reset	Resetting the condenser water temperature to the lowest possible setting allows the cooling tower to generate cooler water whenever possible and decreases the temperature lift between the condenser and the evaporator. This will generally increase chiller part-load efficiency, though it may require increased tower fan energy use.
Water-Cooled Chiller	Water Cooled Chiller High Efficiency Cooling Tower Fans	High-efficiency cooling fans utilize efficient components and variable frequency drives that improve fan performance by adjusting fan speed and rotation as conditions change.
Water-Cooled Chiller	Water Cooled Chiller VSD on Fans	Variable speed drives, which reduce chiller energy use under part load, are modeled for both air-cooled and water-cooled chillers.
Roof Top AC	RTU - Maintenance	Regular cleaning and maintenance enables a roof top unit to function effectively and efficiently throughout its years of service. Neglecting necessary maintenance leads to a steady decline in performance while energy use increases. Maintenance can increase the efficiency of poorly performing equipment by as much as 10%.
Cooling / Heating	Heat Pump - Maintenance	Regular cleaning and maintenance enables a heat pump to function effectively and efficiently throughout its years of service. Neglecting necessary maintenance leads to a steady decline in performance while energy use increases. Maintenance can increase the efficiency of poorly performing equipment by as much as 10%.
HVAC (All)	Roofs - High Reflectivity	The color and material of a building structure surface will determine the amount of solar radiation absorbed by that surface and subsequently transferred into a building. This is called solar absorptance. By using a living roof or a roofing material with a light color (and a lower solar absorptance), the roof will absorb less solar radiation and consequently reduce the cooling load.

End Use	Measure	Description
		Living roofs also reduce stormwater runoff.
HVAC (All)	Energy Management System	An energy management system (EMS) allows managers/owners to monitor and control the major energy-consuming systems within a commercial building. At the minimum, the EMS can be used to monitor and record energy consumption of the different end-uses in a building, and can control operation schedules of the HVAC and lighting systems. The monitoring function helps building managers/owners to identify systems that are operating inefficiently so that actions can be taken to correct the problem. The EMS can also provide preventive maintenance scheduling that will reduce the cost of operations and maintenance in the long run. The control functionality of the EMS allows the building manager/owner to operate building systems from one central location. The operation schedules set via the EMS help to prevent building systems from operating during unwanted or unoccupied periods. This analysis assumes that this measure is limited to buildings with a central HVAC system.
HVAC (All)	Thermostat - Clock/Programmable	A programmable thermostat can be added to most heating/cooling systems. They are typically used during winter to lower temperatures at night and in summer to increase temperatures during the afternoon. There are two-setting models, and well as models that allow separate programming for each day of the week. The energy savings from this type of thermostat are identical to those of a "setback" strategy with standard thermostats, but the convenience of a programmable thermostat makes it a much more attractive option. In this analysis, the baseline is assumed to have no thermostat setback.
Interior Lighting	Interior Lighting - Occupancy Sensors	The installation of occupancy sensors allows lights to be turned off during periods when a space is unoccupied, virtually eliminating the wasted energy due to lights being left on. There are several types of occupancy sensors in the market.
Interior Lighting	Interior Lighting - Skylights	Addition of transparent windows/fixtures in the roof to allow daylight to enter and reduce the need for powered lighting.
Interior Lighting	Interior Lighting - Time Clocks and Timers	In many cases lighting remains on at night and during weekends. A simple timer can set a schedule for turning lights off to reduce operating hours.
Interior Lighting	Interior Lighting - LED Exit Lighting	The lamps inside exit signs represent a significant energy end-use, since they usually operate 24 hours per day. Many old exit signs use incandescent lamps, which consume approximately 40 watts per sign. The incandescent lamps can be replaced with LED lamps that are specially designed for this specific purpose. In comparison, the LED lamps consume approximately 2-5 watts.
Interior Lighting	Interior Lighting - Daylighting Controls	Daylighting controls use a photosensor to detect ambient light and adjust or turn off electric lights accordingly.
Interior Lighting	Interior Screw-in - Task Lighting	Individual work areas can use task lighting instead of brightly lighting the entire area. Significant energy savings can be realized by focusing light directly where it is needed and lowering the general lighting level. An example of task lighting is the common desk lamp. A 25W desk lamp can be installed in place of a typical lamp in a fixture.
Interior Lighting	Interior Fluorescent - Bi-Level Fixture	Bi-level fixtures have the ability to reduce light output to a lower level, given a control strategy that is based on a timer, occupancy sensor, motion sensor, or manual switch.
Interior Lighting	Interior Fluorescent - Delamp and Install Reflectors	While sometimes included in lighting retrofit projects, delamping is often performed as a separate energy efficiency measure in which a lighting engineer analyzes the lighting provided by current systems compared to the requirements of building occupants. This often leads to the removal of unnecessary lamps corresponding to an overall reduction in energy usage. In addition, installing a reflector in each fixture can improve light distribution from the remaining lamps.
Exterior Lighting	Exterior Lighting - Bi-Level Fixture	Bi-level fixtures have the ability to reduce light output to a lower level, given a control strategy that is based on a timer, occupancy sensor, motion sensor, or manual switch.

End Use	Measure	Description
Exterior Lighting	Exterior Lighting - Daylighting Controls	Daylighting controls use a photosensor to detect ambient light and adjust or turn off electric lights accordingly.
Exterior Lighting	Exterior Lighting - Photovoltaic Installation	Solar photovoltaic generation may be used to power exterior lighting and thus eliminate all or part of the electrical energy use.
Process	Process - Conductivity Controls	Automated control of conductivity levels in a process solution, for example by variably injecting CO2 into a stream of rinse water, can maintain an optimal solution that increases process effectiveness, decreases impurities, reduces scaling or corrosion, and minimizes required rinse time.
Process	Process - Controls on Fume Hoods	Improved fume hoods involve installing sensors and variable-speed controls to provide ventilation based on actual demand. When the relevant equipment or process is not active, the controls automatically decrease the fan speed accordingly.
Process	Process - Timers and Controls	Significant energy savings can frequently be attained from processes by adding a timer or altering their control algorithms.
Process	Injection Molding Barrel Insulation	Specific to the plastics industry, insulated blankets wrapped around the cylindrical barrels of an injection molder or extruder can minimize the use of resistance heating without affecting temperature control of the molder or extruded resin.
Process Refrigeration	Refrigeration - Floating Head Pressure	Floating head pressure control allows the pressure in the condenser to "float" with ambient temperatures. This method reduces refrigeration compression ratios, improves system efficiency and extends the compressor life. The greatest savings with a floating head pressure approach occurs when the ambient temperatures are low, such as in the winter season. Floating head pressure control is most practical for new installations. However, retrofits installation can be completed with some existing refrigeration systems. Installing floating head pressure control increases the capacity of the compressor when temperatures are low, which may lead to short cycling.
Process Refrigeration	Refrigeration - System Controls	Refrigeration System Controls would include measures such as temperature sensors, flow/float controls, and pressure controls. These work to improve the refrigeration system by limiting demand and improving overall system efficiency.
Process Refrigeration	Refrigeration - System Maintenance	This measure includes repairing and recharging refrigerant lines, cleaning condenser coils, and replacing the oil. This reduces energy consumption by improving the rate at which the system can compress and cool refrigerant as it moves through the system.
Process Refrigeration	Refrigeration - System Optimization	Refrigeration system optimization is a thorough overhaul of the refrigeration system which involves the resizing, sequencing, and controlling of compressors in order to optimize load.
Compressed Air	Compressed Air - Air Usage Reduction	This measure involves a process audit of the facility to determine if the actual application of compressed air can be reduced, reconfigured, consolidated, or otherwise optimized.
Compressed Air	Compressed Air - Compressor Replacement	This measure is the replacement of existing air compressor equipment with more efficient compressors and motors in order to improve energy efficiency.
Compressed Air	Compressed Air - System Controls	Compressed Air System Controls would include measures such as VSDs, centralized controls, and system performance monitoring. These measures work in tandem to reduce energy usage by lowering system demand.
Compressed Air	Compressed Air - System Maintenance	This measure includes repairing holes in air lines, replacing failed nozzles, and lubricating the compressors. This reduces energy consumption by improving compressor efficiency and reducing line loss as gas moves through the system.
Compressed Air	Compressed Air - System Optimization and Improvements	System optimization is a thorough overhaul of the compressed air system which involves the resizing, sequencing, and improving control over all compressors in a system in order to reduce energy consumption to a minimum. This measure may include those from Controls and Maintenance.

End Use	Measure	Description
Pumps	Pumping System - Controls	Significant energy savings can frequently be attained from processes by adding a timer or altering their control algorithms.
Pumps	Pumping System - Maintenance	This measure includes clearing traps, repairing impellers, and repairing broken seals or valves. This reduces energy consumption by reducing losses incurred by moving fluids through the system.
Pumps	Pumping System - Optimization	Optimization integrates best practices of system analysis, equipment improvements, and operational improvements into a sustaining energy program. A facility that implements such a practice treats its energy program in a similar manner to safety or quality control programs: an individual or team is tasked with developing and enforcing standards, goals are set, regular reports are generated and reported to management, and all plant employees are engaged and held accountable.
Pumps	Pumps - Variable Speed Control	The part-load efficiency of drive systems can be improved by varying the speed of the motor drive. An additional benefit of variable-speed controls is the ability to start and stop the motor and process gradually, thus extending the life of the motor and associated machinery.
Pumps	Pump Equipment Upgrade	Improved design of flow, housing, control valves, impeller trimming, proper sizing, etc to increase productive output per energy input. Moreover, these improved systems could be assessed and managed in accordance with recognized standards such as ASME EA-2-2008.
Fans & Blowers	Fan Equipment Upgrade	Improved design of airflow, blades, housing, sizing, etc to increase productive output per energy input. Fans are widely used in industry for conveyance, drying and ventilation. For example, relatively inefficient centrifugal-radial fans, with efficiency as low as 22%, are commonly used in industry. These fans could be replaced with more efficient centrifugal backwardly inclined fans that increase overall fan efficiency by 20% to 30%. The savings potential for premium-efficiency fans is high, and the costs are relatively low. However, premium-efficiency fans are sometimes not chosen for industrial applications because of concerns about reliable operation in dirty environments.
Fans & Blowers	Fan System - Controls	Significant energy savings can frequently be attained from processes by adding a timer or altering their control algorithms.
Fans & Blowers	Fan System - Maintenance	This measure includes repairing holes in ducts, replacing clogged filters, and lubricating the motors. This reduces energy consumption by improving fan efficiency and reducing system loss as gas moves through the ductwork.
Fans & Blowers	Fan System - Optimization	Optimization integrates best practices of system analysis, equipment improvements, and operational improvements into a sustaining energy program. A facility that implements such a practice treats its energy program in a similar manner to safety or quality control programs: an individual or team is tasked with developing and enforcing standards, goals are set, regular reports are generated and reported to management, and all plant employees are engaged and held accountable.
Fans & Blowers	Fans - Variable Speed Control	The part-load efficiency of drive systems can be improved by varying the speed of the motor drive. An additional benefit of variable-speed controls is the ability to start and stop the motor and process gradually, thus extending the life of the motor and associated machinery.
Motors	Motors - Magnetic Adjustable Speed Drives	To allow for adjustable speed operation, this technology uses magnetic induction to couple a drive to its load. Varying the magnetic slip within the coupling controls the speed of the output shaft. Magnetic drives perform best at the upper end of the speed range due to the energy consumed by the slip. Unlike traditional ASDs, magnetically coupled ASDs create no power distortion on the electrical system. However, magnetically coupled ASD efficiency is best when power needs are greatest. VFDs may show greater efficiency when the average load speed is below 90% of the motor speed, however this occurs when power demands are reduced.
Motors	Motors - Efficient Rewind	When a motor burns out or is in need of repair, the owner may elect to either replace the motor or have it rewound. A typical motor rewind costs less than a

End Use	Measure	Description
		replacement motor, but at the cost of efficiency. An efficient rewind, however, attempts to improve the efficiency of the motor by reducing stator losses. If the manufacturer has left stator slots open, or not entirely filled, additional copper wire can be included to reduce resistance and increase efficiency.
Motors	Motors - Synchronous Belts	Synchronous belts offer higher efficiency compared with standard belts due to reduced slipping, as well as less maintenance and retensioning.
Motors	Motors - Variable Frequency Drive	The part-load efficiency of drive systems can be improved by varying the speed of the motor drive. An additional benefit of variable-speed controls is the ability to start and stop the motor and process gradually, thus extending the life of the motor and associated machinery.
HVAC, Lighting	Commissioning - HVAC, Lighting	For new construction and major renovations, commissioning ensures that building systems are properly designed, specified, and installed to meet the design intent and provide high-efficiency performance. Commissioning begins during the design process.
HVAC, Lighting	Retrocommissioning - HVAC, Lighting	In existing buildings, the retrocommissioning process identifies low-cost or no cost measures, including controls adjustments, to improve building performance and reduce operating costs. Retrocommissioning addresses HVAC, lighting, DHW, and other major building systems.
Ventilation	Ventilation - CO2 Controlled	Also known as Demand Controlled Ventilation, this measure uses carbon dioxide (CO2) levels to indicate the level of occupancy in a space. Sensors monitor CO2 levels so that air handling controls can adjust the amount of outside air the system needs to intake. Ventilation rates are thereby controlled based on occupancy, rather than a fixed rate, thus saving HVAC energy use.
All	Transformer - High Efficiency	All electric power passes through one or more transformers on its way to service equipment, lighting, and other loads. Currently available materials and designs can considerably reduce both load and no-load losses. The new NEMA TP-1 standard is used as the reference definition for energy -efficient products. Tier-1 represents TP-1 dry-type transformers while Tier-2 reflects a switch to liquid immersed TP-1 products. More efficient transformers with attractive payback periods are estimated to save 40 to 50 percent of the energy lost by a "typical" transformer, which translates into a one to three percent reduction in electric bills for commercial and industrial customers.
All	Custom Measures	Custom measures may be included in the analysis to serve as a "catch all" for measures for which costs and savings are not easily quantified and that could be part of a custom program. Typical costs and energy savings are assumed such that the measures pass the economic screen.

Table D-3 Energy Efficiency Equipment Data, Electric—Chemicals, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/Emp)	Incremental Cost ($/Emp)	Lifetime (Years)	BC Ratio	Levelized Cost ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	2,240.99	$819.14	20	1.14	$0.028
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	2,689.16	$1,064.89	20	1.17	$0.031
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	5,602.40	$1,310.63	20	1.46	$0.018
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	5,938.60	$1,556.37	20	1.50	$0.020
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	4,121.83	$399.12	20	1.24	$0.007
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	4,672.78	$798.24	20	1.27	$0.013
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	5,499.90	$957.89	20	1.34	$0.013
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	6,600.93	$1,490.05	20	1.43	$0.017
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	6,876.93	$1,649.70	20	1.45	$0.018
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	7,429.62	$1,809.34	20	1.51	$0.019
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	2,673.17	$1,382.44	16	-	$0.046
Cooling	Roof top AC	EER 11.2	5,356.72	$2,658.53	16	1.00	$0.044
Cooling	Roof top AC	EER 12.0	6,999.57	$5,104.38	16	1.06	$0.065

End Use	Technology	Efficiency Definition	Savings (kWh/Emp)	Incremental Cost ($/Emp)	Lifetime (Years)	BC Ratio	Levelized Cost ($/kWh)
Cooling	Roof top AC	Ductless Minisplit	8,768.80	$16,748.76	16	1.06	$0.169
Cooling	Air-Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air-Source Heat Pump	EER 10.3, COP 3.2	2,912.86	$1,719.86	16	-	$0.052
Cooling	Air-Source Heat Pump	EER 11.0, COP 3.3	4,636.74	$2,472.30	16	1.00	$0.047
Cooling	Air-Source Heat Pump	EER 11.7, COP 3.4	6,154.23	$6,342.00	16	1.04	$0.091
Cooling	Air-Source Heat Pump	EER 12.0, COP 3.4	6,750.68	$8,276.84	16	1.06	$0.109
Cooling	Air-Source Heat Pump	Ductless Minisplit	8,538.79	$15,854.99	16	1.10	$0.164
Cooling	Geothermal Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geothermal Heat Pump	EER 16, COP 3.5	1,693.13	$3,874.27	16	1.07	$0.203
Cooling	Geothermal Heat Pump	EER 18, COP 3.8	3,089.22	$7,748.54	16	1.13	$0.222
Cooling	Geothermal Heat Pump	EER 30, COP 5.0	7,556.70	$10,219.57	16	1.52	$0.120
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	323.36	$940.74	14	1.01	$0.282
Cooling	Other Cooling	EER 10.8	633.61	$10,700.93	14	0.95	$1.635
Cooling	Other Cooling	EER 11	932.39	$11,325.91	14	0.96	$1.176
Cooling	Other Cooling	EER 11.5	1,219.70	$12,888.37	14	0.96	$1.023
Heating	Air-Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air-Source Heat Pump	EER 10.3, COP 3.2	226.16	$3,653.16	16	-	$1.430
Heating	Air-Source Heat Pump	EER 11.0, COP 3.3	432.21	$5,251.42	16	1.00	$1.075
Heating	Air-Source Heat Pump	EER 11.7, COP 3.4	618.16	$13,471.04	16	0.90	$1.929
Heating	Air-Source Heat Pump	EER 12.0, COP 3.4	618.16	$17,580.85	16	0.85	$2.517
Heating	Air-Source Heat Pump	Ductless Minisplit	788.31	$33,677.60	16	0.71	$3.781
Heating	Geothermal Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geothermal Heat Pump	EER 16, COP 3.5	2,161.72	$7,361.13	16	0.93	$0.301
Heating	Geothermal Heat Pump	EER 18, COP 3.8	4,977.65	$14,722.25	16	0.87	$0.262
Heating	Geothermal Heat Pump	EER 30, COP 5.0	1,095.64	$19,417.23	16	0.81	$1.569
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	2,094.74	-$4,266.79	10	1.04	-$0.252
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	748.01	$28.24	3	-	$0.013
Int. Lighting	Screw-in	70W HIR PAR-38	1,149.20	$38.84	3	-	$0.012
Int. Lighting	Screw-in	CFL	2,151.36	$22.50	6	3.63	$0.002
Int. Lighting	Screw-in	LED (2010)	2,329.20	$597.47	20	2.50	$0.020
Int. Lighting	Screw-in	LED (2020)	2,675.49	$168.57	20	-	$0.005
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	110.84	$168.49	15	0.81	$0.140
Int. Lighting	High-Bay Fixtures	T8	112.83	-$4.48	10	1.78	-$0.005
Int. Lighting	High-Bay Fixtures	High Pressure Sodium	120.06	$0.80	6	1.78	$0.001
Int. Lighting	High-Bay Fixtures	Induction	132.40	$47.53	15	1.38	$0.033
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	140.50	$2.61	15	1.98	$0.002
Int. Lighting	High-Bay Fixtures	T5	144.01	-$2.69	10	2.20	-$0.002
Int. Lighting	High-Bay Fixtures	LED (2020)	211.79	$43.46	15	-	$0.019
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	1,218.07	$4,278.55	15	0.61	$0.324
Int. Lighting	Linear Fluorescent	T8	1,267.32	$1.75	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	1,758.16	$28.58	10	1.53	$0.002
Int. Lighting	Linear Fluorescent	T5	2,038.21	$46.08	10	1.66	$0.003
Int. Lighting	Linear Fluorescent	LED (2020)	3,714.16	$1,187.03	15	-	$0.030
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	1.16	$0.04	3	-	$0.013
Ext. Lighting	Screw-in	70W HIR PAR-38	1.78	$0.06	3	-	$0.012
Ext. Lighting	Screw-in	CFL	3.34	$0.03	6	3.34	$0.002
Ext. Lighting	Screw-in	LED (2010)	3.61	$0.93	20	1.80	$0.020
Ext. Lighting	Screw-in	LED (2020)	4.15	$0.26	20	-	$0.005
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	235.78	$836.22	15	0.45	$0.328
Ext. Lighting	HID	T8	245.49	-$6.32	10	1.27	-$0.003
Ext. Lighting	HID	Light Emitting Plasma	380.25	$28.20	15	1.32	$0.007
Ext. Lighting	HID	High Pressure Sodium	380.38	-$0.34	6	1.58	$0.000
Ext. Lighting	HID	T5	397.35	$2.41	10	1.54	$0.001

End Use	Technology	Efficiency Definition	Savings (kWh/Emp)	Incremental Cost ($/Emp)	Lifetime (Years)	BC Ratio	Levelized Cost ($/kWh)
Ext. Lighting	HID	LED (2020)	727.52	$227.18	15	-	$0.029
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.09	$0.32	15	0.47	$0.324
Ext. Lighting	Linear Fluorescent	T8	0.10	$0.00	10	1.34	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.13	$0.00	10	1.51	$0.002
Ext. Lighting	Linear Fluorescent	T5	0.15	$0.00	10	1.63	$0.003
Ext. Lighting	Linear Fluorescent	LED (2020)	0.28	$0.09	15	-	$0.030
Motors	Pumps	Standard	-	$0.00	10	1.00	$0.000
Motors	Pumps	High Efficiency	102.23	$85.43	10	1.00	$0.104
Motors	Fans & Blowers	Standard	-	$0.00	10	1.00	$0.000
Motors	Fans & Blowers	High Efficiency	29.17	$28.15	10	1.00	$0.120
Motors	Compressed Air	Standard	-	$0.00	10	1.00	$0.000
Motors	Compressed Air	High Efficiency	99.70	$61.03	10	1.00	$0.076
Motors	Matl Handling	Standard	-	$0.00	10	1.00	$0.000
Motors	Matl Handling	High Efficiency	28.72	$30.48	10	1.00	$0.132
Motors	Matl Processing	Standard	-	$0.00	10	1.00	$0.000
Motors	Matl Processing	High Efficiency	172.31	$182.88	10	1.00	$0.132
Motors	Other Motors	Standard	-	$0.00	10	1.00	$0.000
Motors	Other Motors	High Efficiency	17.23	$18.29	10	1.00	$0.132
Process	Process Heating	Standard	-	$0.00	15	1.00	$0.000
Process	Process Cool and Refrig	Standard	-	$0.00	15	1.00	$0.000
Process	Electro-Chem Process	Standard	-	$0.00	15	1.00	$0.000
Process	Other Process	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table D-4 Energy Efficiency Equipment Data, Electric—Chemicals, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/Emp)	Incremental Cost ($/Emp)	Lifetime (Years)	BC Ratio	Levelized Cost ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	1,845.30	$886.16	20	1.14	$0.037
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	2,214.36	$1,152.01	20	1.17	$0.040
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	4,613.26	$1,417.86	20	1.45	$0.024
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	4,890.14	$1,683.71	20	1.49	$0.027
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	3,523.65	$458.48	20	1.23	$0.010
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	3,994.68	$916.97	20	1.27	$0.018
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	4,701.69	$1,100.36	20	1.33	$0.018
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	5,641.71	$1,711.67	20	1.42	$0.023
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	5,877.90	$1,895.07	20	1.44	$0.025
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	6,350.30	$2,078.46	20	1.49	$0.025
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	2,366.36	$1,203.07	16	-	$0.045
Cooling	Roof top AC	EER 11.2	4,744.78	$2,313.59	16	1.00	$0.043
Cooling	Roof top AC	EER 12.0	6,199.67	$4,442.10	16	1.06	$0.063
Cooling	Roof top AC	Ductless Minisplit	7,765.55	$14,575.63	16	1.07	$0.166
Cooling	Air-Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air-Source Heat Pump	EER 10.3, COP 3.2	2,517.93	$1,461.63	16	-	$0.051
Cooling	Air-Source Heat Pump	EER 11.0, COP 3.3	4,007.92	$2,101.09	16	1.00	$0.046
Cooling	Air-Source Heat Pump	EER 11.7, COP 3.4	5,320.45	$5,389.75	16	1.04	$0.090
Cooling	Air-Source Heat Pump	EER 12.0, COP 3.4	5,836.05	$7,034.08	16	1.06	$0.107
Cooling	Air-Source Heat Pump	Ductless Minisplit	7,383.11	$13,474.36	16	1.10	$0.162
Cooling	Geothermal Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geothermal Heat Pump	EER 16, COP 3.5	1,489.10	$3,350.05	16	1.07	$0.199
Cooling	Geothermal Heat Pump	EER 18, COP 3.8	2,716.95	$6,700.10	16	1.13	$0.218
Cooling	Geothermal Heat Pump	EER 30, COP 5.0	6,646.08	$8,836.79	16	1.53	$0.118
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	289.69	$839.34	14	1.01	$0.281
Cooling	Other Cooling	EER 10.8	569.63	$9,547.45	14	0.95	$1.623
Cooling	Other Cooling	EER 11	837.78	$10,105.07	14	0.96	$1.168
Cooling	Other Cooling	EER 11.5	1,095.37	$11,499.10	14	0.96	$1.016

End Use	Technology	Efficiency Definition	Savings (kWh/Emp)	Incremental Cost ($/Emp)	Lifetime (Years)	BC Ratio	Levelized Cost ($/kWh)
Heating	Air-Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air-Source Heat Pump	EER 10.3, COP 3.2	642.04	$4,223.26	16	-	$0.582
Heating	Air-Source Heat Pump	EER 11.0, COP 3.3	1,280.94	$6,070.94	16	1.00	$0.420
Heating	Air-Source Heat Pump	EER 11.7, COP 3.4	1,915.14	$15,573.28	16	0.89	$0.720
Heating	Air-Source Heat Pump	EER 12.0, COP 3.4	1,915.14	$20,324.45	16	0.84	$0.939
Heating	Air-Source Heat Pump	Ductless Minisplit	2,544.64	$38,933.19	16	0.69	$1.354
Heating	Geothermal Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geothermal Heat Pump	EER 16, COP 3.5	1,992.22	$8,887.53	16	0.92	$0.395
Heating	Geothermal Heat Pump	EER 18, COP 3.8	4,587.36	$17,775.06	16	0.85	$0.343
Heating	Geothermal Heat Pump	EER 30, COP 5.0	8,922.41	$23,443.59	16	0.83	$0.233
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	1,933.92	-$4,661.27	10	1.04	-$0.299
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	748.01	$28.24	3	-	$0.013
Int. Lighting	Screw-in	70W HIR PAR-38	1,149.20	$38.84	3	-	$0.012
Int. Lighting	Screw-in	CFL	2,151.36	$22.50	6	3.63	$0.002
Int. Lighting	Screw-in	LED (2010)	2,329.20	$597.47	20	2.50	$0.020
Int. Lighting	Screw-in	LED (2020)	2,675.49	$168.57	20	-	$0.005
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	110.84	$168.49	15	0.81	$0.140
Int. Lighting	High-Bay Fixtures	T8	112.83	-$4.48	10	1.78	-$0.005
Int. Lighting	High-Bay Fixtures	High Pressure Sodium	120.06	$0.80	6	1.78	$0.001
Int. Lighting	High-Bay Fixtures	Induction	132.40	$47.53	15	1.38	$0.033
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	140.50	$2.61	15	1.98	$0.002
Int. Lighting	High-Bay Fixtures	T5	144.01	-$2.69	10	2.20	-$0.002
Int. Lighting	High-Bay Fixtures	LED (2020)	211.79	$43.46	15	-	$0.019
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	1,218.07	$4,278.55	15	0.61	$0.324
Int. Lighting	Linear Fluorescent	T8	1,267.32	$1.75	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	1,758.16	$28.58	10	1.53	$0.002
Int. Lighting	Linear Fluorescent	T5	2,038.21	$46.08	10	1.66	$0.003
Int. Lighting	Linear Fluorescent	LED (2020)	3,714.16	$1,187.03	15	-	$0.030
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	1.16	$0.04	3	-	$0.013
Ext. Lighting	Screw-in	70W HIR PAR-38	1.78	$0.06	3	-	$0.012
Ext. Lighting	Screw-in	CFL	3.34	$0.03	6	3.34	$0.002
Ext. Lighting	Screw-in	LED (2010)	3.61	$0.93	20	1.80	$0.020
Ext. Lighting	Screw-in	LED (2020)	4.15	$0.26	20	-	$0.005
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	235.78	$836.22	15	0.45	$0.328
Ext. Lighting	HID	T8	245.49	-$6.32	10	1.27	-$0.003
Ext. Lighting	HID	Light Emitting Plasma	380.25	$28.20	15	1.32	$0.007
Ext. Lighting	HID	High Pressure Sodium	380.38	-$0.34	6	1.58	$0.000
Ext. Lighting	HID	T5	397.35	$2.41	10	1.54	$0.001
Ext. Lighting	HID	LED (2020)	727.52	$227.18	15	-	$0.029
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.09	$0.32	15	0.47	$0.324
Ext. Lighting	Linear Fluorescent	T8	0.10	$0.00	10	1.34	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.13	$0.00	10	1.51	$0.002
Ext. Lighting	Linear Fluorescent	T5	0.15	$0.00	10	1.63	$0.003
Ext. Lighting	Linear Fluorescent	LED (2020)	0.28	$0.09	15	-	$0.030
Motors	Pumps	Standard	-	$0.00	10	1.00	$0.000
Motors	Pumps	High Efficiency	102.23	$84.56	10	1.00	$0.102
Motors	Fans & Blowers	Standard	-	$0.00	10	1.00	$0.000
Motors	Fans & Blowers	High Efficiency	29.17	$27.86	10	1.00	$0.118
Motors	Compressed Air	Standard	-	$0.00	10	1.00	$0.000
Motors	Compressed Air	High Efficiency	99.70	$60.41	10	1.00	$0.075
Motors	Matl Handling	Standard	-	$0.00	10	1.00	$0.000
Motors	Matl Handling	High Efficiency	28.72	$30.17	10	1.00	$0.130
Motors	Matl Processing	Standard	-	$0.00	10	1.00	$0.000

End Use	Technology	Efficiency Definition	Savings (kWh/Emp)	Incremental Cost ($/Emp)	Lifetime (Years)	BC Ratio	Levelized Cost ($/kWh)
Motors	Matl Processing	High Efficiency	172.31	$181.01	10	1.00	$0.130
Motors	Other Motors	Standard	-	$0.00	10	1.00	$0.000
Motors	Other Motors	High Efficiency	17.23	$18.10	10	1.00	$0.130
Process	Process Heating	Standard	-	$0.00	15	1.00	$0.000
Process	Process Cool and Refrig	Standard	-	$0.00	15	1.00	$0.000
Process	Electro-Chem Process	Standard	-	$0.00	15	1.00	$0.000
Process	Other Process	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table D-5 Energy Efficiency Equipment Data, Electric—Plastics, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/Emp)	Incremental Cost ($/Emp)	Lifetime (Years)	BC Ratio	Levelized Cost ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	2,665.86	$974.44	20	1.14	$0.028
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	3,199.00	$1,266.78	20	1.17	$0.031
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	6,664.56	$1,559.11	20	1.46	$0.018
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	7,064.49	$1,851.44	20	1.50	$0.020
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	4,903.29	$474.79	20	1.24	$0.007
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	5,558.70	$949.58	20	1.27	$0.013
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	6,542.63	$1,139.49	20	1.34	$0.013
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	7,852.40	$1,772.54	20	1.43	$0.017
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	8,180.72	$1,962.46	20	1.45	$0.018
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	8,838.20	$2,152.38	20	1.51	$0.019
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	3,179.97	$1,644.53	16	-	$0.046
Cooling	Roof top AC	EER 11.2	6,372.30	$3,162.56	16	1.00	$0.044
Cooling	Roof top AC	EER 12.0	8,326.62	$6,072.12	16	1.06	$0.065
Cooling	Roof top AC	Ductless Minisplit	10,431.27	$19,924.16	16	1.06	$0.169
Cooling	Air-Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air-Source Heat Pump	EER 10.3, COP 3.2	3,465.11	$2,045.93	16	-	$0.052
Cooling	Air-Source Heat Pump	EER 11.0, COP 3.3	5,515.82	$2,941.03	16	1.00	$0.047
Cooling	Air-Source Heat Pump	EER 11.7, COP 3.4	7,321.01	$7,544.38	16	1.04	$0.091
Cooling	Air-Source Heat Pump	EER 12.0, COP 3.4	8,030.53	$9,846.05	16	1.06	$0.109
Cooling	Air-Source Heat Pump	Ductless Minisplit	10,157.66	$18,860.94	16	1.10	$0.164
Cooling	Geothermal Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geothermal Heat Pump	EER 16, COP 3.5	2,014.13	$4,608.79	16	1.07	$0.203
Cooling	Geothermal Heat Pump	EER 18, COP 3.8	3,674.90	$9,217.58	16	1.13	$0.222
Cooling	Geothermal Heat Pump	EER 30, COP 5.0	8,989.38	$12,157.10	16	1.52	$0.120
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	384.67	$1,119.10	14	1.01	$0.282
Cooling	Other Cooling	EER 10.8	753.74	$12,729.71	14	0.95	$1.635
Cooling	Other Cooling	EER 11	1,109.16	$13,473.19	14	0.96	$1.176
Cooling	Other Cooling	EER 11.5	1,450.94	$15,331.87	14	0.96	$1.023
Heating	Air-Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air-Source Heat Pump	EER 10.3, COP 3.2	269.03	$4,345.77	16	-	$1.430
Heating	Air-Source Heat Pump	EER 11.0, COP 3.3	514.15	$6,247.04	16	1.00	$1.075
Heating	Air-Source Heat Pump	EER 11.7, COP 3.4	735.35	$16,025.01	16	0.90	$1.929
Heating	Air-Source Heat Pump	EER 12.0, COP 3.4	735.35	$20,914.00	16	0.85	$2.517
Heating	Air-Source Heat Pump	Ductless Minisplit	937.77	$40,062.53	16	0.71	$3.781
Heating	Geothermal Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geothermal Heat Pump	EER 16, COP 3.5	2,571.56	$8,756.72	16	0.93	$0.301
Heating	Geothermal Heat Pump	EER 18, COP 3.8	5,921.36	$17,513.44	16	0.87	$0.262
Heating	Geothermal Heat Pump	EER 30, COP 5.0	1,303.37	$23,098.54	16	0.81	$1.569
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	2,491.88	-$5,075.74	10	1.04	-$0.252
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	1,085.64	$40.99	3	-	$0.013

End Use	Technology	Efficiency Definition	Savings (kWh/Emp)	Incremental Cost ($/Emp)	Lifetime (Years)	BC Ratio	Levelized Cost ($/kWh)
Int. Lighting	Screw-in	70W HIR PAR-38	1,667.92	$56.38	3	-	$0.012
Int. Lighting	Screw-in	CFL	3,122.43	$32.65	6	3.63	$0.002
Int. Lighting	Screw-in	LED (2010)	3,380.54	$867.15	20	2.50	$0.020
Int. Lighting	Screw-in	LED (2020)	3,883.14	$244.65	20	-	$0.005
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	160.87	$244.55	15	0.81	$0.140
Int. Lighting	High-Bay Fixtures	T8	163.76	-$6.51	10	1.78	-$0.005
Int. Lighting	High-Bay Fixtures	High Pressure Sodium	174.25	$1.16	6	1.78	$0.001
Int. Lighting	High-Bay Fixtures	Induction	192.16	$68.99	15	1.38	$0.033
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	203.91	$3.78	15	1.98	$0.002
Int. Lighting	High-Bay Fixtures	T5	209.01	-$3.90	10	2.20	-$0.002
Int. Lighting	High-Bay Fixtures	LED (2020)	307.39	$63.07	15	-	$0.019
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	1,767.88	$6,209.77	15	0.61	$0.324
Int. Lighting	Linear Fluorescent	T8	1,839.35	$2.54	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	2,551.74	$41.48	10	1.53	$0.002
Int. Lighting	Linear Fluorescent	T5	2,958.20	$66.88	10	1.66	$0.003
Int. Lighting	Linear Fluorescent	LED (2020)	5,390.63	$1,722.82	15	-	$0.030
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	1.68	$0.06	3	-	$0.013
Ext. Lighting	Screw-in	70W HIR PAR-38	2.59	$0.09	3	-	$0.012
Ext. Lighting	Screw-in	CFL	4.84	$0.05	6	3.34	$0.002
Ext. Lighting	Screw-in	LED (2010)	5.24	$1.34	20	1.80	$0.020
Ext. Lighting	Screw-in	LED (2020)	6.02	$0.38	20	-	$0.005
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	342.21	$1,213.67	15	0.45	$0.328
Ext. Lighting	HID	T8	356.29	-$9.17	10	1.27	-$0.003
Ext. Lighting	HID	Light Emitting Plasma	551.89	$40.93	15	1.32	$0.007
Ext. Lighting	HID	High Pressure Sodium	552.07	-$0.50	6	1.58	$0.000
Ext. Lighting	HID	T5	576.71	$3.50	10	1.54	$0.001
Ext. Lighting	HID	LED (2020)	1,055.90	$329.73	15	-	$0.029
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.13	$0.47	15	0.47	$0.324
Ext. Lighting	Linear Fluorescent	T8	0.14	$0.00	10	1.34	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.19	$0.00	10	1.51	$0.002
Ext. Lighting	Linear Fluorescent	T5	0.22	$0.01	10	1.63	$0.003
Ext. Lighting	Linear Fluorescent	LED (2020)	0.41	$0.13	15	-	$0.030
Motors	Pumps	Standard	-	$0.00	10	1.00	$0.000
Motors	Pumps	High Efficiency	66.07	$55.21	10	1.00	$0.104
Motors	Fans & Blowers	Standard	-	$0.00	10	1.00	$0.000
Motors	Fans & Blowers	High Efficiency	15.19	$14.65	10	1.00	$0.120
Motors	Compressed Air	Standard	-	$0.00	10	1.00	$0.000
Motors	Compressed Air	High Efficiency	30.01	$18.37	10	1.00	$0.076
Motors	Matl Handling	Standard	-	$0.00	10	1.00	$0.000
Motors	Matl Handling	High Efficiency	19.91	$21.13	10	1.00	$0.132
Motors	Matl Processing	Standard	-	$0.00	10	1.00	$0.000
Motors	Matl Processing	High Efficiency	119.48	$126.80	10	1.00	$0.132
Motors	Other Motors	Standard	-	$0.00	10	1.00	$0.000
Motors	Other Motors	High Efficiency	9.84	$10.44	10	1.00	$0.132
Process	Process Heating	Standard	-	$0.00	15	1.00	$0.000
Process	Process Cool and Refrig	Standard	-	$0.00	15	1.00	$0.000
Process	Electro-Chem Process	Standard	-	$0.00	15	1.00	$0.000
Process	Other Process	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table D-6 Energy Efficiency Equipment Data, Electric— Plastics, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/Emp)	Incremental Cost ($/Emp)	Lifetime (Years)	BC Ratio	Levelized Cost ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	2,195.15	$1,054.17	20	1.14	$0.037
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	2,634.19	$1,370.42	20	1.17	$0.040

End Use	Technology	Efficiency Definition	Savings (kWh/Emp)	Incremental Cost ($/Emp)	Lifetime (Years)	BC Ratio	Levelized Cost ($/kWh)
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	5,487.89	$1,686.67	20	1.45	$0.024
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	5,817.26	$2,002.92	20	1.49	$0.027
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	4,191.70	$545.41	20	1.23	$0.010
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	4,752.04	$1,090.82	20	1.27	$0.018
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	5,593.08	$1,308.98	20	1.33	$0.018
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	6,711.32	$2,036.19	20	1.42	$0.023
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	6,992.29	$2,254.35	20	1.44	$0.025
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	7,554.25	$2,472.51	20	1.49	$0.025
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	2,815.00	$1,431.16	16	-	$0.045
Cooling	Roof top AC	EER 11.2	5,644.34	$2,752.23	16	1.00	$0.043
Cooling	Roof top AC	EER 12.0	7,375.07	$5,284.27	16	1.06	$0.063
Cooling	Roof top AC	Ductless Minisplit	9,237.82	$17,339.02	16	1.07	$0.166
Cooling	Air-Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air-Source Heat Pump	EER 10.3, COP 3.2	2,995.31	$1,738.74	16	-	$0.051
Cooling	Air-Source Heat Pump	EER 11.0, COP 3.3	4,767.78	$2,499.43	16	1.00	$0.046
Cooling	Air-Source Heat Pump	EER 11.7, COP 3.4	6,329.15	$6,411.59	16	1.04	$0.090
Cooling	Air-Source Heat Pump	EER 12.0, COP 3.4	6,942.50	$8,367.66	16	1.06	$0.107
Cooling	Air-Source Heat Pump	Ductless Minisplit	8,782.87	$16,028.97	16	1.10	$0.162
Cooling	Geothermal Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geothermal Heat Pump	EER 16, COP 3.5	1,771.41	$3,985.19	16	1.07	$0.199
Cooling	Geothermal Heat Pump	EER 18, COP 3.8	3,232.06	$7,970.38	16	1.13	$0.218
Cooling	Geothermal Heat Pump	EER 30, COP 5.0	7,906.10	$10,512.16	16	1.53	$0.118
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	344.61	$998.47	14	1.01	$0.281
Cooling	Other Cooling	EER 10.8	677.62	$11,357.55	14	0.95	$1.623
Cooling	Other Cooling	EER 11	996.62	$12,020.88	14	0.96	$1.168
Cooling	Other Cooling	EER 11.5	1,303.04	$13,679.22	14	0.96	$1.016
Heating	Air-Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air-Source Heat Pump	EER 10.3, COP 3.2	763.76	$5,023.95	16	-	$0.582
Heating	Air-Source Heat Pump	EER 11.0, COP 3.3	1,523.79	$7,221.93	16	1.00	$0.420
Heating	Air-Source Heat Pump	EER 11.7, COP 3.4	2,278.23	$18,525.81	16	0.89	$0.720
Heating	Air-Source Heat Pump	EER 12.0, COP 3.4	2,278.23	$24,177.75	16	0.84	$0.939
Heating	Air-Source Heat Pump	Ductless Minisplit	3,027.07	$46,314.53	16	0.69	$1.354
Heating	Geothermal Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geothermal Heat Pump	EER 16, COP 3.5	2,369.93	$10,572.52	16	0.92	$0.395
Heating	Geothermal Heat Pump	EER 18, COP 3.8	5,457.07	$21,145.03	16	0.85	$0.343
Heating	Geothermal Heat Pump	EER 30, COP 5.0	10,614.01	$27,888.26	16	0.83	$0.233
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	2,300.58	-$5,545.00	10	1.04	-$0.299
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	1,085.64	$40.99	3	-	$0.013
Int. Lighting	Screw-in	70W HIR PAR-38	1,667.92	$56.38	3	-	$0.012
Int. Lighting	Screw-in	CFL	3,122.43	$32.65	6	3.63	$0.002
Int. Lighting	Screw-in	LED (2010)	3,380.54	$867.15	20	2.50	$0.020
Int. Lighting	Screw-in	LED (2020)	3,883.14	$244.65	20	-	$0.005
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	160.87	$244.55	15	0.81	$0.140
Int. Lighting	High-Bay Fixtures	T8	163.76	-$6.51	10	1.78	-$0.005
Int. Lighting	High-Bay Fixtures	High Pressure Sodium	174.25	$1.16	6	1.78	$0.001
Int. Lighting	High-Bay Fixtures	Induction	192.16	$68.99	15	1.38	$0.033
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	203.91	$3.78	15	1.98	$0.002
Int. Lighting	High-Bay Fixtures	T5	209.01	-$3.90	10	2.20	-$0.002
Int. Lighting	High-Bay Fixtures	LED (2020)	307.39	$63.07	15	-	$0.019
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	1,767.88	$6,209.77	15	0.61	$0.324
Int. Lighting	Linear Fluorescent	T8	1,839.35	$2.54	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	2,551.74	$41.48	10	1.53	$0.002
Int. Lighting	Linear Fluorescent	T5	2,958.20	$66.88	10	1.66	$0.003

End Use	Technology	Efficiency Definition	Savings (kWh/Emp)	Incremental Cost ($/Emp)	Lifetime (Years)	BC Ratio	Levelized Cost ($/kWh)
Int. Lighting	Linear Fluorescent	LED (2020)	5,390.63	$1,722.82	15	-	$0.030
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	1.68	$0.06	3	-	$0.013
Ext. Lighting	Screw-in	70W HIR PAR-38	2.59	$0.09	3	-	$0.012
Ext. Lighting	Screw-in	CFL	4.84	$0.05	6	3.34	$0.002
Ext. Lighting	Screw-in	LED (2010)	5.24	$1.34	20	1.80	$0.020
Ext. Lighting	Screw-in	LED (2020)	6.02	$0.38	20	-	$0.005
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	342.21	$1,213.67	15	0.45	$0.328
Ext. Lighting	HID	T8	356.29	-$9.17	10	1.27	-$0.003
Ext. Lighting	HID	Light Emitting Plasma	551.89	$40.93	15	1.32	$0.007
Ext. Lighting	HID	High Pressure Sodium	552.07	-$0.50	6	1.58	$0.000
Ext. Lighting	HID	T5	576.71	$3.50	10	1.54	$0.001
Ext. Lighting	HID	LED (2020)	1,055.90	$329.73	15	-	$0.029
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.13	$0.47	15	0.47	$0.324
Ext. Lighting	Linear Fluorescent	T8	0.14	$0.00	10	1.34	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.19	$0.00	10	1.51	$0.002
Ext. Lighting	Linear Fluorescent	T5	0.22	$0.01	10	1.63	$0.003
Ext. Lighting	Linear Fluorescent	LED (2020)	0.41	$0.13	15	-	$0.030
Motors	Pumps	Standard	-	$0.00	10	1.00	$0.000
Motors	Pumps	High Efficiency	66.07	$54.64	10	1.00	$0.102
Motors	Fans & Blowers	Standard	-	$0.00	10	1.00	$0.000
Motors	Fans & Blowers	High Efficiency	15.19	$14.50	10	1.00	$0.118
Motors	Compressed Air	Standard	-	$0.00	10	1.00	$0.000
Motors	Compressed Air	High Efficiency	30.01	$18.18	10	1.00	$0.075
Motors	Matl Handling	Standard	-	$0.00	10	1.00	$0.000
Motors	Matl Handling	High Efficiency	19.91	$20.92	10	1.00	$0.130
Motors	Matl Processing	Standard	-	$0.00	10	1.00	$0.000
Motors	Matl Processing	High Efficiency	119.48	$125.51	10	1.00	$0.130
Motors	Other Motors	Standard	-	$0.00	10	1.00	$0.000
Motors	Other Motors	High Efficiency	9.84	$10.33	10	1.00	$0.130
Process	Process Heating	Standard	-	$0.00	15	1.00	$0.000
Process	Process Cool and Refrig	Standard	-	$0.00	15	1.00	$0.000
Process	Electro-Chem Process	Standard	-	$0.00	15	1.00	$0.000
Process	Other Process	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table D-7 Energy Efficiency Equipment Data, Electric—Transportation, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/Emp)	Incremental Cost ($/Emp)	Lifetime (Years)	BC Ratio	Levelized Cost ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	2,168.02	$792.47	20	1.14	$0.028
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	2,601.60	$1,030.21	20	1.17	$0.031
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	5,420.00	$1,267.96	20	1.46	$0.018
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	5,745.24	$1,505.70	20	1.50	$0.020
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	3,987.63	$386.13	20	1.24	$0.007
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	4,520.64	$772.25	20	1.27	$0.013
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	5,320.83	$926.70	20	1.34	$0.013
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	6,386.01	$1,441.53	20	1.43	$0.017
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	6,653.02	$1,595.98	20	1.45	$0.018
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	7,187.72	$1,750.43	20	1.51	$0.019
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	2,586.13	$1,337.43	16	-	$0.046
Cooling	Roof top AC	EER 11.2	5,182.31	$2,571.98	16	1.00	$0.044
Cooling	Roof top AC	EER 12.0	6,771.68	$4,938.19	16	1.06	$0.065
Cooling	Roof top AC	Ductless Minisplit	8,483.30	$16,203.44	16	1.06	$0.169
Cooling	Air-Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air-Source Heat Pump	EER 10.3, COP 3.2	2,818.02	$1,663.87	16	-	$0.052

End Use	Technology	Efficiency Definition	Savings (kWh/Emp)	Incremental Cost ($/Emp)	Lifetime (Years)	BC Ratio	Levelized Cost ($/kWh)
Cooling	Air-Source Heat Pump	EER 11.0, COP 3.3	4,485.77	$2,391.81	16	1.00	$0.047
Cooling	Air-Source Heat Pump	EER 11.7, COP 3.4	5,953.86	$6,135.51	16	1.04	$0.091
Cooling	Air-Source Heat Pump	EER 12.0, COP 3.4	6,530.88	$8,007.36	16	1.06	$0.109
Cooling	Air-Source Heat Pump	Ductless Minisplit	8,260.78	$15,338.78	16	1.10	$0.164
Cooling	Geothermal Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geothermal Heat Pump	EER 16, COP 3.5	1,638.00	$3,748.13	16	1.07	$0.203
Cooling	Geothermal Heat Pump	EER 18, COP 3.8	2,988.64	$7,496.25	16	1.13	$0.222
Cooling	Geothermal Heat Pump	EER 30, COP 5.0	7,310.67	$9,886.84	16	1.52	$0.120
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	312.83	$910.11	14	1.01	$0.282
Cooling	Other Cooling	EER 10.8	612.98	$10,352.52	14	0.95	$1.635
Cooling	Other Cooling	EER 11	902.03	$10,957.15	14	0.96	$1.176
Cooling	Other Cooling	EER 11.5	1,179.99	$12,468.74	14	0.96	$1.023
Heating	Air-Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air-Source Heat Pump	EER 10.3, COP 3.2	218.79	$3,534.22	16	-	$1.430
Heating	Air-Source Heat Pump	EER 11.0, COP 3.3	418.14	$5,080.44	16	1.00	$1.075
Heating	Air-Source Heat Pump	EER 11.7, COP 3.4	598.03	$13,032.44	16	0.90	$1.929
Heating	Air-Source Heat Pump	EER 12.0, COP 3.4	598.03	$17,008.44	16	0.85	$2.517
Heating	Air-Source Heat Pump	Ductless Minisplit	762.65	$32,581.10	16	0.71	$3.781
Heating	Geothermal Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geothermal Heat Pump	EER 16, COP 3.5	2,091.34	$7,121.46	16	0.93	$0.301
Heating	Geothermal Heat Pump	EER 18, COP 3.8	4,815.58	$14,242.92	16	0.87	$0.262
Heating	Geothermal Heat Pump	EER 30, COP 5.0	1,059.97	$18,785.03	16	0.81	$1.569
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	2,026.54	-$4,127.87	10	1.04	-$0.252
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	828.27	$31.27	3	-	$0.013
Int. Lighting	Screw-in	70W HIR PAR-38	1,272.52	$43.01	3	-	$0.012
Int. Lighting	Screw-in	CFL	2,382.22	$24.91	6	3.63	$0.002
Int. Lighting	Screw-in	LED (2010)	2,579.14	$661.58	20	2.50	$0.020
Int. Lighting	Screw-in	LED (2020)	2,962.59	$186.65	20	-	$0.005
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	122.73	$186.57	15	0.81	$0.140
Int. Lighting	High-Bay Fixtures	T8	124.94	-$4.96	10	1.78	-$0.005
Int. Lighting	High-Bay Fixtures	High Pressure Sodium	132.94	$0.89	6	1.78	$0.001
Int. Lighting	High-Bay Fixtures	Induction	146.61	$52.63	15	1.38	$0.033
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	155.57	$2.88	15	1.98	$0.002
Int. Lighting	High-Bay Fixtures	T5	159.46	-$2.98	10	2.20	-$0.002
Int. Lighting	High-Bay Fixtures	LED (2020)	234.52	$48.12	15	-	$0.019
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	1,348.78	$4,737.67	15	0.61	$0.324
Int. Lighting	Linear Fluorescent	T8	1,403.31	$1.94	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	1,946.82	$31.65	10	1.53	$0.002
Int. Lighting	Linear Fluorescent	T5	2,256.92	$51.03	10	1.66	$0.003
Int. Lighting	Linear Fluorescent	LED (2020)	4,112.71	$1,314.41	15	-	$0.030
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	1.28	$0.05	3	-	$0.013
Ext. Lighting	Screw-in	70W HIR PAR-38	1.97	$0.07	3	-	$0.012
Ext. Lighting	Screw-in	CFL	3.69	$0.04	6	3.34	$0.002
Ext. Lighting	Screw-in	LED (2010)	4.00	$1.03	20	1.80	$0.020
Ext. Lighting	Screw-in	LED (2020)	4.59	$0.29	20	-	$0.005
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	261.09	$925.95	15	0.45	$0.328
Ext. Lighting	HID	T8	271.83	-$7.00	10	1.27	-$0.003
Ext. Lighting	HID	Light Emitting Plasma	421.06	$31.23	15	1.32	$0.007
Ext. Lighting	HID	High Pressure Sodium	421.20	-$0.38	6	1.58	$0.000
Ext. Lighting	HID	T5	439.99	$2.67	10	1.54	$0.001
Ext. Lighting	HID	LED (2020)	805.59	$251.56	15	-	$0.029
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.10	$0.36	15	0.47	$0.324

End Use	Technology	Efficiency Definition	Savings (kWh/Emp)	Incremental Cost ($/Emp)	Lifetime (Years)	BC Ratio	Levelized Cost ($/kWh)
Ext. Lighting	Linear Fluorescent	T8	0.11	$0.00	10	1.34	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.15	$0.00	10	1.51	$0.002
Ext. Lighting	Linear Fluorescent	T5	0.17	$0.00	10	1.63	$0.003
Ext. Lighting	Linear Fluorescent	LED (2020)	0.31	$0.10	15	-	$0.030
Motors	Pumps	Standard	-	$0.00	10	1.00	$0.000
Motors	Pumps	High Efficiency	-	$0.00	10	1.00	$0.000
Motors	Fans & Blowers	Standard	-	$0.00	10	1.00	$0.000
Motors	Fans & Blowers	High Efficiency	13.77	$13.28	10	1.00	$0.120
Motors	Compressed Air	Standard	-	$0.00	10	1.00	$0.000
Motors	Compressed Air	High Efficiency	4.41	$2.70	10	1.00	$0.076
Motors	Matl Handling	Standard	-	$0.00	10	1.00	$0.000
Motors	Matl Handling	High Efficiency	22.81	$24.21	10	1.00	$0.132
Motors	Matl Processing	Standard	-	$0.00	10	1.00	$0.000
Motors	Matl Processing	High Efficiency	40.65	$43.15	10	1.00	$0.132
Motors	Other Motors	Standard	-	$0.00	10	1.00	$0.000
Motors	Other Motors	High Efficiency	5.08	$5.39	10	1.00	$0.132
Process	Process Heating	Standard	-	$0.00	15	1.00	$0.000
Process	Process Cool and Refrig	Standard	-	$0.00	15	1.00	$0.000
Process	Electro-Chem Process	Standard	-	$0.00	15	1.00	$0.000
Process	Other Process	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table D-8 Energy Efficiency Equipment Data, Electric— Transportation, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/Emp)	Incremental Cost ($/Emp)	Lifetime (Years)	BC Ratio	Levelized Cost ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	1,785.22	$857.31	20	1.14	$0.037
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	2,142.27	$1,114.50	20	1.17	$0.040
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	4,463.06	$1,371.70	20	1.45	$0.024
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	4,730.92	$1,628.89	20	1.49	$0.027
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	3,408.93	$443.56	20	1.23	$0.010
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	3,864.62	$887.11	20	1.27	$0.018
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	4,548.61	$1,064.53	20	1.33	$0.018
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	5,458.02	$1,655.94	20	1.42	$0.023
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	5,686.53	$1,833.37	20	1.44	$0.025
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	6,143.54	$2,010.79	20	1.49	$0.025
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	2,289.32	$1,163.90	16	-	$0.045
Cooling	Roof top AC	EER 11.2	4,590.30	$2,238.26	16	1.00	$0.043
Cooling	Roof top AC	EER 12.0	5,997.82	$4,297.47	16	1.06	$0.063
Cooling	Roof top AC	Ductless Minisplit	7,512.72	$14,101.07	16	1.07	$0.166
Cooling	Air-Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air-Source Heat Pump	EER 10.3, COP 3.2	2,435.95	$1,414.04	16	-	$0.051
Cooling	Air-Source Heat Pump	EER 11.0, COP 3.3	3,877.43	$2,032.68	16	1.00	$0.046
Cooling	Air-Source Heat Pump	EER 11.7, COP 3.4	5,147.22	$5,214.26	16	1.04	$0.090
Cooling	Air-Source Heat Pump	EER 12.0, COP 3.4	5,646.03	$6,805.06	16	1.06	$0.107
Cooling	Air-Source Heat Pump	Ductless Minisplit	7,142.73	$13,035.66	16	1.10	$0.162
Cooling	Geothermal Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geothermal Heat Pump	EER 16, COP 3.5	1,440.61	$3,240.98	16	1.07	$0.199
Cooling	Geothermal Heat Pump	EER 18, COP 3.8	2,628.49	$6,481.96	16	1.13	$0.218
Cooling	Geothermal Heat Pump	EER 30, COP 5.0	6,429.69	$8,549.08	16	1.53	$0.118
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	280.26	$812.01	14	1.01	$0.281
Cooling	Other Cooling	EER 10.8	551.08	$9,236.60	14	0.95	$1.623
Cooling	Other Cooling	EER 11	810.50	$9,776.06	14	0.96	$1.168
Cooling	Other Cooling	EER 11.5	1,059.71	$11,124.71	14	0.96	$1.016
Heating	Air-Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000

End Use	Technology	Efficiency Definition	Savings (kWh/Emp)	Incremental Cost ($/Emp)	Lifetime (Years)	BC Ratio	Levelized Cost ($/kWh)
Heating	Air-Source Heat Pump	EER 10.3, COP 3.2	621.13	$4,085.76	16	-	$0.582
Heating	Air-Source Heat Pump	EER 11.0, COP 3.3	1,239.24	$5,873.28	16	1.00	$0.420
Heating	Air-Source Heat Pump	EER 11.7, COP 3.4	1,852.79	$15,066.23	16	0.89	$0.720
Heating	Air-Source Heat Pump	EER 12.0, COP 3.4	1,852.79	$19,662.71	16	0.84	$0.939
Heating	Air-Source Heat Pump	Ductless Minisplit	2,461.79	$37,665.58	16	0.69	$1.354
Heating	Geothermal Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geothermal Heat Pump	EER 16, COP 3.5	1,927.36	$8,598.16	16	0.92	$0.395
Heating	Geothermal Heat Pump	EER 18, COP 3.8	4,438.00	$17,196.33	16	0.85	$0.343
Heating	Geothermal Heat Pump	EER 30, COP 5.0	8,631.91	$22,680.30	16	0.83	$0.233
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	1,870.96	-$4,509.51	10	1.04	-$0.299
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	828.27	$31.27	3	-	$0.013
Int. Lighting	Screw-in	70W HIR PAR-38	1,272.52	$43.01	3	-	$0.012
Int. Lighting	Screw-in	CFL	2,382.22	$24.91	6	3.63	$0.002
Int. Lighting	Screw-in	LED (2010)	2,579.14	$661.58	20	2.50	$0.020
Int. Lighting	Screw-in	LED (2020)	2,962.59	$186.65	20	-	$0.005
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	122.73	$186.57	15	0.81	$0.140
Int. Lighting	High-Bay Fixtures	T8	124.94	-$4.96	10	1.78	-$0.005
Int. Lighting	High-Bay Fixtures	High Pressure Sodium	132.94	$0.89	6	1.78	$0.001
Int. Lighting	High-Bay Fixtures	Induction	146.61	$52.63	15	1.38	$0.033
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	155.57	$2.88	15	1.98	$0.002
Int. Lighting	High-Bay Fixtures	T5	159.46	-$2.98	10	2.20	-$0.002
Int. Lighting	High-Bay Fixtures	LED (2020)	234.52	$48.12	15	-	$0.019
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	1,348.78	$4,737.67	15	0.61	$0.324
Int. Lighting	Linear Fluorescent	T8	1,403.31	$1.94	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	1,946.82	$31.65	10	1.53	$0.002
Int. Lighting	Linear Fluorescent	T5	2,256.92	$51.03	10	1.66	$0.003
Int. Lighting	Linear Fluorescent	LED (2020)	4,112.71	$1,314.41	15	-	$0.030
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	1.28	$0.05	3	-	$0.013
Ext. Lighting	Screw-in	70W HIR PAR-38	1.97	$0.07	3	-	$0.012
Ext. Lighting	Screw-in	CFL	3.69	$0.04	6	3.34	$0.002
Ext. Lighting	Screw-in	LED (2010)	4.00	$1.03	20	1.80	$0.020
Ext. Lighting	Screw-in	LED (2020)	4.59	$0.29	20	-	$0.005
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	261.09	$925.95	15	0.45	$0.328
Ext. Lighting	HID	T8	271.83	-$7.00	10	1.27	-$0.003
Ext. Lighting	HID	Light Emitting Plasma	421.06	$31.23	15	1.32	$0.007
Ext. Lighting	HID	High Pressure Sodium	421.20	-$0.38	6	1.58	$0.000
Ext. Lighting	HID	T5	439.99	$2.67	10	1.54	$0.001
Ext. Lighting	HID	LED (2020)	805.59	$251.56	15	-	$0.029
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.10	$0.36	15	0.47	$0.324
Ext. Lighting	Linear Fluorescent	T8	0.11	$0.00	10	1.34	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.15	$0.00	10	1.51	$0.002
Ext. Lighting	Linear Fluorescent	T5	0.17	$0.00	10	1.63	$0.003
Ext. Lighting	Linear Fluorescent	LED (2020)	0.31	$0.10	15	-	$0.030
Motors	Pumps	Standard	-	$0.00	10	1.00	$0.000
Motors	Pumps	High Efficiency	-	$0.00	10	1.00	$0.000
Motors	Fans & Blowers	Standard	-	$0.00	10	1.00	$0.000
Motors	Fans & Blowers	High Efficiency	13.77	$13.15	10	1.00	$0.118
Motors	Compressed Air	Standard	-	$0.00	10	1.00	$0.000
Motors	Compressed Air	High Efficiency	4.41	$2.67	10	1.00	$0.075
Motors	Matl Handling	Standard	-	$0.00	10	1.00	$0.000
Motors	Matl Handling	High Efficiency	22.81	$23.97	10	1.00	$0.130
Motors	Matl Processing	Standard	-	$0.00	10	1.00	$0.000
Motors	Matl Processing	High Efficiency	40.65	$42.71	10	1.00	$0.130

End Use	Technology	Efficiency Definition	Savings (kWh/Emp)	Incremental Cost ($/Emp)	Lifetime (Years)	BC Ratio	Levelized Cost ($/kWh)
Motors	Other Motors	Standard	-	$0.00	10	1.00	$0.000
Motors	Other Motors	High Efficiency	5.08	$5.34	10	1.00	$0.130
Process	Process Heating	Standard	-	$0.00	15	1.00	$0.000
Process	Process Cool and Refrig	Standard	-	$0.00	15	1.00	$0.000
Process	Electro-Chem Process	Standard	-	$0.00	15	1.00	$0.000
Process	Other Process	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table D-9 Energy Efficiency Equipment Data, Electric—Other Industrial, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/Emp)	Incremental Cost ($/Emp)	Lifetime (Years)	BC Ratio	Levelized Cost ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	2,401.71	$877.89	20	1.14	$0.028
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	2,882.03	$1,141.26	20	1.17	$0.031
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	6,004.21	$1,404.63	20	1.46	$0.018
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	6,364.52	$1,668.00	20	1.50	$0.020
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	4,417.46	$427.75	20	1.24	$0.007
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	5,007.92	$855.49	20	1.27	$0.013
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	5,894.36	$1,026.59	20	1.34	$0.013
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	7,074.36	$1,596.91	20	1.43	$0.017
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	7,370.15	$1,768.01	20	1.45	$0.018
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	7,962.48	$1,939.11	20	1.51	$0.019
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	2,864.89	$1,481.59	16	-	$0.046
Cooling	Roof top AC	EER 11.2	5,740.91	$2,849.21	16	1.00	$0.044
Cooling	Roof top AC	EER 12.0	7,501.59	$5,470.48	16	1.06	$0.065
Cooling	Roof top AC	Ductless Minisplit	9,397.70	$17,950.00	16	1.06	$0.169
Cooling	Air-Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air-Source Heat Pump	EER 10.3, COP 3.2	3,121.77	$1,843.21	16	-	$0.052
Cooling	Air-Source Heat Pump	EER 11.0, COP 3.3	4,969.29	$2,649.62	16	1.00	$0.047
Cooling	Air-Source Heat Pump	EER 11.7, COP 3.4	6,595.62	$6,796.85	16	1.04	$0.091
Cooling	Air-Source Heat Pump	EER 12.0, COP 3.4	7,234.84	$8,870.47	16	1.06	$0.109
Cooling	Air-Source Heat Pump	Ductless Minisplit	9,151.20	$16,992.13	16	1.10	$0.164
Cooling	Geothermal Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geothermal Heat Pump	EER 16, COP 3.5	1,814.56	$4,152.13	16	1.07	$0.203
Cooling	Geothermal Heat Pump	EER 18, COP 3.8	3,310.78	$8,304.27	16	1.13	$0.222
Cooling	Geothermal Heat Pump	EER 30, COP 5.0	8,098.68	$10,952.53	16	1.52	$0.120
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	346.55	$1,008.21	14	1.01	$0.282
Cooling	Other Cooling	EER 10.8	679.05	$11,468.41	14	0.95	$1.635
Cooling	Other Cooling	EER 11	999.26	$12,138.22	14	0.96	$1.176
Cooling	Other Cooling	EER 11.5	1,307.18	$13,812.73	14	0.96	$1.023
Heating	Air-Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air-Source Heat Pump	EER 10.3, COP 3.2	242.38	$3,915.17	16	-	$1.430
Heating	Air-Source Heat Pump	EER 11.0, COP 3.3	463.21	$5,628.06	16	1.00	$1.075
Heating	Air-Source Heat Pump	EER 11.7, COP 3.4	662.49	$14,437.20	16	0.90	$1.929
Heating	Air-Source Heat Pump	EER 12.0, COP 3.4	662.49	$18,841.76	16	0.85	$2.517
Heating	Air-Source Heat Pump	Ductless Minisplit	844.85	$36,092.99	16	0.71	$3.781
Heating	Geothermal Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geothermal Heat Pump	EER 16, COP 3.5	2,316.76	$7,889.07	16	0.93	$0.301
Heating	Geothermal Heat Pump	EER 18, COP 3.8	5,334.65	$15,778.15	16	0.87	$0.262
Heating	Geothermal Heat Pump	EER 30, COP 5.0	1,174.22	$20,809.86	16	0.81	$1.569
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	2,244.97	-$4,572.81	10	1.04	-$0.252
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	834.11	$31.49	3	-	$0.013
Int. Lighting	Screw-in	70W HIR PAR-38	1,281.48	$43.32	3	-	$0.012

End Use	Technology	Efficiency Definition	Savings (kWh/Emp)	Incremental Cost ($/Emp)	Lifetime (Years)	BC Ratio	Levelized Cost ($/kWh)
Int. Lighting	Screw-in	CFL	2,399.00	$25.09	6	3.63	$0.002
Int. Lighting	Screw-in	LED (2010)	2,597.31	$666.24	20	2.50	$0.020
Int. Lighting	Screw-in	LED (2020)	2,983.46	$187.97	20	-	$0.005
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	123.60	$187.89	15	0.81	$0.140
Int. Lighting	High-Bay Fixtures	T8	125.82	-$5.00	10	1.78	-$0.005
Int. Lighting	High-Bay Fixtures	High Pressure Sodium	133.88	$0.89	6	1.78	$0.001
Int. Lighting	High-Bay Fixtures	Induction	147.64	$53.00	15	1.38	$0.033
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	156.67	$2.90	15	1.98	$0.002
Int. Lighting	High-Bay Fixtures	T5	160.59	-$3.00	10	2.20	-$0.002
Int. Lighting	High-Bay Fixtures	LED (2020)	236.17	$48.46	15	-	$0.019
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	1,358.28	$4,771.05	15	0.61	$0.324
Int. Lighting	Linear Fluorescent	T8	1,413.19	$1.95	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	1,960.53	$31.87	10	1.53	$0.002
Int. Lighting	Linear Fluorescent	T5	2,272.82	$51.39	10	1.66	$0.003
Int. Lighting	Linear Fluorescent	LED (2020)	4,141.69	$1,323.67	15	-	$0.030
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	1.29	$0.05	3	-	$0.013
Ext. Lighting	Screw-in	70W HIR PAR-38	1.99	$0.07	3	-	$0.012
Ext. Lighting	Screw-in	CFL	3.72	$0.04	6	3.34	$0.002
Ext. Lighting	Screw-in	LED (2010)	4.03	$1.03	20	1.80	$0.020
Ext. Lighting	Screw-in	LED (2020)	4.63	$0.29	20	-	$0.005
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	262.92	$932.48	15	0.45	$0.328
Ext. Lighting	HID	T8	273.74	-$7.05	10	1.27	-$0.003
Ext. Lighting	HID	Light Emitting Plasma	424.02	$31.45	15	1.32	$0.007
Ext. Lighting	HID	High Pressure Sodium	424.16	-$0.38	6	1.58	$0.000
Ext. Lighting	HID	T5	443.09	$2.69	10	1.54	$0.001
Ext. Lighting	HID	LED (2020)	811.26	$253.33	15	-	$0.029
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.10	$0.36	15	0.47	$0.324
Ext. Lighting	Linear Fluorescent	T8	0.11	$0.00	10	1.34	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.15	$0.00	10	1.51	$0.002
Ext. Lighting	Linear Fluorescent	T5	0.17	$0.00	10	1.63	$0.003
Ext. Lighting	Linear Fluorescent	LED (2020)	0.31	$0.10	15	-	$0.030
Motors	Pumps	Standard	-	$0.00	10	1.00	$0.000
Motors	Pumps	High Efficiency	13.41	$11.20	10	1.00	$0.104
Motors	Fans & Blowers	Standard	-	$0.00	10	1.00	$0.000
Motors	Fans & Blowers	High Efficiency	16.54	$15.96	10	1.00	$0.120
Motors	Compressed Air	Standard	-	$0.00	10	1.00	$0.000
Motors	Compressed Air	High Efficiency	11.43	$6.99	10	1.00	$0.076
Motors	Matl Handling	Standard	-	$0.00	10	1.00	$0.000
Motors	Matl Handling	High Efficiency	5.61	$5.95	10	1.00	$0.132
Motors	Matl Processing	Standard	-	$0.00	10	1.00	$0.000
Motors	Matl Processing	High Efficiency	22.24	$23.60	10	1.00	$0.132
Motors	Other Motors	Standard	-	$0.00	10	1.00	$0.000
Motors	Other Motors	High Efficiency	0.47	$0.50	10	1.00	$0.132
Process	Process Heating	Standard	-	$0.00	15	1.00	$0.000
Process	Process Cool and Refrig	Standard	-	$0.00	15	1.00	$0.000
Process	Electro-Chem Process	Standard	-	$0.00	15	1.00	$0.000
Process	Other Process	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table D-10 Energy Efficiency Equipment Data, Electric— Other Industrial, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/Emp)	Incremental Cost ($/Emp)	Lifetime (Years)	BC Ratio	Levelized Cost ($/kWh)
Cooling	Air-Cooled Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	1.00	$0.000
Cooling	Air-Cooled Chiller	1.3 kw/ton, COP 2.7	1,977.65	$949.72	20	1.14	$0.037
Cooling	Air-Cooled Chiller	1.26 kw/ton, COP 2.8	2,373.18	$1,234.64	20	1.17	$0.040

End Use	Technology	Efficiency Definition	Savings (kWh/Emp)	Incremental Cost ($/Emp)	Lifetime (Years)	BC Ratio	Levelized Cost ($/kWh)
Cooling	Air-Cooled Chiller	1.0 kw/ton, COP 3.5	4,944.13	$1,519.55	20	1.45	$0.024
Cooling	Air-Cooled Chiller	0.97 kw/ton, COP 3.6	5,240.86	$1,804.47	20	1.49	$0.027
Cooling	Water-Cooled Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	1.00	$0.000
Cooling	Water-Cooled Chiller	0.60 kw/ton, COP 5.9	3,776.37	$491.37	20	1.23	$0.010
Cooling	Water-Cooled Chiller	0.58 kw/ton, COP 6.1	4,281.19	$982.73	20	1.27	$0.018
Cooling	Water-Cooled Chiller	0.55 kw/Ton, COP 6.4	5,038.90	$1,179.28	20	1.33	$0.018
Cooling	Water-Cooled Chiller	0.51 kw/ton, COP 6.9	6,046.34	$1,834.44	20	1.42	$0.023
Cooling	Water-Cooled Chiller	0.50 kw/Ton, COP 7.0	6,299.47	$2,030.98	20	1.44	$0.025
Cooling	Water-Cooled Chiller	0.48 kw/ton, COP 7.3	6,805.75	$2,227.53	20	1.49	$0.025
Cooling	Roof top AC	EER 9.2	-	$0.00	16	-	$0.000
Cooling	Roof top AC	EER 10.1	2,536.08	$1,289.35	16	-	$0.045
Cooling	Roof top AC	EER 11.2	5,085.08	$2,479.53	16	1.00	$0.043
Cooling	Roof top AC	EER 12.0	6,644.32	$4,760.69	16	1.06	$0.063
Cooling	Roof top AC	Ductless Minisplit	8,322.51	$15,621.01	16	1.07	$0.166
Cooling	Air-Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Cooling	Air-Source Heat Pump	EER 10.3, COP 3.2	2,698.52	$1,566.46	16	-	$0.051
Cooling	Air-Source Heat Pump	EER 11.0, COP 3.3	4,295.37	$2,251.78	16	1.00	$0.046
Cooling	Air-Source Heat Pump	EER 11.7, COP 3.4	5,702.04	$5,776.30	16	1.04	$0.090
Cooling	Air-Source Heat Pump	EER 12.0, COP 3.4	6,254.61	$7,538.57	16	1.06	$0.107
Cooling	Air-Source Heat Pump	Ductless Minisplit	7,912.63	$14,440.76	16	1.10	$0.162
Cooling	Geothermal Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Cooling	Geothermal Heat Pump	EER 16, COP 3.5	1,595.90	$3,590.32	16	1.07	$0.199
Cooling	Geothermal Heat Pump	EER 18, COP 3.8	2,911.81	$7,180.64	16	1.13	$0.218
Cooling	Geothermal Heat Pump	EER 30, COP 5.0	7,122.74	$9,470.58	16	1.53	$0.118
Cooling	Other Cooling	EER 9.8	-	$0.00	14	1.00	$0.000
Cooling	Other Cooling	EER 10.2	310.47	$899.53	14	1.01	$0.281
Cooling	Other Cooling	EER 10.8	610.48	$10,232.20	14	0.95	$1.623
Cooling	Other Cooling	EER 11	897.87	$10,829.81	14	0.96	$1.168
Cooling	Other Cooling	EER 11.5	1,173.93	$12,323.83	14	0.96	$1.016
Heating	Air-Source Heat Pump	EER 9.3, COP 3.1	-	$0.00	16	-	$0.000
Heating	Air-Source Heat Pump	EER 10.3, COP 3.2	688.09	$4,526.16	16	-	$0.582
Heating	Air-Source Heat Pump	EER 11.0, COP 3.3	1,372.81	$6,506.35	16	1.00	$0.420
Heating	Air-Source Heat Pump	EER 11.7, COP 3.4	2,052.50	$16,690.21	16	0.89	$0.720
Heating	Air-Source Heat Pump	EER 12.0, COP 3.4	2,052.50	$21,782.14	16	0.84	$0.939
Heating	Air-Source Heat Pump	Ductless Minisplit	2,727.14	$41,725.52	16	0.69	$1.354
Heating	Geothermal Heat Pump	EER 14.1, COP 3.3	-	$0.00	16	1.00	$0.000
Heating	Geothermal Heat Pump	EER 16, COP 3.5	2,135.11	$9,524.95	16	0.92	$0.395
Heating	Geothermal Heat Pump	EER 18, COP 3.8	4,916.37	$19,049.91	16	0.85	$0.343
Heating	Geothermal Heat Pump	EER 30, COP 5.0	9,562.34	$25,124.99	16	0.83	$0.233
Heating	Electric Room Heat	Standard	-	$0.00	25	1.00	$0.000
Heating	Electric Furnace	Standard	-	$0.00	25	1.00	$0.000
Ventilation	Ventilation	Constant Volume	-	$0.00	10	1.00	$0.000
Ventilation	Ventilation	Variable Air Volume	2,072.63	-$4,995.58	10	1.04	-$0.299
Int. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Int. Lighting	Screw-in	90W Halogen PAR-38	834.11	$31.49	3	-	$0.013
Int. Lighting	Screw-in	70W HIR PAR-38	1,281.48	$43.32	3	-	$0.012
Int. Lighting	Screw-in	CFL	2,399.00	$25.09	6	3.63	$0.002
Int. Lighting	Screw-in	LED (2010)	2,597.31	$666.24	20	2.50	$0.020
Int. Lighting	Screw-in	LED (2020)	2,983.46	$187.97	20	-	$0.005
Int. Lighting	High-Bay Fixtures	Metal Halides	-	$0.00	3	1.00	$0.000
Int. Lighting	High-Bay Fixtures	LED (2010)	123.60	$187.89	15	0.81	$0.140
Int. Lighting	High-Bay Fixtures	T8	125.82	-$5.00	10	1.78	-$0.005
Int. Lighting	High-Bay Fixtures	High Pressure Sodium	133.88	$0.89	6	1.78	$0.001
Int. Lighting	High-Bay Fixtures	Induction	147.64	$53.00	15	1.38	$0.033
Int. Lighting	High-Bay Fixtures	Light Emitting Plasma	156.67	$2.90	15	1.98	$0.002
Int. Lighting	High-Bay Fixtures	T5	160.59	-$3.00	10	2.20	-$0.002
Int. Lighting	High-Bay Fixtures	LED (2020)	236.17	$48.46	15	-	$0.019
Int. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Int. Lighting	Linear Fluorescent	LED (2010)	1,358.28	$4,771.05	15	0.61	$0.324
Int. Lighting	Linear Fluorescent	T8	1,413.19	$1.95	10	1.34	$0.000
Int. Lighting	Linear Fluorescent	Super T8	1,960.53	$31.87	10	1.53	$0.002
Int. Lighting	Linear Fluorescent	T5	2,272.82	$51.39	10	1.66	$0.003

End Use	Technology	Efficiency Definition	Savings (kWh/Emp)	Incremental Cost ($/Emp)	Lifetime (Years)	BC Ratio	Levelized Cost ($/kWh)
Int. Lighting	Linear Fluorescent	LED (2020)	4,141.69	$1,323.67	15	-	$0.030
Ext. Lighting	Screw-in	Incandescent	-	$0.00	2	1.00	$0.000
Ext. Lighting	Screw-in	90W Halogen PAR-38	1.29	$0.05	3	-	$0.013
Ext. Lighting	Screw-in	70W HIR PAR-38	1.99	$0.07	3	-	$0.012
Ext. Lighting	Screw-in	CFL	3.72	$0.04	6	3.34	$0.002
Ext. Lighting	Screw-in	LED (2010)	4.03	$1.03	20	1.80	$0.020
Ext. Lighting	Screw-in	LED (2020)	4.63	$0.29	20	-	$0.005
Ext. Lighting	HID	Metal Halides	-	$0.00	3	1.00	$0.000
Ext. Lighting	HID	LED (2010)	262.92	$932.48	15	0.45	$0.328
Ext. Lighting	HID	T8	273.74	-$7.05	10	1.27	-$0.003
Ext. Lighting	HID	Light Emitting Plasma	424.02	$31.45	15	1.32	$0.007
Ext. Lighting	HID	High Pressure Sodium	424.16	-$0.38	6	1.58	$0.000
Ext. Lighting	HID	T5	443.09	$2.69	10	1.54	$0.001
Ext. Lighting	HID	LED (2020)	811.26	$253.33	15	-	$0.029
Ext. Lighting	Linear Fluorescent	T12	-	$0.00	10	1.00	$0.000
Ext. Lighting	Linear Fluorescent	LED (2010)	0.10	$0.36	15	0.47	$0.324
Ext. Lighting	Linear Fluorescent	T8	0.11	$0.00	10	1.34	$0.000
Ext. Lighting	Linear Fluorescent	Super T8	0.15	$0.00	10	1.51	$0.002
Ext. Lighting	Linear Fluorescent	T5	0.17	$0.00	10	1.63	$0.003
Ext. Lighting	Linear Fluorescent	LED (2020)	0.31	$0.10	15	-	$0.030
Motors	Pumps	Standard	-	$0.00	10	1.00	$0.000
Motors	Pumps	High Efficiency	13.41	$11.09	10	1.00	$0.102
Motors	Fans & Blowers	Standard	-	$0.00	10	1.00	$0.000
Motors	Fans & Blowers	High Efficiency	16.54	$15.80	10	1.00	$0.118
Motors	Compressed Air	Standard	-	$0.00	10	1.00	$0.000
Motors	Compressed Air	High Efficiency	11.43	$6.92	10	1.00	$0.075
Motors	Matl Handling	Standard	-	$0.00	10	1.00	$0.000
Motors	Matl Handling	High Efficiency	5.61	$5.89	10	1.00	$0.130
Motors	Matl Processing	Standard	-	$0.00	10	1.00	$0.000
Motors	Matl Processing	High Efficiency	22.24	$23.36	10	1.00	$0.130
Motors	Other Motors	Standard	-	$0.00	10	1.00	$0.000
Motors	Other Motors	High Efficiency	0.47	$0.49	10	1.00	$0.130
Process	Process Heating	Standard	-	$0.00	15	1.00	$0.000
Process	Process Cool and Refrig	Standard	-	$0.00	15	1.00	$0.000
Process	Electro-Chem Process	Standard	-	$0.00	15	1.00	$0.000
Process	Other Process	Standard	-	$0.00	15	1.00	$0.000
Miscellaneous	Miscellaneous	Standard	-	$0.00	5	1.00	$0.000

Table D-11 Energy Efficiency Non-Equipment Data— Chemicals, Existing Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/Emp)	Savings (kWh/Emp)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	3.6%	12.5%	20	$0.52	3.558	8.75	$0.011
Insulation - Ducting	7.0%	12.5%	20	$0.77	0.439	0.92	$0.135
Insulation - Wall Cavity	3.6%	12.5%	20	$0.49	2.546	6.47	$0.015
HVAC - Duct Repair and Sealing	5.0%	25.0%	15	$0.50	1.020	1.96	$0.045
Air-Cooled Chiller - Economizer	26.8%	48.8%	15	$0.00	0.571	1,302.79	$0.000
Air-Cooled Chiller - Efficient Mechanical Layout	62.2%	90.0%	4	$0.06	0.496	6.86	$0.033
Air-Cooled Chiller - Maintenance	46.4%	90.0%	4	$0.04	0.334	10.06	$0.031
Air-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.06	0.375	18.16	$0.020
Air-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	10	$0.01	0.070	14.29	$0.025
Air-Cooled Chiller - Condenser Water Temperature Reset	30.0%	75.0%	4	$0.18	0.207	1.32	$0.234
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	10	$0.10	0.680	19.05	$0.019
Air-Cooled Chiller - VSD on Fans	15.0%	66.2%	20	$1.17	0.808	3.92	$0.112
Water-Cooled Chiller - Economizer	26.8%	48.8%	15	$0.00	0.565	1,275.99	$0.000

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/Emp)	Savings (kWh/Emp)	BC Ratio	Levelized Cost of Energy ($/kWh)
Water-Cooled Chiller - Efficient Mechanical Layout	62.2%	90.0%	4	$0.06	0.481	6.65	$0.034
Water-Cooled Chiller - Maintenance	46.4%	90.0%	4	$0.04	0.321	9.75	$0.032
Water-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.06	0.467	22.57	$0.016
Water-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	10	$0.01	0.080	16.41	$0.022
Water-Cooled Chiller - Condenser Water Temperature Reset	30.0%	75.0%	4	$0.18	0.043	0.27	$1.136
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	10	$0.10	0.001	0.04	$8.874
Water-Cooled Chiller - VSD on Fans	15.0%	66.2%	20	$1.17	0.193	0.92	$0.466
RTU - Maintenance	46.4%	90.0%	4	$0.08	0.514	5.29	$0.039
Heat Pump - Maintenance	46.4%	95.0%	4	$0.06	0.257	3.19	$0.063
Roof - High Reflectivity	35.9%	75.0%	15	$0.32	0.351	3.14	$0.084
Energy Management System	33.0%	75.0%	14	$0.35	2.380	8.89	$0.014
Thermostat - Clock/Programmable	40.8%	50.0%	11	$0.13	0.214	0.98	$0.070
Interior Lighting - Occupancy Sensors	6.9%	56.3%	8	$0.01	0.305	29.68	$0.003
Interior Lighting - Skylights	15.3%	20.3%	8	$0.29	0.976	1.44	$0.043
Interior Lighting - Timeclocks and Timers	27.6%	56.3%	8	$0.01	0.038	3.29	$0.029
Interior Lighting - LED Exit Lighting	50.0%	85.5%	10	$0.00	0.002	0.90	$0.114
Interior Lighting - Daylighting Controls	4.3%	20.3%	8	$0.00	0.228	1.00	$0.000
Interior Lighting - Task Lighting	0.6%	75.0%	5	$0.24	0.079	0.09	$0.670
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.20	0.222	0.56	$0.133
Interior Fluorescent - Delamp and Install Reflectors	0.6%	56.3%	11	$0.50	0.188	0.28	$0.306
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.000	0.00	$207.804
Exterior Lighting - Daylighting Controls	18.0%	37.5%	8	$0.02	0.001	0.25	$4.156
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.000	0.00	$474.955
Process - Conductivity Controls	20.0%	100.0%	5	$0.53	1.000	0.44	$0.117
Process - Controls on Fume Hoods	30.0%	100.0%	10	$0.13	1.000	4.15	$0.016
Process - Timers and Controls	40.0%	100.0%	5	$0.42	2.000	1.12	$0.046
Refrigeration - Floating Head Pressure	30.0%	90.0%	18	$0.57	1.000	1.99	$0.047
Refrigeration - System Controls	40.0%	56.0%	18	$1.33	1.000	0.85	$0.109
Refrigeration - System Maintenance	30.0%	72.0%	3	$0.24	1.000	0.56	$0.085
Refrigeration - System Optimization	40.0%	56.0%	15	$0.15	1.000	5.99	$0.014
Compressed Air - Air Usage Reduction	20.2%	25.9%	10	$0.08	1.000	7.16	$0.010
Compressed Air - Compressor Replacement	14.6%	17.1%	10	$0.06	1.000	9.67	$0.008
Compressed Air - System Controls	5.0%	33.8%	15	$0.01	1.000	84.74	$0.001
Compressed Air - System Maintenance	5.0%	33.8%	3	$0.03	1.000	4.09	$0.012
Compressed Air - System Optimization and Improvements	24.8%	35.6%	10	$0.20	1.000	3.29	$0.025
Pumping System - Controls	22.8%	31.0%	10	$0.01	1.000	48.63	$0.001
Pumping System - Maintenance	5.0%	33.8%	3	$0.02	1.000	6.08	$0.008
Pumping System - Optimization	22.4%	30.0%	10	$0.28	1.000	2.40	$0.034
Pumps - Variable Speed Control	5.0%	33.8%	15	$0.02	1.000	46.38	$0.002
Pump Equipment Upgrade	24.0%	33.6%	10	$0.13	1.000	4.50	$0.016
Fan Equipment Upgrade	18.6%	23.2%	10	$0.09	1.000	7.03	$0.011
Fan System - Controls	20.9%	27.2%	10	$0.01	1.000	49.28	$0.001
Fan System - Maintenance	10.0%	37.5%	3	$0.01	1.000	12.79	$0.004

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/Emp)	Savings (kWh/Emp)	BC Ratio	Levelized Cost of Energy ($/kWh)
Fan System - Optimization	22.2%	29.6%	10	$0.13	1.000	5.00	$0.016
Fans - Variable Speed Control	10.0%	37.5%	15	$0.01	1.000	73.58	$0.001
Motors - Magnetic Adjustable Speed Drives	5.0%	15.0%	20	$0.19	1.000	7.85	$0.014
Motors - Efficient Rewind	14.9%	17.4%	10	$0.35	1.000	1.49	$0.043
Motors - Variable Frequency Drive	5.0%	33.8%	15	$0.02	1.000	46.38	$0.002
Motors - Synchronous Belts	17.3%	21.0%	10	$0.22	1.000	2.43	$0.027
Commissioning - HVAC	75.0%	75.0%	25	$0.00	-	3.00	$0.000
Commissioning - Lighting	60.0%	75.0%	25	$0.00	-	2.00	$0.000
Retrocommissioning - HVAC	0.6%	24.0%	4	$0.75	1.356	0.61	$0.149
Retrocommissioning - Lighting	0.6%	30.6%	5	$0.05	0.076	0.60	$0.145
Ventilation - CO2 Controlled	1.0%	7.5%	10	$0.65	0.045	0.06	$1.772
Transformer - High Efficiency	8.6%	9.4%	10	$0.11	0.930	5.23	$0.015
Custom Measures	10.0%	45.0%	15	$0.67	-	-	$0.000

Table D-12 Energy Efficiency Non-Equipment Data— Chemicals, New Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/Emp)	Savings (kWh/Emp)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	3.6%	12.5%	20	$0.68	1.322	3.01	$0.040
Insulation - Ducting	7.0%	12.5%	20	$0.77	0.461	0.92	$0.129
Insulation - Wall Cavity	3.6%	12.5%	20	$0.32	0.552	2.38	$0.045
HVAC - Duct Repair and Sealing	25.0%	25.0%	15	$0.50	0.426	0.91	$0.108
Air-Cooled Chiller - Economizer	26.8%	48.8%	15	$0.00	0.355	972.93	$0.001
Air-Cooled Chiller - Efficient Mechanical Layout	62.8%	90.0%	4	$0.06	0.316	5.45	$0.051
Air-Cooled Chiller - Maintenance	46.4%	90.0%	4	$0.04	0.210	8.52	$0.046
Air-Cooled Chiller - Chilled Water Reset	25.0%	75.0%	10	$0.06	0.248	14.38	$0.032
Air-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	10	$0.01	0.079	22.10	$0.021
Air-Cooled Chiller - Condenser Water Temperature Reset	60.0%	75.0%	4	$0.18	0.147	1.20	$0.329
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	10	$0.11	0.520	17.47	$0.026
Air-Cooled Chiller - VSD on Fans	15.0%	66.2%	20	$1.17	0.598	3.74	$0.151
Water-Cooled Chiller - Economizer	26.8%	48.8%	15	$0.00	0.244	627.62	$0.001
Water-Cooled Chiller - Efficient Mechanical Layout	62.8%	90.0%	4	$0.06	0.338	5.45	$0.048
Water-Cooled Chiller - Maintenance	46.4%	90.0%	4	$0.04	0.222	8.49	$0.044
Water-Cooled Chiller - Chilled Water Reset	25.0%	75.0%	10	$0.06	0.288	15.68	$0.027
Water-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	10	$0.01	0.107	27.87	$0.015
Water-Cooled Chiller - Condenser Water Temperature Reset	60.0%	75.0%	4	$0.18	0.011	0.08	$4.460
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	10	$0.11	0.002	0.07	$6.032
Water-Cooled Chiller - VSD on Fans	15.0%	66.2%	20	$1.17	0.086	0.50	$1.052
RTU - Maintenance	46.4%	90.0%	4	$0.08	0.328	4.34	$0.062
Heat Pump - Maintenance	46.4%	95.0%	4	$0.06	0.207	3.22	$0.078
Roof - High Reflectivity	35.9%	95.0%	15	$0.32	0.234	2.77	$0.127
Energy Management System	33.0%	75.0%	14	$0.35	1.827	7.97	$0.019
Thermostat - Clock/Programmable	40.8%	86.3%	11	$0.13	1.091	9.69	$0.014
Interior Lighting - Occupancy	6.9%	56.3%	8	$0.01	0.210	25.68	$0.005

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/Emp)	Savings (kWh/Emp)	BC Ratio	Levelized Cost of Energy ($/kWh)
Sensors							
Interior Lighting - Skylights	42.2%	42.2%	8	$0.19	0.614	1.67	$0.046
Interior Lighting - Timeclocks and Timers	27.6%	56.3%	8	$0.01	0.026	2.85	$0.045
Interior Lighting - LED Exit Lighting	85.5%	85.5%	10	$0.00	0.001	0.77	$0.177
Interior Lighting - Daylighting Controls	4.3%	42.2%	8	$0.00	0.157	1.00	$0.000
Interior Lighting - Task Lighting	0.6%	75.0%	5	$0.24	0.054	0.12	$0.972
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.20	0.208	0.54	$0.142
Interior Fluorescent - Delamp and Install Reflectors	0.6%	56.3%	11	$0.50	-	-	$0.000
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.000	0.01	$363.410
Exterior Lighting - Daylighting Controls	18.0%	37.5%	8	$0.02	0.000	0.34	$7.268
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.000	0.00	$830.607
Process - Conductivity Controls	20.0%	100.0%	5	$0.53	1.000	0.44	$0.117
Process - Controls on Fume Hoods	30.0%	100.0%	10	$0.13	1.000	4.15	$0.016
Process - Timers and Controls	40.0%	100.0%	5	$0.42	2.000	1.13	$0.046
Refrigeration - Floating Head Pressure	30.0%	90.0%	18	$0.57	1.000	1.99	$0.047
Refrigeration - System Controls	40.0%	56.0%	18	$1.33	1.000	0.85	$0.109
Refrigeration - System Maintenance	30.0%	72.0%	3	$0.24	1.000	0.56	$0.085
Refrigeration - System Optimization	40.0%	56.0%	15	$0.15	1.000	5.99	$0.014
Compressed Air - Air Usage Reduction	20.2%	25.9%	10	$0.08	1.000	7.21	$0.010
Compressed Air - Compressor Replacement	14.6%	17.1%	10	$0.06	1.000	9.75	$0.008
Compressed Air - System Controls	5.0%	33.8%	15	$0.01	1.000	85.48	$0.001
Compressed Air - System Maintenance	5.0%	33.8%	3	$0.03	1.000	4.11	$0.012
Compressed Air - System Optimization and Improvements	24.8%	35.6%	10	$0.20	1.000	3.32	$0.025
Pumping System - Controls	22.8%	31.0%	10	$0.01	1.000	49.02	$0.001
Pumping System - Maintenance	5.0%	33.8%	3	$0.02	1.000	6.11	$0.008
Pumping System - Optimization	22.4%	30.0%	10	$0.28	1.000	2.42	$0.034
Pumps - Variable Speed Control	5.0%	33.8%	15	$0.02	1.000	46.79	$0.002
Pump Equipment Upgrade	24.0%	33.6%	10	$0.13	1.000	4.54	$0.016
Fan Equipment Upgrade	18.6%	23.2%	10	$0.09	1.000	7.09	$0.011
Fan System - Controls	20.9%	27.2%	10	$0.01	1.000	49.67	$0.001
Fan System - Maintenance	10.0%	37.5%	3	$0.01	1.000	12.86	$0.004
Fan System - Optimization	22.2%	29.6%	10	$0.13	1.000	5.04	$0.016
Fans - Variable Speed Control	10.0%	37.5%	15	$0.01	1.000	74.23	$0.001
Motors - Magnetic Adjustable Speed Drives	5.0%	15.0%	20	$0.19	1.000	7.92	$0.014
Motors - Efficient Rewind	14.9%	17.4%	10	$0.35	1.000	1.50	$0.043
Motors - Variable Frequency Drive	5.0%	33.8%	15	$0.02	1.000	46.79	$0.002
Motors - Synchronous Belts	17.3%	21.0%	10	$0.22	1.000	2.45	$0.027
Commissioning - HVAC	75.0%	75.0%	25	$1.00	1.203	3.31	$0.057
Commissioning - Lighting	60.0%	75.0%	25	$0.15	0.053	1.05	$0.195
Retrocommissioning - HVAC	0.6%	24.0%	4	$0.75	-	-	$0.000
Retrocommissioning - Lighting	0.6%	30.6%	5	$0.00	-	2.00	$0.000
Ventilation - CO2 Controlled	5.9%	7.5%	10	$0.65	0.036	0.06	$2.216
Transformer - High Efficiency	8.6%	9.4%	10	$0.11	0.930	5.37	$0.015
Custom Measures	10.0%	45.0%	15	$0.67	-	-	$0.000

Table D-13 Energy Efficiency Non-Equipment Data— Plastics, Existing Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/Emp)	Savings (kWh/Emp)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	3.6%	12.5%	20	$0.52	3.558	8.75	$0.011
Insulation - Ducting	7.0%	12.5%	20	$0.77	0.439	0.92	$0.135
Insulation - Wall Cavity	3.6%	12.5%	20	$0.49	2.546	6.47	$0.015
HVAC - Duct Repair and Sealing	5.0%	25.0%	15	$0.50	1.020	1.96	$0.045
Air-Cooled Chiller - Economizer	26.8%	48.8%	15	$0.00	0.571	1,302.79	$0.000
Air-Cooled Chiller - Efficient Mechanical Layout	62.2%	90.0%	4	$0.06	0.496	6.86	$0.033
Air-Cooled Chiller - Maintenance	46.4%	90.0%	4	$0.04	0.334	10.06	$0.031
Air-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.06	0.375	18.16	$0.020
Air-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	10	$0.01	0.070	14.29	$0.025
Air-Cooled Chiller - Condenser Water Temperature Reset	30.0%	75.0%	4	$0.18	0.207	1.32	$0.234
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	10	$0.10	0.680	19.05	$0.019
Air-Cooled Chiller - VSD on Fans	15.0%	66.2%	20	$1.17	0.808	3.92	$0.112
Water-Cooled Chiller - Economizer	26.8%	48.8%	15	$0.00	0.565	1,275.99	$0.000
Water-Cooled Chiller - Efficient Mechanical Layout	62.2%	90.0%	4	$0.06	0.481	6.65	$0.034
Water-Cooled Chiller - Maintenance	46.4%	90.0%	4	$0.04	0.321	9.75	$0.032
Water-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.06	0.467	22.57	$0.016
Water-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	10	$0.01	0.080	16.41	$0.022
Water-Cooled Chiller - Condenser Water Temperature Reset	30.0%	75.0%	4	$0.18	0.043	0.27	$1.136
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	10	$0.10	0.001	0.04	$8.874
Water-Cooled Chiller - VSD on Fans	15.0%	66.2%	20	$1.17	0.193	0.92	$0.466
RTU - Maintenance	46.4%	90.0%	4	$0.08	0.514	5.29	$0.039
Heat Pump - Maintenance	46.4%	95.0%	4	$0.06	0.257	3.19	$0.063
Roof - High Reflectivity	35.9%	75.0%	15	$0.32	0.351	3.14	$0.084
Energy Management System	33.0%	75.0%	14	$0.35	2.380	8.89	$0.014
Thermostat - Clock/Programmable	40.8%	50.0%	11	$0.13	0.214	0.98	$0.070
Interior Lighting - Occupancy Sensors	6.9%	56.3%	8	$0.01	0.305	29.68	$0.003
Interior Lighting - Skylights	15.3%	20.3%	8	$0.29	0.976	1.44	$0.043
Interior Lighting - Timeclocks and Timers	27.6%	56.3%	8	$0.01	0.038	3.29	$0.029
Interior Lighting - LED Exit Lighting	50.0%	85.5%	10	$0.00	0.002	0.90	$0.114
Interior Lighting - Daylighting Controls	4.3%	20.3%	8	$0.00	0.228	1.00	$0.000
Interior Lighting - Task Lighting	0.6%	75.0%	5	$0.24	0.079	0.09	$0.670
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.20	0.222	0.56	$0.133
Interior Fluorescent - Delamp and Install Reflectors	0.6%	56.3%	11	$0.50	0.188	0.28	$0.306
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.000	0.00	$207.804
Exterior Lighting - Daylighting Controls	18.0%	37.5%	8	$0.02	0.001	0.25	$4.156
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.000	0.00	$474.955
Process - Conductivity Controls	20.0%	100.0%	5	$0.53	1.000	0.44	$0.117
Process - Controls on Fume Hoods	30.0%	100.0%	10	$0.13	1.000	4.15	$0.016
Process - Timers and Controls	40.0%	100.0%	5	$0.42	2.000	1.12	$0.046
Refrigeration - Floating Head Pressure	30.0%	90.0%	18	$0.57	1.000	1.99	$0.047
Refrigeration - System Controls	40.0%	56.0%	18	$1.33	1.000	0.85	$0.109

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/Emp)	Savings (kWh/Emp)	BC Ratio	Levelized Cost of Energy ($/kWh)
Refrigeration - System Maintenance	30.0%	72.0%	3	$0.24	1.000	0.56	$0.085
Refrigeration - System Optimization	40.0%	56.0%	15	$0.15	1.000	5.99	$0.014
Compressed Air - Air Usage Reduction	20.2%	25.9%	10	$0.08	1.000	7.16	$0.010
Compressed Air - Compressor Replacement	14.6%	17.1%	10	$0.06	1.000	9.67	$0.008
Compressed Air - System Controls	5.0%	33.8%	15	$0.01	1.000	84.74	$0.001
Compressed Air - System Maintenance	5.0%	33.8%	3	$0.03	1.000	4.09	$0.012
Compressed Air - System Optimization and Improvements	24.8%	35.6%	10	$0.20	1.000	3.29	$0.025
Pumping System - Controls	22.8%	31.0%	10	$0.01	1.000	48.63	$0.001
Pumping System - Maintenance	5.0%	33.8%	3	$0.02	1.000	6.08	$0.008
Pumping System - Optimization	22.4%	30.0%	10	$0.28	1.000	2.40	$0.034
Pumps - Variable Speed Control	5.0%	33.8%	15	$0.02	1.000	46.38	$0.002
Pump Equipment Upgrade	24.0%	33.6%	10	$0.13	1.000	4.50	$0.016
Fan Equipment Upgrade	18.6%	23.2%	10	$0.09	1.000	7.03	$0.011
Fan System - Controls	20.9%	27.2%	10	$0.01	1.000	49.28	$0.001
Fan System - Maintenance	10.0%	37.5%	3	$0.01	1.000	12.79	$0.004
Fan System - Optimization	22.2%	29.6%	10	$0.13	1.000	5.00	$0.016
Fans - Variable Speed Control	10.0%	37.5%	15	$0.01	1.000	73.58	$0.001
Motors - Magnetic Adjustable Speed Drives	5.0%	15.0%	20	$0.19	1.000	7.85	$0.014
Motors - Efficient Rewind	10.9%	12.1%	10	$0.35	1.000	1.49	$0.043
Motors - Variable Frequency Drive	5.0%	33.8%	15	$0.02	1.000	46.38	$0.002
Motors - Synchronous Belts	17.3%	21.0%	10	$0.22	1.000	2.33	$0.028
Commissioning - HVAC	75.0%	75.0%	25	$0.00	-	3.00	$0.000
Commissioning - Lighting	60.0%	75.0%	25	$0.00	-	2.00	$0.000
Retrocommissioning - HVAC	0.6%	24.0%	4	$0.75	1.356	0.61	$0.149
Retrocommissioning - Lighting	0.6%	30.6%	5	$0.05	0.076	0.60	$0.145
Ventilation - CO2 Controlled	1.0%	7.5%	10	$0.65	0.045	0.06	$1.772
Transformer - High Efficiency	8.6%	9.4%	10	$0.13	0.903	4.22	$0.018
Custom Measures	10.0%	45.0%	15	$0.67	-	-	$0.000
Injection Molding Barrel Insulation	25.0%	25.0%	5	$490.00	10,000.000	6.33	$0.011

Table D-14 Energy Efficiency Non-Equipment Data— Plastics, New Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/Emp)	Savings (kWh/Emp)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	3.6%	12.5%	20	$0.68	1.322	3.01	$0.040
Insulation - Ducting	7.0%	12.5%	20	$0.77	0.461	0.92	$0.129
Insulation - Wall Cavity	3.6%	12.5%	20	$0.32	0.552	2.38	$0.045
HVAC - Duct Repair and Sealing	25.0%	25.0%	15	$0.50	0.426	0.91	$0.108
Air-Cooled Chiller - Economizer	26.8%	48.8%	15	$0.00	0.355	972.93	$0.001
Air-Cooled Chiller - Efficient Mechanical Layout	62.8%	90.0%	4	$0.06	0.316	5.45	$0.051
Air-Cooled Chiller - Maintenance	46.4%	90.0%	4	$0.04	0.210	8.52	$0.046
Air-Cooled Chiller - Chilled Water Reset	25.0%	75.0%	10	$0.06	0.248	14.38	$0.032
Air-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	10	$0.01	0.079	22.10	$0.021
Air-Cooled Chiller - Condenser Water Temperature Reset	60.0%	75.0%	4	$0.18	0.147	1.20	$0.329
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	10	$0.11	0.520	17.47	$0.026
Air-Cooled Chiller - VSD on Fans	15.0%	66.2%	20	$1.17	0.598	3.74	$0.151
Water-Cooled Chiller - Economizer	26.8%	48.8%	15	$0.00	0.244	627.62	$0.001

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/Emp)	Savings (kWh/Emp)	BC Ratio	Levelized Cost of Energy ($/kWh)
Water-Cooled Chiller - Efficient Mechanical Layout	62.8%	90.0%	4	$0.06	0.338	5.45	$0.048
Water-Cooled Chiller - Maintenance	46.4%	90.0%	4	$0.04	0.222	8.49	$0.044
Water-Cooled Chiller - Chilled Water Reset	25.0%	75.0%	10	$0.06	0.288	15.68	$0.027
Water-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	10	$0.01	0.107	27.87	$0.015
Water-Cooled Chiller - Condenser Water Temperature Reset	60.0%	75.0%	4	$0.18	0.011	0.08	$4.460
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	10	$0.11	0.002	0.07	$6.032
Water-Cooled Chiller - VSD on Fans	15.0%	66.2%	20	$1.17	0.086	0.50	$1.052
RTU - Maintenance	46.4%	90.0%	4	$0.08	0.328	4.34	$0.062
Heat Pump - Maintenance	46.4%	95.0%	4	$0.06	0.207	3.22	$0.078
Roof - High Reflectivity	35.9%	95.0%	15	$0.32	0.234	2.77	$0.127
Energy Management System	33.0%	75.0%	14	$0.35	1.827	7.97	$0.019
Thermostat - Clock/Programmable	40.8%	86.3%	11	$0.13	1.091	9.69	$0.014
Interior Lighting - Occupancy Sensors	6.9%	56.3%	8	$0.01	0.210	25.68	$0.005
Interior Lighting - Skylights	42.2%	42.2%	8	$0.19	0.614	1.67	$0.046
Interior Lighting - Timeclocks and Timers	27.6%	56.3%	8	$0.01	0.026	2.85	$0.045
Interior Lighting - LED Exit Lighting	85.5%	85.5%	10	$0.00	0.001	0.77	$0.177
Interior Lighting - Daylighting Controls	4.3%	42.2%	8	$0.00	0.157	1.00	$0.000
Interior Lighting - Task Lighting	0.6%	75.0%	5	$0.24	0.054	0.12	$0.972
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.20	0.208	0.54	$0.142
Interior Fluorescent - Delamp and Install Reflectors	0.6%	56.3%	11	$0.50	-	-	$0.000
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.000	0.01	$363.410
Exterior Lighting - Daylighting Controls	18.0%	37.5%	8	$0.02	0.000	0.34	$7.268
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.000	0.00	$830.607
Process - Conductivity Controls	20.0%	100.0%	5	$0.53	1.000	0.44	$0.117
Process - Controls on Fume Hoods	30.0%	100.0%	10	$0.13	1.000	4.15	$0.016
Process - Timers and Controls	40.0%	100.0%	5	$0.42	2.000	1.13	$0.046
Refrigeration - Floating Head Pressure	30.0%	90.0%	18	$0.57	1.000	1.99	$0.047
Refrigeration - System Controls	40.0%	56.0%	18	$1.33	1.000	0.85	$0.109
Refrigeration - System Maintenance	30.0%	72.0%	3	$0.24	1.000	0.56	$0.085
Refrigeration - System Optimization	40.0%	56.0%	15	$0.15	1.000	5.99	$0.014
Compressed Air - Air Usage Reduction	20.2%	25.9%	10	$0.08	1.000	7.21	$0.010
Compressed Air - Compressor Replacement	14.6%	17.1%	10	$0.06	1.000	9.75	$0.008
Compressed Air - System Controls	5.0%	33.8%	15	$0.01	1.000	85.48	$0.001
Compressed Air - System Maintenance	5.0%	33.8%	3	$0.03	1.000	4.11	$0.012
Compressed Air - System Optimization and Improvements	24.8%	35.6%	10	$0.20	1.000	3.32	$0.025
Pumping System - Controls	22.8%	31.0%	10	$0.01	1.000	49.02	$0.001
Pumping System - Maintenance	5.0%	33.8%	3	$0.02	1.000	6.11	$0.008
Pumping System - Optimization	22.4%	30.0%	10	$0.28	1.000	2.42	$0.034
Pumps - Variable Speed Control	5.0%	33.8%	15	$0.02	1.000	46.79	$0.002
Pump Equipment Upgrade	24.0%	33.6%	10	$0.13	1.000	4.54	$0.016
Fan Equipment Upgrade	18.6%	23.2%	10	$0.09	1.000	7.09	$0.011
Fan System - Controls	20.9%	27.2%	10	$0.01	1.000	49.67	$0.001
Fan System - Maintenance	10.0%	37.5%	3	$0.01	1.000	12.86	$0.004
Fan System - Optimization	22.2%	29.6%	10	$0.13	1.000	5.04	$0.016
Fans - Variable Speed Control	10.0%	37.5%	15	$0.01	1.000	74.23	$0.001
Motors - Magnetic Adjustable Speed Drives	5.0%	15.0%	20	$0.19	1.000	7.92	$0.014

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/Emp)	Savings (kWh/Emp)	BC Ratio	Levelized Cost of Energy ($/kWh)
Motors - Efficient Rewind	10.9%	12.1%	10	$0.35	1.000	1.50	$0.043
Motors - Variable Frequency Drive	5.0%	33.8%	15	$0.02	1.000	46.79	$0.002
Motors - Synchronous Belts	17.3%	21.0%	10	$0.22	1.000	2.35	$0.028
Commissioning - HVAC	75.0%	75.0%	25	$1.00	1.203	3.31	$0.057
Commissioning - Lighting	60.0%	75.0%	25	$0.15	0.053	1.05	$0.195
Retrocommissioning - HVAC	0.6%	24.0%	4	$0.75	-	-	$0.000
Retrocommissioning - Lighting	0.6%	30.6%	5	$0.00	-	2.00	$0.000
Ventilation - CO2 Controlled	5.9%	7.5%	10	$0.65	0.036	0.06	$2.216
Transformer - High Efficiency	8.6%	9.4%	10	$0.13	0.903	4.35	$0.018
Custom Measures	10.0%	45.0%	15	$0.67	-	-	$0.000
Injection Molding Barrel Insulation	25.0%	25.0%	5	$490.00	10,000.000	6.33	$0.011

Table D-15 Energy Efficiency Non-Equipment Data— Transportation, Existing Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/Emp)	Savings (kWh/Emp)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	3.6%	12.5%	20	$0.52	3.558	8.75	$0.011
Insulation - Ducting	7.0%	12.5%	20	$0.77	0.439	0.92	$0.135
Insulation - Wall Cavity	3.6%	12.5%	20	$0.49	2.546	6.47	$0.015
HVAC - Duct Repair and Sealing	5.0%	25.0%	15	$0.50	1.020	1.96	$0.045
Air-Cooled Chiller - Economizer	26.8%	48.8%	15	$0.00	0.571	1,302.79	$0.000
Air-Cooled Chiller - Efficient Mechanical Layout	62.2%	90.0%	4	$0.06	0.496	6.86	$0.033
Air-Cooled Chiller - Maintenance	46.4%	90.0%	4	$0.04	0.334	10.06	$0.031
Air-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.06	0.375	18.16	$0.020
Air-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	10	$0.01	0.070	14.29	$0.025
Air-Cooled Chiller - Condenser Water Temperature Reset	30.0%	75.0%	4	$0.18	0.207	1.32	$0.234
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	10	$0.10	0.680	19.05	$0.019
Air-Cooled Chiller - VSD on Fans	15.0%	66.2%	20	$1.17	0.808	3.92	$0.112
Water-Cooled Chiller - Economizer	26.8%	48.8%	15	$0.00	0.565	1,275.99	$0.000
Water-Cooled Chiller - Efficient Mechanical Layout	62.2%	90.0%	4	$0.06	0.481	6.65	$0.034
Water-Cooled Chiller - Maintenance	46.4%	90.0%	4	$0.04	0.321	9.75	$0.032
Water-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.06	0.467	22.57	$0.016
Water-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	10	$0.01	0.080	16.41	$0.022
Water-Cooled Chiller - Condenser Water Temperature Reset	30.0%	75.0%	4	$0.18	0.043	0.27	$1.136
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	10	$0.10	0.001	0.04	$8.874
Water-Cooled Chiller - VSD on Fans	15.0%	66.2%	20	$1.17	0.193	0.92	$0.466
RTU - Maintenance	46.4%	90.0%	4	$0.08	0.514	5.29	$0.039
Heat Pump - Maintenance	46.4%	95.0%	4	$0.06	0.257	3.19	$0.063
Roof - High Reflectivity	35.9%	75.0%	15	$0.32	0.351	3.14	$0.084
Energy Management System	33.0%	75.0%	14	$0.35	2.380	8.89	$0.014
Thermostat - Clock/Programmable	40.8%	50.0%	11	$0.13	0.214	0.98	$0.070
Interior Lighting - Occupancy Sensors	6.9%	56.3%	8	$0.01	0.305	29.68	$0.003
Interior Lighting - Skylights	15.3%	20.3%	8	$0.29	0.976	1.44	$0.043
Interior Lighting - Timeclocks and Timers	27.6%	56.3%	8	$0.01	0.038	3.29	$0.029
Interior Lighting - LED Exit Lighting	50.0%	85.5%	10	$0.00	0.002	0.90	$0.114
Interior Lighting - Daylighting	4.3%	20.3%	8	$0.00	0.228	1.00	$0.000

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/Emp)	Savings (kWh/Emp)	BC Ratio	Levelized Cost of Energy ($/kWh)
Controls							
Interior Lighting - Task Lighting	0.6%	75.0%	5	$0.24	0.079	0.09	$0.670
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.20	0.222	0.56	$0.133
Interior Fluorescent - Delamp and Install Reflectors	0.6%	56.3%	11	$0.50	0.188	0.28	$0.306
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.000	0.00	$207.804
Exterior Lighting - Daylighting Controls	18.0%	37.5%	8	$0.02	0.001	0.25	$4.156
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.000	0.00	$474.955
Process - Conductivity Controls	20.0%	100.0%	5	$0.53	1.000	0.44	$0.117
Process - Controls on Fume Hoods	30.0%	100.0%	10	$0.13	1.000	4.15	$0.016
Process - Timers and Controls	40.0%	100.0%	5	$0.42	2.000	1.12	$0.046
Refrigeration - Floating Head Pressure	30.0%	90.0%	18	$0.57	1.000	1.99	$0.047
Refrigeration - System Controls	40.0%	56.0%	18	$1.33	1.000	0.85	$0.109
Refrigeration - System Maintenance	30.0%	72.0%	3	$0.24	1.000	0.56	$0.085
Refrigeration - System Optimization	40.0%	56.0%	15	$0.15	1.000	5.99	$0.014
Compressed Air - Air Usage Reduction	20.2%	25.9%	10	$0.08	1.000	7.16	$0.010
Compressed Air - Compressor Replacement	14.6%	17.1%	10	$0.06	1.000	9.67	$0.008
Compressed Air - System Controls	5.0%	33.8%	15	$0.01	1.000	84.74	$0.001
Compressed Air - System Maintenance	5.0%	33.8%	3	$0.03	1.000	4.09	$0.012
Compressed Air - System Optimization and Improvements	24.8%	35.6%	10	$0.20	1.000	3.29	$0.025
Pumping System - Controls	22.8%	31.0%	10	$0.01	1.000	49.02	$0.001
Pumping System - Maintenance	5.0%	33.8%	3	$0.02	1.000	6.11	$0.008
Pumping System - Optimization	22.4%	30.0%	10	$0.28	1.000	2.42	$0.034
Pumps - Variable Speed Control	5.0%	33.8%	15	$0.02	1.000	46.79	$0.002
Pump Equipment Upgrade	24.0%	33.6%	10	$0.13	1.000	4.54	$0.016
Fan Equipment Upgrade	18.6%	23.2%	10	$0.09	1.000	7.03	$0.011
Fan System - Controls	20.9%	27.2%	10	$0.01	1.000	49.28	$0.001
Fan System - Maintenance	10.0%	37.5%	3	$0.01	1.000	12.79	$0.004
Fan System - Optimization	22.2%	29.6%	10	$0.13	1.000	5.00	$0.016
Fans - Variable Speed Control	10.0%	37.5%	15	$0.01	1.000	73.58	$0.001
Motors - Magnetic Adjustable Speed Drives	5.0%	15.0%	20	$0.19	1.000	7.85	$0.014
Motors - Efficient Rewind	14.9%	17.4%	10	$0.35	1.000	1.49	$0.043
Motors - Variable Frequency Drive	5.0%	33.8%	15	$0.02	1.000	46.38	$0.002
Motors - Synchronous Belts	17.3%	21.0%	10	$0.22	1.000	2.43	$0.027
Commissioning - HVAC	75.0%	75.0%	25	$0.00	-	3.00	$0.000
Commissioning - Lighting	60.0%	75.0%	25	$0.00	-	2.00	$0.000
Retrocommissioning - HVAC	0.6%	24.0%	4	$0.75	1.356	0.61	$0.149
Retrocommissioning - Lighting	0.6%	30.6%	5	$0.05	0.076	0.60	$0.145
Ventilation - CO2 Controlled	1.0%	7.5%	10	$0.65	0.045	0.06	$1.772
Transformer - High Efficiency	8.6%	9.4%	10	$0.11	0.802	4.50	$0.017
Custom Measures	10.0%	45.0%	15	$0.67	-	-	$0.000

Table D-16 Energy Efficiency Non-Equipment Data— Transportation, New Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/Emp)	Savings (kWh/Emp)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	3.6%	12.5%	20	$0.68	1.322	3.01	$0.040
Insulation - Ducting	7.0%	12.5%	20	$0.77	0.461	0.92	$0.129

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/Emp)	Savings (kWh/Emp)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Wall Cavity	3.6%	12.5%	20	$0.32	0.552	2.38	$0.045
HVAC - Duct Repair and Sealing	25.0%	25.0%	15	$0.50	0.426	0.91	$0.108
Air-Cooled Chiller - Economizer	26.8%	48.8%	15	$0.00	0.355	972.93	$0.001
Air-Cooled Chiller - Efficient Mechanical Layout	62.8%	90.0%	4	$0.06	0.316	5.45	$0.051
Air-Cooled Chiller - Maintenance	46.4%	90.0%	4	$0.04	0.210	8.52	$0.046
Air-Cooled Chiller - Chilled Water Reset	25.0%	75.0%	10	$0.06	0.248	14.38	$0.032
Air-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	10	$0.01	0.079	22.10	$0.021
Air-Cooled Chiller - Condenser Water Temperature Reset	60.0%	75.0%	4	$0.18	0.147	1.20	$0.329
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	10	$0.11	0.520	17.47	$0.026
Air-Cooled Chiller - VSD on Fans	15.0%	66.2%	20	$1.17	0.598	3.74	$0.151
Water-Cooled Chiller - Economizer	26.8%	48.8%	15	$0.00	0.244	627.62	$0.001
Water-Cooled Chiller - Efficient Mechanical Layout	62.8%	90.0%	4	$0.06	0.338	5.45	$0.048
Water-Cooled Chiller - Maintenance	46.4%	90.0%	4	$0.04	0.222	8.49	$0.044
Water-Cooled Chiller - Chilled Water Reset	25.0%	75.0%	10	$0.06	0.288	15.68	$0.027
Water-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	10	$0.01	0.107	27.87	$0.015
Water-Cooled Chiller - Condenser Water Temperature Reset	60.0%	75.0%	4	$0.18	0.011	0.08	$4.460
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	10	$0.11	0.002	0.07	$6.032
Water-Cooled Chiller - VSD on Fans	15.0%	66.2%	20	$1.17	0.086	0.50	$1.052
RTU - Maintenance	46.4%	90.0%	4	$0.08	0.328	4.34	$0.062
Heat Pump - Maintenance	46.4%	95.0%	4	$0.06	0.207	3.22	$0.078
Roof - High Reflectivity	35.9%	95.0%	15	$0.32	0.234	2.77	$0.127
Energy Management System	33.0%	75.0%	14	$0.35	1.827	7.97	$0.019
Thermostat - Clock/Programmable	40.8%	86.3%	11	$0.13	1.091	9.69	$0.014
Interior Lighting - Occupancy Sensors	6.9%	56.3%	8	$0.01	0.210	25.68	$0.005
Interior Lighting - Skylights	42.2%	42.2%	8	$0.19	0.614	1.67	$0.046
Interior Lighting - Timeclocks and Timers	27.6%	56.3%	8	$0.01	0.026	2.85	$0.045
Interior Lighting - LED Exit Lighting	85.5%	85.5%	10	$0.00	0.001	0.77	$0.177
Interior Lighting - Daylighting Controls	4.3%	42.2%	8	$0.00	0.157	1.00	$0.000
Interior Lighting - Task Lighting	0.6%	75.0%	5	$0.24	0.054	0.12	$0.972
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.20	0.208	0.54	$0.142
Interior Fluorescent - Delamp and Install Reflectors	0.6%	56.3%	11	$0.50	-	-	$0.000
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.000	0.01	$363.410
Exterior Lighting - Daylighting Controls	18.0%	37.5%	8	$0.02	0.000	0.34	$7.268
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.000	0.00	$830.607
Process - Conductivity Controls	20.0%	100.0%	5	$0.53	1.000	0.44	$0.117
Process - Controls on Fume Hoods	30.0%	100.0%	10	$0.13	1.000	4.15	$0.016
Process - Timers and Controls	40.0%	100.0%	5	$0.42	2.000	1.13	$0.046
Refrigeration - Floating Head Pressure	30.0%	90.0%	18	$0.57	1.000	1.99	$0.047
Refrigeration - System Controls	40.0%	56.0%	18	$1.33	1.000	0.85	$0.109
Refrigeration - System Maintenance	30.0%	72.0%	3	$0.24	1.000	0.56	$0.085
Refrigeration - System Optimization	40.0%	56.0%	15	$0.15	1.000	5.99	$0.014
Compressed Air - Air Usage	20.2%	25.9%	10	$0.08	1.000	7.21	$0.010

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/Emp)	Savings (kWh/Emp)	BC Ratio	Levelized Cost of Energy ($/kWh)
Reduction							
Compressed Air - Compressor Replacement	14.6%	17.1%	10	$0.06	1.000	9.75	$0.008
Compressed Air - System Controls	5.0%	33.8%	15	$0.01	1.000	85.48	$0.001
Compressed Air - System Maintenance	5.0%	33.8%	3	$0.03	1.000	4.11	$0.012
Compressed Air - System Optimization and Improvements	24.8%	35.6%	10	$0.20	1.000	3.32	$0.025
Pumping System - Controls	22.8%	31.0%	10	$0.01	1.000	49.02	$0.001
Pumping System - Maintenance	5.0%	33.8%	3	$0.02	1.000	6.11	$0.008
Pumping System - Optimization	22.4%	30.0%	10	$0.28	1.000	2.42	$0.034
Pumps - Variable Speed Control	5.0%	33.8%	15	$0.02	1.000	46.79	$0.002
Pump Equipment Upgrade	24.0%	33.6%	10	$0.13	1.000	4.54	$0.016
Fan Equipment Upgrade	18.6%	23.2%	10	$0.09	1.000	7.09	$0.011
Fan System - Controls	20.9%	27.2%	10	$0.01	1.000	49.67	$0.001
Fan System - Maintenance	10.0%	37.5%	3	$0.01	1.000	12.86	$0.004
Fan System - Optimization	22.2%	29.6%	10	$0.13	1.000	5.04	$0.016
Fans - Variable Speed Control	10.0%	37.5%	15	$0.01	1.000	74.23	$0.001
Motors - Magnetic Adjustable Speed Drives	5.0%	15.0%	20	$0.19	1.000	7.92	$0.014
Motors - Efficient Rewind	14.9%	17.4%	10	$0.35	1.000	1.50	$0.043
Motors - Variable Frequency Drive	5.0%	33.8%	15	$0.02	1.000	46.79	$0.002
Motors - Synchronous Belts	17.3%	21.0%	10	$0.22	1.000	2.45	$0.027
Commissioning - HVAC	75.0%	75.0%	25	$1.00	1.203	3.31	$0.057
Commissioning - Lighting	60.0%	75.0%	25	$0.15	0.053	1.05	$0.195
Retrocommissioning - HVAC	0.6%	24.0%	4	$0.75	-	-	$0.000
Retrocommissioning - Lighting	0.6%	30.6%	5	$0.00	-	2.00	$0.000
Ventilation - CO2 Controlled	5.9%	7.5%	10	$0.65	0.036	0.06	$2.216
Transformer - High Efficiency	8.6%	9.4%	10	$0.11	0.802	4.74	$0.017
Custom Measures	10.0%	45.0%	15	$0.67	-	-	$0.000

Table D-17 Energy Efficiency Non-Equipment Data— Other Industrial, Existing Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/Emp)	Savings (kWh/Emp)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	3.6%	12.5%	20	$0.52	3.558	8.75	$0.011
Insulation - Ducting	7.0%	12.5%	20	$0.77	0.439	0.92	$0.135
Insulation - Wall Cavity	3.6%	12.5%	20	$0.49	2.546	6.47	$0.015
HVAC - Duct Repair and Sealing	5.0%	25.0%	15	$0.50	1.020	1.96	$0.045
Air-Cooled Chiller - Economizer	26.8%	48.8%	15	$0.00	0.571	1,302.79	$0.000
Air-Cooled Chiller - Efficient Mechanical Layout	62.2%	90.0%	4	$0.06	0.496	6.86	$0.033
Air-Cooled Chiller - Maintenance	46.4%	90.0%	4	$0.04	0.334	10.06	$0.031
Air-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.06	0.375	18.16	$0.020
Air-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	10	$0.01	0.070	14.29	$0.025
Air-Cooled Chiller - Condenser Water Temperature Reset	30.0%	75.0%	4	$0.18	0.207	1.32	$0.234
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	10	$0.10	0.680	19.05	$0.019
Air-Cooled Chiller - VSD on Fans	15.0%	66.2%	20	$1.17	0.808	3.92	$0.112
Water-Cooled Chiller - Economizer	26.8%	48.8%	15	$0.00	0.565	1,275.99	$0.000
Water-Cooled Chiller - Efficient Mechanical Layout	62.2%	90.0%	4	$0.06	0.481	6.65	$0.034
Water-Cooled Chiller - Maintenance	46.4%	90.0%	4	$0.04	0.321	9.75	$0.032
Water-Cooled Chiller - Chilled Water Reset	5.0%	75.0%	10	$0.06	0.467	22.57	$0.016

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/Emp)	Savings (kWh/Emp)	BC Ratio	Levelized Cost of Energy ($/kWh)
Water-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	10	$0.01	0.080	16.41	$0.022
Water-Cooled Chiller - Condenser Water Temperature Reset	30.0%	75.0%	4	$0.18	0.043	0.27	$1.136
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	10	$0.10	0.001	0.04	$8.874
Water-Cooled Chiller - VSD on Fans	15.0%	66.2%	20	$1.17	0.193	0.92	$0.466
RTU - Maintenance	46.4%	90.0%	4	$0.08	0.514	5.29	$0.039
Heat Pump - Maintenance	46.4%	95.0%	4	$0.06	0.257	3.19	$0.063
Roof - High Reflectivity	35.9%	75.0%	15	$0.32	0.351	3.14	$0.084
Energy Management System	33.0%	75.0%	14	$0.35	2.380	8.89	$0.014
Thermostat - Clock/Programmable	40.8%	50.0%	11	$0.13	0.214	0.98	$0.070
Interior Lighting - Occupancy Sensors	6.9%	56.3%	8	$0.01	0.305	29.68	$0.003
Interior Lighting - Skylights	15.3%	20.3%	8	$0.29	0.976	1.44	$0.043
Interior Lighting - Timeclocks and Timers	27.6%	56.3%	8	$0.01	0.038	3.29	$0.029
Interior Lighting - LED Exit Lighting	50.0%	85.5%	10	$0.00	0.002	0.90	$0.114
Interior Lighting - Daylighting Controls	4.3%	20.3%	8	$0.00	0.228	1.00	$0.000
Interior Lighting - Task Lighting	0.6%	75.0%	5	$0.24	0.079	0.09	$0.670
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.20	0.222	0.56	$0.133
Interior Fluorescent - Delamp and Install Reflectors	0.6%	56.3%	11	$0.50	0.188	0.28	$0.306
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.000	0.00	$207.804
Exterior Lighting - Daylighting Controls	18.0%	37.5%	8	$0.02	0.001	0.25	$4.156
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.000	0.00	$474.955
Process - Conductivity Controls	20.0%	100.0%	5	$0.53	1.000	0.44	$0.117
Process - Controls on Fume Hoods	30.0%	100.0%	10	$0.13	1.000	4.15	$0.016
Process - Timers and Controls	40.0%	100.0%	5	$0.42	2.000	1.12	$0.046
Refrigeration - Floating Head Pressure	30.0%	90.0%	18	$0.57	1.000	1.99	$0.047
Refrigeration - System Controls	40.0%	56.0%	18	$1.33	1.000	0.85	$0.109
Refrigeration - System Maintenance	30.0%	72.0%	3	$0.24	1.000	0.56	$0.085
Refrigeration - System Optimization	40.0%	56.0%	15	$0.15	1.000	5.99	$0.014
Compressed Air - Air Usage Reduction	20.2%	25.9%	10	$0.08	1.000	7.16	$0.010
Compressed Air - Compressor Replacement	14.6%	17.1%	10	$0.06	1.000	9.67	$0.008
Compressed Air - System Controls	5.0%	33.8%	15	$0.01	1.000	84.74	$0.001
Compressed Air - System Maintenance	5.0%	33.8%	3	$0.03	1.000	4.09	$0.012
Compressed Air - System Optimization and Improvements	24.8%	35.6%	10	$0.20	1.000	3.29	$0.025
Pumping System - Controls	22.8%	31.0%	10	$0.01	1.000	48.63	$0.001
Pumping System - Maintenance	5.0%	33.8%	3	$0.02	1.000	6.08	$0.008
Pumping System - Optimization	22.4%	30.0%	10	$0.28	1.000	2.40	$0.034
Pumps - Variable Speed Control	5.0%	33.8%	15	$0.02	1.000	46.38	$0.002
Pump Equipment Upgrade	24.0%	33.6%	10	$0.13	1.000	4.50	$0.016
Fan Equipment Upgrade	18.6%	23.2%	10	$0.09	1.000	7.03	$0.011
Fan System - Controls	20.9%	27.2%	10	$0.01	1.000	49.28	$0.001
Fan System - Maintenance	10.0%	37.5%	3	$0.01	1.000	12.79	$0.004
Fan System - Optimization	22.2%	29.6%	10	$0.13	1.000	5.00	$0.016
Fans - Variable Speed Control	10.0%	37.5%	15	$0.01	1.000	73.58	$0.001
Motors - Magnetic Adjustable Speed Drives	5.0%	15.0%	20	$0.19	1.000	7.85	$0.014
Motors - Efficient Rewind	14.9%	17.4%	10	$0.35	1.000	1.49	$0.043

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/Emp)	Savings (kWh/Emp)	BC Ratio	Levelized Cost of Energy ($/kWh)
Motors - Variable Frequency Drive	5.0%	33.8%	15	$0.02	1.000	46.38	$0.002
Motors - Synchronous Belts	17.3%	21.0%	10	$0.22	1.000	2.43	$0.027
Commissioning - HVAC	75.0%	75.0%	25	$0.00	-	3.00	$0.000
Commissioning - Lighting	60.0%	75.0%	25	$0.00	-	2.00	$0.000
Retrocommissioning - HVAC	0.6%	24.0%	4	$0.75	1.356	0.61	$0.149
Retrocommissioning - Lighting	0.6%	30.6%	5	$0.05	0.076	0.60	$0.145
Ventilation - CO2 Controlled	1.0%	7.5%	10	$0.65	0.045	0.06	$1.772
Transformer - High Efficiency	8.6%	9.4%	10	$0.11	0.802	4.50	$0.017
Custom Measures	10.0%	45.0%	15	$0.67	-	-	$0.000

Table D-18 Energy Efficiency Non-Equipment Data— Other Industrial, New Vintage

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/Emp)	Savings (kWh/Emp)	BC Ratio	Levelized Cost of Energy ($/kWh)
Insulation - Ceiling	3.6%	12.5%	20	$0.68	1.322	3.01	$0.040
Insulation - Ducting	7.0%	12.5%	20	$0.77	0.461	0.92	$0.129
Insulation - Wall Cavity	3.6%	12.5%	20	$0.32	0.552	2.38	$0.045
HVAC - Duct Repair and Sealing	25.0%	25.0%	15	$0.50	0.426	0.91	$0.108
Air-Cooled Chiller - Economizer	26.8%	48.8%	15	$0.00	0.355	972.93	$0.001
Air-Cooled Chiller - Efficient Mechanical Layout	62.8%	90.0%	4	$0.06	0.316	5.45	$0.051
Air-Cooled Chiller - Maintenance	46.4%	90.0%	4	$0.04	0.210	8.52	$0.046
Air-Cooled Chiller - Chilled Water Reset	25.0%	75.0%	10	$0.06	0.248	14.38	$0.032
Air-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	10	$0.01	0.079	22.10	$0.021
Air-Cooled Chiller - Condenser Water Temperature Reset	60.0%	75.0%	4	$0.18	0.147	1.20	$0.329
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	10	$0.11	0.520	17.47	$0.026
Air-Cooled Chiller - VSD on Fans	15.0%	66.2%	20	$1.17	0.598	3.74	$0.151
Water-Cooled Chiller - Economizer	26.8%	48.8%	15	$0.00	0.244	627.62	$0.001
Water-Cooled Chiller - Efficient Mechanical Layout	62.8%	90.0%	4	$0.06	0.338	5.45	$0.048
Water-Cooled Chiller - Maintenance	46.4%	90.0%	4	$0.04	0.222	8.49	$0.044
Water-Cooled Chiller - Chilled Water Reset	25.0%	75.0%	10	$0.06	0.288	15.68	$0.027
Water-Cooled Chiller - Chilled Water Variable-Flow System	30.0%	75.0%	10	$0.01	0.107	27.87	$0.015
Water-Cooled Chiller - Condenser Water Temperature Reset	60.0%	75.0%	4	$0.18	0.011	0.08	$4.460
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	15.0%	41.3%	10	$0.11	0.002	0.07	$6.032
Water-Cooled Chiller - VSD on Fans	15.0%	66.2%	20	$1.17	0.086	0.50	$1.052
RTU - Maintenance	46.4%	90.0%	4	$0.08	0.328	4.34	$0.062
Heat Pump - Maintenance	46.4%	95.0%	4	$0.06	0.207	3.22	$0.078
Roof - High Reflectivity	35.9%	95.0%	15	$0.32	0.234	2.77	$0.127
Energy Management System	33.0%	75.0%	14	$0.35	1.827	7.97	$0.019
Thermostat - Clock/Programmable	40.8%	86.3%	11	$0.13	1.091	9.69	$0.014
Interior Lighting - Occupancy Sensors	6.9%	56.3%	8	$0.01	0.210	25.68	$0.005
Interior Lighting - Skylights	42.2%	42.2%	8	$0.19	0.614	1.67	$0.046
Interior Lighting - Timeclocks and Timers	27.6%	56.3%	8	$0.01	0.026	2.85	$0.045
Interior Lighting - LED Exit Lighting	85.5%	85.5%	10	$0.00	0.001	0.77	$0.177
Interior Lighting - Daylighting Controls	4.3%	42.2%	8	$0.00	0.157	1.00	$0.000
Interior Lighting - Task Lighting	0.6%	75.0%	5	$0.24	0.054	0.12	$0.972

Measure	Base Saturation	Applicability	Lifetime (Years)	Incremental Cost ($/Emp)	Savings (kWh/Emp)	BC Ratio	Levelized Cost of Energy ($/kWh)
Interior Fluorescent - Bi-Level Fixture	10.0%	22.5%	8	$0.20	0.208	0.54	$0.142
Interior Fluorescent - Delamp and Install Reflectors	0.6%	56.3%	11	$0.50	-	-	$0.000
Exterior Lighting - Bi-Level Fixture	10.0%	30.0%	8	$0.20	0.000	0.01	$363.410
Exterior Lighting - Daylighting Controls	18.0%	37.5%	8	$0.02	0.000	0.34	$7.268
Exterior Lighting - Photovoltaic Installation	0.0%	12.5%	5	$0.92	0.000	0.00	$830.607
Process - Conductivity Controls	20.0%	100.0%	5	$0.53	1.000	0.44	$0.117
Process - Controls on Fume Hoods	30.0%	100.0%	10	$0.13	1.000	4.15	$0.016
Process - Timers and Controls	40.0%	100.0%	5	$0.42	2.000	1.13	$0.046
Refrigeration - Floating Head Pressure	30.0%	90.0%	18	$0.57	1.000	1.99	$0.047
Refrigeration - System Controls	40.0%	56.0%	18	$1.33	1.000	0.85	$0.109
Refrigeration - System Maintenance	30.0%	72.0%	3	$0.24	1.000	0.56	$0.085
Refrigeration - System Optimization	40.0%	56.0%	15	$0.15	1.000	5.99	$0.014
Compressed Air - Air Usage Reduction	20.2%	25.9%	10	$0.08	1.000	7.21	$0.010
Compressed Air - Compressor Replacement	14.6%	17.1%	10	$0.06	1.000	9.75	$0.008
Compressed Air - System Controls	5.0%	33.8%	15	$0.01	1.000	85.48	$0.001
Compressed Air - System Maintenance	5.0%	33.8%	3	$0.03	1.000	4.11	$0.012
Compressed Air - System Optimization and Improvements	24.8%	35.6%	10	$0.20	1.000	3.32	$0.025
Pumping System - Controls	22.8%	31.0%	10	$0.01	1.000	49.02	$0.001
Pumping System - Maintenance	5.0%	33.8%	3	$0.02	1.000	6.11	$0.008
Pumping System - Optimization	22.4%	30.0%	10	$0.28	1.000	2.42	$0.034
Pumps - Variable Speed Control	5.0%	33.8%	15	$0.02	1.000	46.79	$0.002
Pump Equipment Upgrade	24.0%	33.6%	10	$0.13	1.000	4.54	$0.016
Fan Equipment Upgrade	18.6%	23.2%	10	$0.09	1.000	7.09	$0.011
Fan System - Controls	20.9%	27.2%	10	$0.01	1.000	49.67	$0.001
Fan System - Maintenance	10.0%	37.5%	3	$0.01	1.000	12.86	$0.004
Fan System - Optimization	22.2%	29.6%	10	$0.13	1.000	5.04	$0.016
Fans - Variable Speed Control	10.0%	37.5%	15	$0.01	1.000	74.23	$0.001
Motors - Magnetic Adjustable Speed Drives	5.0%	15.0%	20	$0.19	1.000	7.92	$0.014
Motors - Efficient Rewind	14.9%	17.4%	10	$0.35	1.000	1.50	$0.043
Motors - Variable Frequency Drive	5.0%	33.8%	15	$0.02	1.000	46.79	$0.002
Motors - Synchronous Belts	17.3%	21.0%	10	$0.22	1.000	2.45	$0.027
Commissioning - HVAC	75.0%	75.0%	25	$1.00	1.203	3.31	$0.057
Commissioning - Lighting	60.0%	75.0%	25	$0.15	0.053	1.05	$0.195
Retrocommissioning - HVAC	0.6%	24.0%	4	$0.75	-	-	$0.000
Retrocommissioning - Lighting	0.6%	30.6%	5	$0.00	-	2.00	$0.000
Ventilation - CO2 Controlled	5.9%	7.5%	10	$0.65	0.036	0.06	$2.216
Transformer - High Efficiency	8.6%	9.4%	10	$0.11	0.802	4.74	$0.017
Custom Measures	10.0%	45.0%	15	$0.67	-	-	$0.000

MARKET ADOPTION FACTORS

To calculate achievable potential, we apply a set of market adoption factors to economic potential. These parameters are described below, along with a discussion of how they are applied to calculate achievable potential. Finally, we present the various sets of factors at the end of this section.

Achievable High adoption rates

These factors are applied to Economic potential to estimate the upper bound: Achievable High potential. These estimate customer adoption of economic measures when delivered through efficiency programs under ideal market, implementation, and customer preference conditions. Information channels are assumed to be established and efficient for marketing, educating consumers, and coordinating with trade allies and delivery partners. The Achievable High adoption rates are based on the ramp rates from the Northwest Power & Conservation Council's Sixth Plan as a starting point. The NWPCC has been running programs in the Pacific Northwest for many years, so the portfolio of programs reflects a more mature profile of market maturity. Because of this, the ramp rates are adjusted downward by 10%, and then further adjusted with actual Vectren program history and information from program evaluations. Achievable High potential establishes a maximum target for the EE savings that an administrator can hope to achieve through its EE programs and involves incentives that represent a substantial portion of the incremental cost combined with high administrative and marketing costs. These adoption rates increase over time, reflecting an increasing awareness and willingness to adopt energy-efficient measures.

Again, the Achievable High adoption rates are applied directly to economic potential to calculate the Achievable High potential estimates.

Achievable Low adoption rates

These factors are applied to Achievable High potential to calculate Achievable Low potential, decrementing them by a range of 40% to 75% based on where measures lie in the time horizon of the study or whether they are already familiar inclusions in existing programs. They reflect expected program participation given significant barriers to customer acceptance, non-ideal implementation conditions, and limited program budgets. This represents a lower bound on achievable potential. Like the Achievable High rates, these rates increase over time.

To review, the Achievable Low adoption rates are applied directly to the Achievable High potential to calculate the Achievable Low potential estimates. Stated differently, both Low and High adoption rates are applied to Economic potential to calculate the Achievable Low estimates.

Tabulated adoption rates

Table E-1 through Table E-4 present the Achievable High factors (High) that represent how Economic potential is changed to reach Achievable High potential for residential equipment and non-equipment measures.

Table E-5 through Table E-8 present the product of Achievable High factors and Achievable Low factors (High x Low) to show how Economic potential is changed to reach Achievable Low potential for residential equipment and non-equipment measures.

Table E-9 through Table E-12 present the (High) and (High x Low) factors for commercial equipment and measures.

Table E-13 through Table E-16 presents the same data for industrial equipment and measures.

Table E-1 Single Family Equipment Measures—(Achievable High factor)

End Use	Fuel	Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Cooling	Electric	Central AC	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Cooling	Electric	Room AC	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Cooling	Electric	Air-Source Heat Pump	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Cooling	Electric	Geothermal Heat Pump	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Heating	Electric	Electric Resistance	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Heating	Electric	Furnace	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Heating	Electric	Air-Source Heat Pump	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Heating	Electric	Geothermal Heat Pump	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Water Heating	Electric	Water Heater <= 55 gal	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Water Heating	Electric	Water Heater > 55 gal	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Interior Lighting	Electric	Screw-in	0%	18%	36%	54%	72%	77%	77%	77%	77%	77%	77%	77%	77%
Interior Lighting	Electric	Linear Fluorescent	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Interior Lighting	Electric	Specialty	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Exterior Lighting	Electric	Exterior Lighting	0%	18%	36%	54%	72%	77%	77%	77%	77%	77%	77%	77%	77%
Appliances	Electric	Clothes Washer	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Appliances	Electric	Clothes Dryer	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Appliances	Electric	Dishwasher	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Appliances	Electric	Refrigerator	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Appliances	Electric	Freezer	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Appliances	Electric	Second Refrigerator	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Appliances	Electric	Stove	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Appliances	Electric	Microwave	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Electronics	Electric	Personal Computers	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Electronics	Electric	Monitor	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Electronics	Electric	Laptops	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Electronics	Electric	TVs	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Electronics	Electric	Printer/Fax/Copier	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Electronics	Electric	Set-top Boxes/DVR	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Electronics	Electric	Devices and Gadgets	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Miscellaneous	Electric	Pool Pump	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Miscellaneous	Electric	Pool Heater	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Miscellaneous	Electric	Hot Tub / Spa	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Miscellaneous	Electric	Well Pump	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Miscellaneous	Electric	Furnace Fan	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Miscellaneous	Electric	Miscellaneous	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%

Table E-2 Single Family Non-Equipment Measures—(Achievable High factor)

Measures	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Insulation - Ceiling	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Insulation - Ducting	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Insulation - Foundation	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Insulation - Infiltration Control	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Insulation - Radiant Barrier	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Insulation - Wall Cavity	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Insulation - Wall Sheathing	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Ducting - Repair and Sealing	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Windows - High Efficiency/ENERGY STAR	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Windows - Install Reflective Film	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Doors - Storm and Thermal	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Roofs - High Reflectivity	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Attic Fan - Installation	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Attic Fan - Photovoltaic - Installation	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Whole-House Fan - Installation	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Ceiling Fan - Installation	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Thermostat - Clock/Programmable	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Home Energy Management System	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Central AC - Early Replacement	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Central AC - Maintenance and Tune-Up	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Central Heat Pump - Maintenance	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Room AC - Removal of Second Unit	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Water Heater - Drainwater Heat Recovery	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Water Heater - Faucet Aerators	0%	18%	36%	54%	72%	77%	77%	77%	77%	77%	77%	77%	77%
Water Heater - Low-Flow Showerheads	0%	18%	36%	54%	72%	77%	77%	77%	77%	77%	77%	77%	77%
Water Heater - Pipe Insulation	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Water Heater - Timer	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Water Heater - Desuperheater	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Water Heater - Solar System	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Interior Lighting - Occupancy Sensors	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Exterior Lighting - Photosensor Control	0%	18%	36%	54%	72%	77%	77%	77%	77%	77%	77%	77%	77%
Exterior Lighting - Photovoltaic Installation	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Exterior Lighting - Timeclock Installation	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Refrigerator - Early Replacement	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Refrigerator - Maintenance	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Refrigerator - Remove Second Unit	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Freezer - Remove Second Unit	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Freezer - Early Replacement	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Freezer - Maintenance	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Electronics - Smart Power Strips	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%

Measures	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Pool Pump - Timer	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Pool Heater - Solar System	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
ENERGY STAR Home Design	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Dehumidifier	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
PC Power Management Software	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%

Table E-3 Multi Family Equipment Measures—(Achievable High factor)

End Use	Fuel	Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Cooling	Electric	Central AC	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Cooling	Electric	Room AC	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Cooling	Electric	Air-Source Heat Pump	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Cooling	Electric	Geothermal Heat Pump	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Heating	Electric	Electric Resistance	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Heating	Electric	Furnace	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Heating	Electric	Air-Source Heat Pump	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Heating	Electric	Geothermal Heat Pump	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Water Heating	Electric	Water Heater <= 55 gal	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Water Heating	Electric	Water Heater > 55 gal	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Interior Lighting	Electric	Screw-in	0%	18%	36%	54%	72%	77%	77%	77%	77%	77%	77%	77%	77%
Interior Lighting	Electric	Linear Fluorescent	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Interior Lighting	Electric	Specialty	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Exterior Lighting	Electric	Exterior Lighting	0%	18%	36%	54%	72%	77%	77%	77%	77%	77%	77%	77%	77%
Appliances	Electric	Clothes Washer	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Appliances	Electric	Clothes Dryer	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Appliances	Electric	Dishwasher	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Appliances	Electric	Refrigerator	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Appliances	Electric	Freezer	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Appliances	Electric	Second Refrigerator	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Appliances	Electric	Stove	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Appliances	Electric	Microwave	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Electronics	Electric	Personal Computers	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Electronics	Electric	Monitor	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Electronics	Electric	Laptops	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Electronics	Electric	TVs	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Electronics	Electric	Printer/Fax/Copier	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Electronics	Electric	Set-top Boxes/DVR	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Electronics	Electric	Devices and Gadgets	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Miscellaneous	Electric	Pool Pump	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Miscellaneous	Electric	Pool Heater	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Miscellaneous	Electric	Hot Tub / Spa	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Miscellaneous	Electric	Well Pump	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Miscellaneous	Electric	Furnace Fan	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Miscellaneous	Electric	Miscellaneous	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%

Table E-4 Multi Family Non-Equipment Measures—(Achievable High factor)

Measures	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Insulation - Ceiling	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Insulation - Ducting	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Insulation - Foundation	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Insulation - Infiltration Control	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Insulation - Radiant Barrier	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Insulation - Wall Cavity	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Insulation - Wall Sheathing	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Ducting - Repair and Sealing	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Windows - High Efficiency/ENERGY STAR	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Windows - Install Reflective Film	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Doors - Storm and Thermal	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Roofs - High Reflectivity	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Attic Fan - Installation	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Attic Fan - Photovoltaic - Installation	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Whole-House Fan - Installation	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Ceiling Fan - Installation	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Thermostat - Clock/Programmable	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Home Energy Management System	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Central AC - Early Replacement	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Central AC - Maintenance and Tune-Up	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Central Heat Pump - Maintenance	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Room AC - Removal of Second Unit	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Water Heater - Drainwater Heat Recovery	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Water Heater - Faucet Aerators	0%	18%	36%	54%	72%	77%	77%	77%	77%	77%	77%	77%	77%
Water Heater - Low-Flow Showerheads	0%	18%	36%	54%	72%	77%	77%	77%	77%	77%	77%	77%	77%
Water Heater - Pipe Insulation	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Water Heater - Timer	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Water Heater - Desuperheater	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Water Heater - Solar System	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Interior Lighting - Occupancy Sensors	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Exterior Lighting - Photosensor Control	0%	18%	36%	54%	72%	77%	77%	77%	77%	77%	77%	77%	77%
Exterior Lighting - Photovoltaic Installation	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Exterior Lighting - Timeclock Installation	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Refrigerator - Early Replacement	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Refrigerator - Maintenance	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Refrigerator - Remove Second Unit	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Freezer - Remove Second Unit	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Freezer - Early Replacement	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Freezer - Maintenance	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Electronics - Smart Power Strips	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%

Measures	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Pool Pump - Timer	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Pool Heater - Solar System	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
ENERGY STAR Home Design	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Dehumidifier	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
PC Power Management Software	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%

Table E-5 Single Family Equipment Measures—(Achievable High factor x Achievable Low factor)

End Use	Fuel	Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Cooling	Electric	Central AC	0%	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%
Cooling	Electric	Room AC	0%	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%
Cooling	Electric	Air-Source Heat Pump	0%	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%
Cooling	Electric	Geothermal Heat Pump	0%	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%
Heating	Electric	Electric Resistance	0%	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%
Heating	Electric	Furnace	0%	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%
Heating	Electric	Air-Source Heat Pump	0%	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%
Heating	Electric	Geothermal Heat Pump	0%	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%
Water Heating	Electric	Water Heater <= 55 gal	0%	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%
Water Heating	Electric	Water Heater > 55 gal	0%	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%
Interior Lighting	Electric	Screw-in	0%	0%	3%	14%	23%	32%	35%	37%	38%	40%	41%	43%	44%
Interior Lighting	Electric	Linear Fluorescent	0%	0%	1%	7%	11%	16%	21%	26%	32%	37%	41%	43%	44%
Interior Lighting	Electric	Specialty	0%	0%	1%	7%	11%	16%	21%	26%	32%	37%	41%	43%	44%
Exterior Lighting	Electric	Exterior Lighting	0%	0%	3%	14%	23%	32%	35%	37%	38%	40%	41%	43%	44%
Appliances	Electric	Clothes Washer	0%	0%	1%	7%	11%	16%	21%	26%	32%	37%	41%	43%	44%
Appliances	Electric	Clothes Dryer	0%	0%	1%	7%	11%	16%	21%	26%	32%	37%	41%	43%	44%
Appliances	Electric	Dishwasher	0%	0%	1%	7%	11%	16%	21%	26%	32%	37%	41%	43%	44%
Appliances	Electric	Refrigerator	0%	0%	1%	7%	11%	16%	21%	26%	32%	37%	41%	43%	44%
Appliances	Electric	Freezer	0%	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%
Appliances	Electric	Second Refrigerator	0%	0%	1%	7%	11%	16%	21%	26%	32%	37%	41%	43%	44%
Appliances	Electric	Stove	0%	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%
Appliances	Electric	Microwave	0%	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%
Electronics	Electric	Personal Computers	0%	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%
Electronics	Electric	Monitor	0%	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%
Electronics	Electric	Laptops	0%	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%
Electronics	Electric	TVs	0%	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%
Electronics	Electric	Printer/Fax/Copier	0%	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%
Electronics	Electric	Set-top Boxes/DVR	0%	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%
Electronics	Electric	Devices and Gadgets	0%	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%
Miscellaneous	Electric	Pool Pump	0%	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%
Miscellaneous	Electric	Pool Heater	0%	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%
Miscellaneous	Electric	Hot Tub / Spa	0%	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%
Miscellaneous	Electric	Well Pump	0%	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%
Miscellaneous	Electric	Furnace Fan	0%	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%

End Use	Fuel	Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Miscellaneous	Electric	Miscellaneous	0%	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%

Table E-6 Single Family Non-Equipment Measures—(Achievable High factor x Achievable Low factor)

Measures	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Insulation - Ceiling	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Insulation - Ducting	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Insulation - Foundation	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Insulation - Infiltration Control	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Insulation - Radiant Barrier	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Insulation - Wall Cavity	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Insulation - Wall Sheathing	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Ducting - Repair and Sealing	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Windows - High Efficiency/ENERGY STAR	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Windows - Install Reflective Film	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Doors - Storm and Thermal	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Roofs - High Reflectivity	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Attic Fan - Installation	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Attic Fan - Photovoltaic - Installation	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Whole-House Fan - Installation	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Ceiling Fan - Installation	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Thermostat - Clock/Programmable	0%	1%	7%	11%	16%	21%	26%	32%	37%	41%	43%	44%	46%
Home Energy Management System	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Central AC - Early Replacement	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Central AC - Maintenance and Tune-Up	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Central Heat Pump - Maintenance	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Room AC - Removal of Second Unit	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Water Heater - Drainwater Heat Recovery	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Water Heater - Faucet Aerators	0%	3%	14%	23%	32%	35%	37%	38%	40%	41%	43%	44%	46%
Water Heater - Low-Flow Showerheads	0%	3%	14%	23%	32%	35%	37%	38%	40%	41%	43%	44%	46%
Water Heater - Pipe Insulation	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Water Heater - Timer	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Water Heater - Desuperheater	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Water Heater - Solar System	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Interior Lighting - Occupancy Sensors	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Exterior Lighting - Photosensor Control	0%	3%	14%	23%	32%	35%	37%	38%	40%	41%	43%	44%	46%
Exterior Lighting - Photovoltaic Installation	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Exterior Lighting - Timeclock Installation	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Refrigerator - Early Replacement	0%	1%	7%	11%	16%	21%	26%	32%	37%	41%	43%	44%	46%

Measures	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Refrigerator - Maintenance	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Refrigerator - Remove Second Unit	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Freezer - Remove Second Unit	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Freezer - Early Replacement	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Freezer - Maintenance	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Electronics - Smart Power Strips	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Pool Pump - Timer	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Pool Heater - Solar System	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
ENERGY STAR Home Design	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Dehumidifier	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
PC Power Management Software	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%

Table E-7 Multi Family Equipment Measures—(Achievable High factor x Achievable Low factor)

End Use	Fuel	Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Cooling	Electric	Central AC	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Cooling	Electric	Room AC	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Cooling	Electric	Air-Source Heat Pump	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Cooling	Electric	Geothermal Heat Pump	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Heating	Electric	Electric Resistance	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Heating	Electric	Furnace	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Heating	Electric	Air-Source Heat Pump	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Heating	Electric	Geothermal Heat Pump	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Water Heating	Electric	Water Heater <= 55 gal	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Water Heating	Electric	Water Heater > 55 gal	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Interior Lighting	Electric	Screw-in	0%	3%	14%	23%	32%	35%	37%	38%	40%	41%	43%	44%	46%
Interior Lighting	Electric	Linear Fluorescent	0%	1%	7%	11%	16%	21%	26%	32%	37%	41%	43%	44%	46%
Interior Lighting	Electric	Specialty	0%	1%	7%	11%	16%	21%	26%	32%	37%	41%	43%	44%	46%
Exterior Lighting	Electric	Exterior Lighting	0%	3%	14%	23%	32%	35%	37%	38%	40%	41%	43%	44%	46%
Appliances	Electric	Clothes Washer	0%	1%	7%	11%	16%	21%	26%	32%	37%	41%	43%	44%	46%
Appliances	Electric	Clothes Dryer	0%	1%	7%	11%	16%	21%	26%	32%	37%	41%	43%	44%	46%
Appliances	Electric	Dishwasher	0%	1%	7%	11%	16%	21%	26%	32%	37%	41%	43%	44%	46%
Appliances	Electric	Refrigerator	0%	1%	7%	11%	16%	21%	26%	32%	37%	41%	43%	44%	46%
Appliances	Electric	Freezer	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Appliances	Electric	Second Refrigerator	0%	1%	7%	11%	16%	21%	26%	32%	37%	41%	43%	44%	46%
Appliances	Electric	Stove	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Appliances	Electric	Microwave	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Electronics	Electric	Personal Computers	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Electronics	Electric	Monitor	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Electronics	Electric	Laptops	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Electronics	Electric	TVs	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Electronics	Electric	Printer/Fax/Copier	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Electronics	Electric	Set-top Boxes/DVR	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Electronics	Electric	Devices and Gadgets	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Miscellaneous	Electric	Pool Pump	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Miscellaneous	Electric	Pool Heater	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Miscellaneous	Electric	Hot Tub / Spa	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Miscellaneous	Electric	Well Pump	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Miscellaneous	Electric	Furnace Fan	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Miscellaneous	Electric	Miscellaneous	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%

Table E-8 Multi Family Non-Equipment Measures—(Achievable High factor x Achievable Low factor)

Measures	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Insulation - Ceiling	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Insulation - Ducting	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Insulation - Foundation	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Insulation - Infiltration Control	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Insulation - Radiant Barrier	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Insulation - Wall Cavity	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Insulation - Wall Sheathing	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Ducting - Repair and Sealing	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Windows - High Efficiency/ENERGY STAR	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Windows - Install Reflective Film	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Doors - Storm and Thermal	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Roofs - High Reflectivity	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Attic Fan - Installation	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Attic Fan - Photovoltaic - Installation	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Whole-House Fan - Installation	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Ceiling Fan - Installation	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Thermostat - Clock/Programmable	0%	1%	7%	11%	16%	21%	26%	32%	37%	41%	43%	44%	46%
Home Energy Management System	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Central AC - Early Replacement	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Central AC - Maintenance and Tune-Up	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Central Heat Pump - Maintenance	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Room AC - Removal of Second Unit	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Water Heater - Drainwater Heat Recovery	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Water Heater - Faucet Aerators	0%	3%	14%	23%	32%	35%	37%	38%	40%	41%	43%	44%	46%
Water Heater - Low-Flow Showerheads	0%	3%	14%	23%	32%	35%	37%	38%	40%	41%	43%	44%	46%
Water Heater - Pipe Insulation	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Water Heater - Timer	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Water Heater - Desuperheater	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Water Heater - Solar System	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Interior Lighting - Occupancy Sensors	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Exterior Lighting - Photosensor Control	0%	3%	14%	23%	32%	35%	37%	38%	40%	41%	43%	44%	46%
Exterior Lighting - Photovoltaic Installation	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Exterior Lighting - Timeclock Installation	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Refrigerator - Early Replacement	0%	1%	7%	11%	16%	21%	26%	32%	37%	41%	43%	44%	46%

Measures	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Refrigerator - Maintenance	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Refrigerator - Remove Second Unit	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Freezer - Remove Second Unit	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Freezer - Early Replacement	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Freezer - Maintenance	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Electronics - Smart Power Strips	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Pool Pump - Timer	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Pool Heater - Solar System	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
ENERGY STAR Home Design	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Dehumidifier	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
PC Power Management Software	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%

Table E-9 Commercial Equipment Measures (Achievable High factor)

End Use	Fuel	Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Cooling	Electric	Air-Cooled Chiller	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Cooling	Electric	Water-Cooled Chiller	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Cooling	Electric	Roof top AC	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Cooling	Electric	Air Source Heat Pump	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Cooling	Electric	Geothermal Heat Pump	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%
Cooling	Electric	Other Cooling	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Heating	Electric	Air Source Heat Pump	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Heating	Electric	Geothermal Heat Pump	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%
Heating	Electric	Electric Room Heat	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Heating	Electric	Electric Furnace	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Ventilation	Electric	Ventilation	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%
Water Heating	Electric	Water Heating	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Interior Lighting	Electric	Screw-in	0%	18%	36%	54%	72%	77%	77%	77%	77%	77%	77%	77%	77%
Interior Lighting	Electric	High-Bay Fixtures	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Interior Lighting	Electric	Linear Fluorescent	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Exterior Lighting	Electric	Screw-in	0%	18%	36%	54%	72%	77%	77%	77%	77%	77%	77%	77%	77%
Exterior Lighting	Electric	HID	0%	18%	36%	54%	72%	77%	77%	77%	77%	77%	77%	77%	77%
Exterior Lighting	Electric	Linear Fluorescent	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Refrigeration	Electric	Walk-in Refrigerator	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Refrigeration	Electric	Reach-in Refrigerator	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Refrigeration	Electric	Glass Door Display	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Refrigeration	Electric	Open Display Case	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Refrigeration	Electric	Icemaker	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Refrigeration	Electric	Vending Machine	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Food Preparation	Electric	Oven	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Food Preparation	Electric	Fryer	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Food Preparation	Electric	Dishwasher	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Food Preparation	Electric	Hot Food Container	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Office Equipment	Electric	Desktop Computer	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Office Equipment	Electric	Laptop	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Office Equipment	Electric	Server	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Office Equipment	Electric	Monitor	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Office Equipment	Electric	Printer/Copier/Fax	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Office Equipment	Electric	POS Terminal	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Miscellaneous	Electric	Non-HVAC Motors	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Miscellaneous	Electric	Pool Pump	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Miscellaneous	Electric	Pool Heater	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Miscellaneous	Electric	Miscellaneous	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%

Table E-10 Commercial Non-Equipment Measures (Achievable High factor)

Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Insulation - Ceiling	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%
Insulation - Ducting	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%
Insulation - Radiant Barrier	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%
Insulation - Wall Cavity	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%
HVAC - Duct Repair and Sealing	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Doors - High Efficiency	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Windows - High Efficiency	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Roof - High Reflectivity	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%
Air-Cooled Chiller - Condenser Water Temperature Reset	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Air-Cooled Chiller - Economizer	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Air-Cooled Chiller - Thermal Energy Storage	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%
Air-Cooled Chiller - VSD on Fans	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Air-Cooled Chiller - Chilled Water Reset	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Air-Cooled Chiller - Chilled Water Variable-Flow System	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Air-Cooled Chiller - Maintenance	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Air-Cooled Chiller - Chiller Heat Recovery	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Water-Cooled Chiller - Condenser Water Temperature Reset	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Water-Cooled Chiller - Economizer	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Water-Cooled Chiller - Thermal Energy Storage	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%
Water-Cooled Chiller - VSD on Fans	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Water-Cooled Chiller - Chilled Water Reset	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Water-Cooled Chiller - Chilled Water Variable-Flow System	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Water-Cooled Chiller - Maintenance	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Water-Cooled Chiller - Chiller Heat Recovery	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
RTU - Evaporative Precooler	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
RTU - Maintenance	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Space Heating - Heat Recovery Ventilator	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%
Heat Pump - Maintenance	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Ventilation - ECM on VAV Boxes	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Ventilation - Variable Speed Control	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Water Heater - Drainwater Heat Recovery	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%
Water Heater - Faucet Aerators/Low Flow Nozzles	0%	18%	36%	54%	72%	77%	77%	77%	77%	77%	77%	77%	77%

Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Water Heater - High Efficiency Circulation Pump	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Water Heater - Desuperheater	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%
Water Heater - Solar System	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%
Water Heater - Install Timer	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Water Heater - Pipe Insulation	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Water Heater - Tank Blanket/Insulation	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Interior Lighting - Daylighting Controls	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Interior Lighting - LED Exit Lighting	0%	18%	36%	54%	72%	77%	77%	77%	77%	77%	77%	77%	77%
Interior Lighting - Occupancy Sensors	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Interior Lighting - Timeclocks and Timers	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Interior Lighting - Task Lighting	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Interior Fluorescent - Bi-Level Fixture	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Interior Fluorescent - Delamp and Install Reflectors	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Exterior Lighting - Bi-Level Fixture	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Exterior Lighting - Daylighting Controls	0%	18%	36%	54%	72%	77%	77%	77%	77%	77%	77%	77%	77%
Exterior Lighting - Photovoltaic Installation	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Refrigerator - Anti-Sweat Heater	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Refrigerator - Decommissioning	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Refrigerator - Demand Defrost	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Refrigerator - Door Gasket Replacement	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Refrigerator - Evaporator Fan Controls	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Refrigerator - Floating Head Pressure	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Refrigerator - Strip Curtain	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Refrigerator - High Efficiency Compressor	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Refrigerator - Variable Speed Compressor	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Refrigerator - eCube	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Vending Machine - Controller	0%	18%	36%	54%	72%	77%	77%	77%	77%	77%	77%	77%	77%
Grocery - Display Case - LED Lighting	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Grocery - Display Case Motion Sensors	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Grocery - ECMs for Display Cases	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Grocery - Open Display Case - Night Covers	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Office Equipment - ENERGY STAR Power Supplies	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%
Office Equipment - Plug Load Occupancy Sensors	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Pool Heater - Solar	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Pool Pump - Timer	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Ventilation - CO2 Controlled	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%

Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Non-HVAC Motors - Variable Speed Control	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Energy Management System	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Thermostat - Clock/Programmable	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
HVAC - Occupancy Sensors	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Commissioning - HVAC	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%
Commissioning - Lighting	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Retrocommissioning - HVAC	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Retrocommissioning - Lighting	0%	18%	36%	54%	72%	77%	77%	77%	77%	77%	77%	77%	77%
Advanced New Construction Designs	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%
Custom Measures	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%
PC Power Management Software	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%
Pre-rinse Sprayer	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%

Table E-11 Commercial Equipment Measures (Achievable High factor x Achievable Low factor)

End Use	Fuel	Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Cooling	Electric	Air-Cooled Chiller	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Cooling	Electric	Water-Cooled Chiller	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Cooling	Electric	Roof top AC	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Cooling	Electric	Air Source Heat Pump	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Cooling	Electric	Geothermal Heat Pump	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Cooling	Electric	Other Cooling	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Heating	Electric	Air Source Heat Pump	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Heating	Electric	Geothermal Heat Pump	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Heating	Electric	Electric Room Heat	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Heating	Electric	Electric Furnace	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Ventilation	Electric	Ventilation	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Water Heating	Electric	Water Heating	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Interior Lighting	Electric	Screw-in	0%	3%	14%	23%	32%	35%	37%	38%	40%	41%	43%	44%	46%
Interior Lighting	Electric	High-Bay Fixtures	0%	1%	7%	11%	16%	21%	26%	32%	37%	41%	43%	44%	46%
Interior Lighting	Electric	Linear Fluorescent	0%	1%	7%	11%	16%	21%	26%	32%	37%	41%	43%	44%	46%
Exterior Lighting	Electric	Screw-in	0%	3%	14%	23%	32%	35%	37%	38%	40%	41%	43%	44%	46%
Exterior Lighting	Electric	HID	0%	3%	14%	23%	32%	35%	37%	38%	40%	41%	43%	44%	46%
Exterior Lighting	Electric	Linear Fluorescent	0%	1%	7%	11%	16%	21%	26%	32%	37%	41%	43%	44%	46%
Refrigeration	Electric	Walk-in Refrigerator	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Refrigeration	Electric	Reach-in Refrigerator	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Refrigeration	Electric	Glass Door Display	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Refrigeration	Electric	Open Display Case	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Refrigeration	Electric	Icemaker	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Refrigeration	Electric	Vending Machine	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Food Preparation	Electric	Oven	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Food Preparation	Electric	Fryer	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Food Preparation	Electric	Dishwasher	0%	1%	7%	11%	16%	21%	26%	32%	37%	41%	43%	44%	46%
Food Preparation	Electric	Hot Food Container	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Office Equipment	Electric	Desktop Computer	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Office Equipment	Electric	Laptop	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Office Equipment	Electric	Server	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Office Equipment	Electric	Monitor	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Office Equipment	Electric	Printer/Copier/Fax	0%	3%	14%	23%	26%	27%	28%	29%	30%	32%	33%	34%	35%
Office Equipment	Electric	POS Terminal	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Miscellaneous	Electric	Non-HVAC Motors	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Miscellaneous	Electric	Pool Pump	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Miscellaneous	Electric	Pool Heater	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Miscellaneous	Electric	Miscellaneous	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%

Table E-12 Commercial Non-Equipment Measures (Achievable High factor x Achievable Low factor)

Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Insulation - Ceiling	0%	2%	4%	6%	8%	11%	14%	16%	19%	23%	26%	30%	30%
Insulation - Ducting	0%	2%	4%	6%	8%	11%	14%	16%	19%	23%	26%	30%	30%
Insulation - Radiant Barrier	0%	2%	4%	6%	8%	11%	14%	16%	19%	23%	26%	30%	30%
Insulation - Wall Cavity	0%	2%	4%	6%	8%	11%	14%	16%	19%	23%	26%	30%	30%
HVAC - Duct Repair and Sealing	0%	2%	5%	8%	11%	14%	18%	22%	26%	30%	34%	35%	35%
Doors - High Efficiency	0%	2%	5%	8%	11%	14%	18%	22%	26%	30%	34%	35%	35%
Windows - High Efficiency	0%	2%	5%	8%	11%	14%	18%	22%	26%	30%	34%	35%	35%
Roof - High Reflectivity	0%	2%	4%	6%	8%	11%	14%	16%	19%	23%	26%	30%	30%
Air-Cooled Chiller - Condenser Water Temperature Reset	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Air-Cooled Chiller - Economizer	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Air-Cooled Chiller - Thermal Energy Storage	0%	2%	4%	6%	8%	11%	14%	16%	19%	23%	26%	30%	30%
Air-Cooled Chiller - VSD on Fans	0%	7%	15%	24%	27%	28%	29%	30%	32%	33%	34%	35%	35%
Air-Cooled Chiller - Chilled Water Reset	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Air-Cooled Chiller - Chilled Water Variable-Flow System	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Air-Cooled Chiller - Maintenance	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Air-Cooled Chiller - Chiller Heat Recovery	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Water-Cooled Chiller - Condenser Water Temperature Reset	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Water-Cooled Chiller - Economizer	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Water-Cooled Chiller - Thermal Energy Storage	0%	2%	4%	6%	8%	11%	14%	16%	19%	23%	26%	30%	30%
Water-Cooled Chiller - VSD on Fans	0%	7%	15%	24%	27%	28%	29%	30%	32%	33%	34%	35%	35%
Water-Cooled Chiller - Chilled Water Reset	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Water-Cooled Chiller - Chilled Water Variable-Flow System	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Water-Cooled Chiller - Maintenance	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Water-Cooled Chiller - Chiller Heat Recovery	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
RTU - Evaporative Precooler	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
RTU - Maintenance	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Space Heating - Heat Recovery Ventilator	0%	2%	4%	6%	8%	11%	14%	16%	19%	23%	26%	30%	30%
Heat Pump - Maintenance	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Ventilation - ECM on VAV Boxes	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Ventilation - Variable Speed Control	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Water Heater - Drainwater Heat Recovery	0%	2%	4%	6%	8%	11%	14%	16%	19%	23%	26%	30%	30%
Water Heater - Faucet Aerators/Low Flow Nozzles	0%	7%	15%	24%	33%	37%	38%	40%	41%	43%	44%	46%	46%

Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Water Heater - High Efficiency Circulation Pump	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Water Heater - Desuperheater	0%	2%	4%	6%	8%	11%	14%	16%	19%	23%	26%	30%	30%
Water Heater - Solar System	0%	2%	4%	6%	8%	11%	14%	16%	19%	23%	26%	30%	30%
Water Heater - Install Timer	0%	7%	15%	24%	27%	28%	29%	30%	32%	33%	34%	35%	35%
Water Heater - Pipe Insulation	0%	7%	15%	24%	27%	28%	29%	30%	32%	33%	34%	35%	35%
Water Heater - Tank Blanket/Insulation	0%	7%	15%	24%	27%	28%	29%	30%	32%	33%	34%	35%	35%
Interior Lighting - Daylighting Controls	0%	7%	15%	24%	27%	28%	29%	30%	32%	33%	34%	35%	35%
Interior Lighting - LED Exit Lighting	0%	7%	15%	24%	33%	37%	38%	40%	41%	43%	44%	46%	46%
Interior Lighting - Occupancy Sensors	0%	4%	8%	12%	17%	22%	27%	33%	39%	43%	44%	46%	46%
Interior Lighting - Timeclocks and Timers	0%	4%	8%	12%	17%	22%	27%	33%	39%	43%	44%	46%	46%
Interior Lighting - Task Lighting	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Interior Fluorescent - Bi-Level Fixture	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Interior Fluorescent - Delamp and Install Reflectors	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Exterior Lighting - Bi-Level Fixture	0%	7%	15%	24%	27%	28%	29%	30%	32%	33%	34%	35%	35%
Exterior Lighting - Daylighting Controls	0%	7%	15%	24%	33%	37%	38%	40%	41%	43%	44%	46%	46%
Exterior Lighting - Photovoltaic Installation	0%	2%	5%	8%	11%	14%	18%	22%	26%	30%	34%	35%	35%
Refrigerator - Anti-Sweat Heater	0%	7%	15%	24%	27%	28%	29%	30%	32%	33%	34%	35%	35%
Refrigerator - Decommissioning	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Refrigerator - Demand Defrost	0%	7%	15%	24%	27%	28%	29%	30%	32%	33%	34%	35%	35%
Refrigerator - Door Gasket Replacement	0%	7%	15%	24%	27%	28%	29%	30%	32%	33%	34%	35%	35%
Refrigerator - Evaporator Fan Controls	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Refrigerator - Floating Head Pressure	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Refrigerator - Strip Curtain	0%	7%	15%	24%	27%	28%	29%	30%	32%	33%	34%	35%	35%
Refrigerator - High Efficiency Compressor	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Refrigerator - Variable Speed Compressor	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Refrigerator - eCube	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Vending Machine - Controller	0%	7%	15%	24%	33%	37%	38%	40%	41%	43%	44%	46%	46%
Grocery - Display Case - LED Lighting	0%	7%	15%	24%	27%	28%	29%	30%	32%	33%	34%	35%	35%
Grocery - Display Case Motion Sensors	0%	7%	15%	24%	27%	28%	29%	30%	32%	33%	34%	35%	35%
Grocery - ECMs for Display Cases	0%	2%	5%	8%	11%	14%	18%	22%	26%	30%	34%	35%	35%
Grocery - Open Display Case - Night Covers	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Office Equipment - ENERGY STAR Power Supplies	0%	2%	4%	6%	8%	11%	14%	16%	19%	23%	26%	30%	30%
Office Equipment - Plug Load Occupancy Sensors	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Pool Heater - Solar	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Pool Pump - Timer	0%	4%	8%	12%	17%	22%	27%	33%	39%	43%	44%	46%	46%
Ventilation - CO2 Controlled	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%

Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Non-HVAC Motors - Variable Speed Control	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Energy Management System	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Thermostat - Clock/Programmable	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
HVAC - Occupancy Sensors	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Commissioning - HVAC	0%	2%	4%	6%	8%	11%	14%	16%	19%	23%	26%	30%	30%
Commissioning - Lighting	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Retrocommissioning - HVAC	0%	7%	15%	24%	27%	28%	29%	30%	32%	33%	34%	35%	35%
Retrocommissioning - Lighting	0%	7%	15%	24%	33%	37%	38%	40%	41%	43%	44%	46%	46%
Advanced New Construction Designs	0%	2%	4%	6%	8%	11%	14%	16%	19%	23%	26%	30%	30%
Custom Measures	0%	2%	4%	6%	8%	11%	14%	16%	19%	23%	26%	30%	30%
PC Power Management Software	0%	2%	4%	6%	8%	11%	14%	16%	19%	23%	26%	30%	30%
Pre-rinse Sprayer	0%	2%	4%	6%	8%	11%	14%	16%	19%	23%	26%	30%	30%

Table E-13 Industrial Equipment Measures (Achievable High factor)

End Use	Fuel	Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Cooling	Electric	Air-Cooled Chiller	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Cooling	Electric	Water-Cooled Chiller	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Cooling	Electric	Roof top AC	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Cooling	Electric	Air-Source Heat Pump	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Cooling	Electric	Geothermal Heat Pump	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Cooling	Electric	Other Cooling	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Heating	Electric	Air-Source Heat Pump	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Heating	Electric	Geothermal Heat Pump	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Heating	Electric	Electric Room Heat	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Heating	Electric	Electric Furnace	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Ventilation	Electric	Ventilation	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	54%
Interior Lighting	Electric	Screw-in	0%	18%	36%	54%	72%	77%	77%	77%	77%	77%	77%	77%	77%
Interior Lighting	Electric	High-Bay Fixtures	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Interior Lighting	Electric	Linear Fluorescent	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Exterior Lighting	Electric	Screw-in	0%	18%	36%	54%	72%	77%	77%	77%	77%	77%	77%	77%	77%
Exterior Lighting	Electric	HID	0%	18%	36%	54%	72%	77%	77%	77%	77%	77%	77%	77%	77%
Exterior Lighting	Electric	Linear Fluorescent	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Motors	Electric	Pumps	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Motors	Electric	Fans & Blowers	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Motors	Electric	Compressed Air	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Motors	Electric	Matl Handling	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Motors	Electric	Matl Processing	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Motors	Electric	Other Motors	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Process	Electric	Process Heating	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Process	Electric	Process Cooling and Refrigeration	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Process	Electric	Electro-Chemical Processes	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Process	Electric	Other Process	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Miscellaneous	Electric	Miscellaneous	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%

Table E-14 Industrial Non-Equipment Measures (Achievable High factor)

Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Insulation - Ceiling	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%
Insulation - Ducting	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%
Insulation - Wall Cavity	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%
HVAC - Duct Repair and Sealing	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Air-Cooled Chiller - Economizer	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Air-Cooled Chiller - Efficient Mechanical Layout	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%
Air-Cooled Chiller - Maintenance	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Air-Cooled Chiller - Chilled Water Reset	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Air-Cooled Chiller - Chilled Water Variable-Flow System	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Air-Cooled Chiller - Condenser Water Temperature Reset	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Air-Cooled Chiller - VSD on Fans	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Water-Cooled Chiller - Economizer	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Water-Cooled Chiller - Efficient Mechanical Layout	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%
Water-Cooled Chiller - Maintenance	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Water-Cooled Chiller - Chilled Water Reset	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Water-Cooled Chiller - Chilled Water Variable-Flow System	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Water-Cooled Chiller - Condenser Water Temperature Reset	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Water-Cooled Chiller - VSD on Fans	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
RTU - Maintenance	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Heat Pump - Maintenance	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Roof - High Reflectivity	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%
Energy Management System	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Thermostat - Clock/Programmable	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Interior Lighting - Occupancy Sensors	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Interior Lighting - Skylights	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Interior Lighting - Timeclocks and Timers	0%	9%	18%	27%	36%	45%	54%	63%	72%	77%	77%	77%	77%
Interior Lighting - LED Exit Lighting	0%	18%	36%	54%	72%	77%	77%	77%	77%	77%	77%	77%	77%
Interior Lighting - Daylighting Controls	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Interior Lighting - Task Lighting	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Interior Fluorescent - Bi-Level Fixture	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Interior Fluorescent - Delamp and Install Reflectors	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Exterior Lighting - Bi-Level Fixture	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Exterior Lighting - Daylighting Controls	0%	18%	36%	54%	72%	77%	77%	77%	77%	77%	77%	77%	77%
Exterior Lighting - Photovoltaic Installation	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Process - Conductivity Controls	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Process - Controls on Fume Hoods	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Process - Timers and Controls	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Refrigeration - Floating Head Pressure	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%

Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Refrigeration - System Controls	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Refrigeration - System Maintenance	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Refrigeration - System Optimization	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Compressed Air - Air Usage Reduction	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Compressed Air - Compressor Replacement	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Compressed Air - System Controls	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Compressed Air - System Maintenance	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Compressed Air - System Optimization and Improvements	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Pumping System - Controls	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Pumping System - Maintenance	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Pumping System - Optimization	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Pumps - Variable Speed Control	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Pump Equipment Upgrade	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Fan Equipment Upgrade	0%	6%	12%	18%	24%	30%	36%	42%	48%	54%	59%	59%	59%
Fan System - Controls	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Fan System - Maintenance	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Fan System - Optimization	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Fans - Variable Speed Control	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Motors - Magnetic Adjustable Speed Drives	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%
Motors - Efficient Rewind	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Motors - Variable Frequency Drive	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Motors - Synchronous Belts	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Commissioning - HVAC	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Commissioning - Lighting	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Retrocommissioning - HVAC	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Retrocommissioning - Lighting	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Ventilation - CO2 Controlled	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%
Transformer - High Efficiency	0%	5%	9%	14%	18%	23%	27%	32%	36%	41%	45%	50%	50%
Custom Measures	0%	9%	18%	27%	36%	45%	54%	59%	59%	59%	59%	59%	59%
Injection Molding Barrel Insulation	0%	18%	36%	54%	59%	59%	59%	59%	59%	59%	59%	59%	59%

Table E-15 Industrial Equipment Measures (Achievable High factor x Achievable Low factor)

End Use	Fuel	Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Cooling	Electric	Air-Cooled Chiller	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Cooling	Electric	Water-Cooled Chiller	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Cooling	Electric	Roof top AC	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%
Cooling	Electric	Air-Source Heat Pump	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Cooling	Electric	Geothermal Heat Pump	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Cooling	Electric	Other Cooling	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Heating	Electric	Air-Source Heat Pump	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Heating	Electric	Geothermal Heat Pump	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Heating	Electric	Electric Room Heat	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Heating	Electric	Electric Furnace	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Ventilation	Electric	Ventilation	0%	0%	4%	6%	8%	10%	13%	16%	19%	22%	25%	29%	32%
Interior Lighting	Electric	Screw-in	0%	3%	14%	23%	32%	35%	37%	38%	40%	41%	43%	44%	46%
Interior Lighting	Electric	High-Bay Fixtures	0%	1%	7%	11%	16%	21%	26%	32%	37%	41%	43%	44%	46%
Interior Lighting	Electric	Linear Fluorescent	0%	1%	7%	11%	16%	21%	26%	32%	37%	41%	43%	44%	46%
Exterior Lighting	Electric	Screw-in	0%	3%	14%	23%	32%	35%	37%	38%	40%	41%	43%	44%	46%
Exterior Lighting	Electric	HID	0%	3%	14%	23%	32%	35%	37%	38%	40%	41%	43%	44%	46%
Exterior Lighting	Electric	Linear Fluorescent	0%	1%	7%	11%	16%	21%	26%	32%	37%	41%	43%	44%	46%
Motors	Electric	Pumps	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Motors	Electric	Fans & Blowers	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Motors	Electric	Compressed Air	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Motors	Electric	Matl Handling	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Motors	Electric	Matl Processing	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Motors	Electric	Other Motors	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Process	Electric	Process Heating	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Process	Electric	Process Cooling and Refrigeration	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Process	Electric	Electro-Chemical Processes	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Process	Electric	Other Process	0%	0%	5%	8%	11%	14%	17%	21%	25%	29%	33%	34%	35%
Miscellaneous	Electric	Miscellaneous	0%	1%	7%	11%	16%	21%	26%	29%	30%	32%	33%	34%	35%

Table E-16 Industrial Non-Equipment Measures (Achievable High factor x Achievable Low factor)

Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Insulation - Ceiling	0%	2%	4%	6%	8%	11%	14%	16%	19%	23%	26%	30%	30%
Insulation - Ducting	0%	2%	4%	6%	8%	11%	14%	16%	19%	23%	26%	30%	30%
Insulation - Wall Cavity	0%	2%	4%	6%	8%	11%	14%	16%	19%	23%	26%	30%	30%
HVAC - Duct Repair and Sealing	0%	2%	5%	8%	11%	14%	18%	22%	26%	30%	34%	35%	35%
Air-Cooled Chiller - Economizer	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Air-Cooled Chiller - Efficient Mechanical Layout	0%	2%	4%	6%	8%	11%	14%	16%	19%	23%	26%	30%	30%
Air-Cooled Chiller - Maintenance	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Air-Cooled Chiller - Chilled Water Reset	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Air-Cooled Chiller - Chilled Water Variable-Flow System	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Air-Cooled Chiller - Condenser Water Temperature Reset	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Air-Cooled Chiller - High Efficiency Cooling Tower Fans	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Air-Cooled Chiller - VSD on Fans	0%	7%	15%	24%	27%	28%	29%	30%	32%	33%	34%	35%	35%
Water-Cooled Chiller - Economizer	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Water-Cooled Chiller - Efficient Mechanical Layout	0%	2%	4%	6%	8%	11%	14%	16%	19%	23%	26%	30%	30%
Water-Cooled Chiller - Maintenance	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Water-Cooled Chiller - Chilled Water Reset	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Water-Cooled Chiller - Chilled Water Variable-Flow System	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Water-Cooled Chiller - Condenser Water Temperature Reset	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Water-Cooled Chiller - High Efficiency Cooling Tower Fans	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Water-Cooled Chiller - VSD on Fans	0%	7%	15%	24%	27%	28%	29%	30%	32%	33%	34%	35%	35%
RTU - Maintenance	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Heat Pump - Maintenance	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Roof - High Reflectivity	0%	2%	4%	6%	8%	11%	14%	16%	19%	23%	26%	30%	30%
Energy Management System	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Thermostat - Clock/Programmable	0%	4%	8%	12%	17%	22%	27%	33%	39%	43%	44%	46%	46%
Interior Lighting - Occupancy Sensors	0%	4%	8%	12%	17%	22%	27%	33%	39%	43%	44%	46%	46%
Interior Lighting - Skylights	0%	2%	5%	8%	11%	14%	18%	22%	26%	30%	34%	35%	35%
Interior Lighting - Timeclocks and Timers	0%	4%	8%	12%	17%	22%	27%	33%	39%	43%	44%	46%	46%
Interior Lighting - LED Exit Lighting	0%	7%	15%	24%	33%	37%	38%	40%	41%	43%	44%	46%	46%
Interior Lighting - Daylighting Controls	0%	7%	15%	24%	27%	28%	29%	30%	32%	33%	34%	35%	35%
Interior Lighting - Task Lighting	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Interior Fluorescent - Bi-Level Fixture	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Interior Fluorescent - Delamp and Install Reflectors	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Exterior Lighting - Bi-Level Fixture	0%	7%	15%	24%	27%	28%	29%	30%	32%	33%	34%	35%	35%
Exterior Lighting - Daylighting Controls	0%	7%	15%	24%	33%	37%	38%	40%	41%	43%	44%	46%	46%
Exterior Lighting - Photovoltaic Installation	0%	2%	5%	8%	11%	14%	18%	22%	26%	30%	34%	35%	35%
Process - Conductivity Controls	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Process - Controls on Fume Hoods	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Process - Timers and Controls	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Refrigeration - Floating Head Pressure	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%

Technology	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Refrigeration - System Controls	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Refrigeration - System Maintenance	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Refrigeration - System Optimization	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Compressed Air - Air Usage Reduction	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Compressed Air - Compressor Replacement	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Compressed Air - System Controls	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Compressed Air - System Maintenance	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Compressed Air - System Optimization and Improvements	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Pumping System - Controls	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Pumping System - Maintenance	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Pumping System - Optimization	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Pumps - Variable Speed Control	0%	7%	15%	24%	27%	28%	29%	30%	32%	33%	34%	35%	35%
Pump Equipment Upgrade	0%	2%	5%	8%	11%	14%	18%	22%	26%	30%	34%	35%	35%
Fan Equipment Upgrade	0%	2%	5%	8%	11%	14%	18%	22%	26%	30%	34%	35%	35%
Fan System - Controls	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Fan System - Maintenance	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Fan System - Optimization	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Fans - Variable Speed Control	0%	7%	15%	24%	27%	28%	29%	30%	32%	33%	34%	35%	35%
Motors - Magnetic Adjustable Speed Drives	0%	7%	15%	24%	27%	28%	29%	30%	32%	33%	34%	35%	35%
Motors - Efficient Rewind	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Motors - Variable Frequency Drive	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Motors - Synchronous Belts	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Commissioning - HVAC	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Commissioning - Lighting	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Retrocommissioning - HVAC	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Retrocommissioning - Lighting	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Ventilation - CO2 Controlled	0%	2%	4%	6%	8%	11%	14%	16%	19%	23%	26%	30%	30%
Transformer - High Efficiency	0%	2%	4%	6%	8%	11%	14%	16%	19%	23%	26%	30%	30%
Custom Measures	0%	4%	8%	12%	17%	22%	27%	30%	32%	33%	34%	35%	35%
Injection Molding Barrel Insulation	0%	7%	15%	24%	27%	28%	29%	30%	32%	33%	34%	35%	35%

MEASURE-LEVEL POTENTIAL SAVINGS

This section presents the estimates of annual savings at the measure level. Selected years are shown in Chapter 6 and 7 of the report. Table F-1 and Table F-2 show the overall annual savings for electric energy and peak demand, respectively. Table F-3 through Table F-8 show the annual savings for each sector. Note that the downstream steps of measure bundling, program design, and program delivery produce different results that are presented in the next section at the program-level.

Table F-1 Measure-Level Annual Electric Energy Savings, All Sectors

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Baseline Forecast	5,646	5,605	5,627	5,630	5,608	5,626	5,673	5,738	5,799	5,861	5,923	5,977	6,033
Cumulative Savings (GWh)													
Achievable Potential Low	-	-	-	-	32	63	100	151	203	270	338	405	456
Achievable Potential High	-	-	-	-	67	125	192	277	357	455	548	637	711
Economic Potential	-	-	-	-	112	191	274	377	478	602	725	846	947
Technical Potential	-	-	-	-	142	251	366	504	640	791	935	1,075	1,192
Cumulative Savings % of Baseline													
Achievable Potential Low	0.0%	0.0%	0.0%	0.0%	0.6%	1.1%	1.8%	2.6%	3.5%	4.6%	5.7%	6.8%	7.5%
Achievable Potential High	0.0%	0.0%	0.0%	0.0%	1.2%	2.2%	3.4%	4.8%	6.2%	7.8%	9.3%	10.7%	11.8%
Economic Potential	0.0%	0.0%	0.0%	0.0%	2.0%	3.4%	4.8%	6.6%	8.2%	10.3%	12.2%	14.2%	15.7%
Technical Potential	0.0%	0.0%	0.0%	0.0%	2.5%	4.5%	6.5%	8.8%	11.0%	13.5%	15.8%	18.0%	19.8%
Incremental Savings (GWh)													
Achievable Potential Low	-	-	-	-	32	31	38	51	52	67	68	67	51
Achievable Potential High	-	-	-	-	67	58	68	85	79	99	93	88	74
Economic Potential	-	-	-	-	112	79	83	103	101	124	122	122	101
Technical Potential	-	-	-	-	142	109	115	138	136	151	144	140	117
Incremental Savings % of Baseline													
Achievable Potential Low	0.0%	0.0%	0.0%	0.0%	0.6%	0.5%	0.7%	0.9%	0.9%	1.1%	1.2%	1.1%	0.8%
Achievable Potential High	0.0%	0.0%	0.0%	0.0%	1.2%	1.0%	1.2%	1.5%	1.4%	1.7%	1.6%	1.5%	1.2%
Economic Potential	0.0%	0.0%	0.0%	0.0%	2.0%	1.4%	1.5%	1.8%	1.7%	2.1%	2.1%	2.0%	1.7%
Technical Potential	0.0%	0.0%	0.0%	0.0%	2.5%	1.9%	2.0%	2.4%	2.3%	2.6%	2.4%	2.3%	1.9%

Table F-2 Measure-Level Annual Electric Peak Demand Savings, All Sectors

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Baseline Forecast	4,752	4,706	4,718	4,667	4,635	4,621	4,641	4,686	4,725	4,768	4,806	4,836	4,873
Peak Demand Savings (GWh)													
Achievable Potential Low	-	-	-	-	23	47	80	123	165	218	271	325	366
Achievable Potential High	-	-	-	-	45	87	144	218	283	362	436	506	566
Economic Potential	-	-	-	-	63	111	180	277	368	474	575	671	755
Technical Potential	-	-	-	-	87	159	254	376	494	626	749	867	969
Peak Demand Savings % of Baseline													
Achievable Potential Low	0.0%	0.0%	0.0%	0.0%	0.5%	1.0%	1.7%	2.6%	3.5%	4.6%	5.6%	6.7%	7.5%
Achievable Potential High	0.0%	0.0%	0.0%	0.0%	1.0%	1.9%	3.1%	4.7%	6.0%	7.6%	9.1%	10.5%	11.6%
Economic Potential	0.0%	0.0%	0.0%	0.0%	1.4%	2.4%	3.9%	5.9%	7.8%	9.9%	12.0%	13.9%	15.5%
Technical Potential	0.0%	0.0%	0.0%	0.0%	1.9%	3.4%	5.5%	8.0%	10.5%	13.1%	15.6%	17.9%	19.9%
Peak Demand Incremental Savings (GWh)													
Achievable Potential Low	-	-	-	-	23	24	32	44	42	53	53	54	40
Achievable Potential High	-	-	-	-	45	42	57	74	65	78	74	71	60
Economic Potential	-	-	-	-	63	48	69	96	91	107	100	97	83
Technical Potential	-	-	-	-	87	73	95	122	118	132	124	117	102
Peak Demand Incremental Savings % o f Baseline													
Achievable Potential Low	0.0%	0.0%	0.0%	0.0%	0.5%	0.5%	0.7%	0.9%	0.9%	1.1%	1.1%	1.1%	0.8%
Achievable Potential High	0.0%	0.0%	0.0%	0.0%	1.0%	0.9%	1.2%	1.6%	1.4%	1.6%	1.5%	1.5%	1.2%
Economic Potential	0.0%	0.0%	0.0%	0.0%	1.4%	1.0%	1.5%	2.1%	1.9%	2.2%	2.1%	2.0%	1.7%
Technical Potential	0.0%	0.0%	0.0%	0.0%	1.9%	1.6%	2.0%	2.6%	2.5%	2.8%	2.6%	2.4%	2.1%

Table F-3 Measure-Level Annual Electric Energy Savings, Residential

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Baseline Forecast	1,483	1,482	1,485	1,482	1,459	1,453	1,463	1,476	1,488	1,497	1,514	1,529	1,541
Cumulative Savings (GWh)													
Achievable Potential Low	-	-	-	-	9	16	22	32	43	55	70	83	94
Achievable Potential High	-	-	-	-	20	32	44	61	77	94	118	135	148
Economic Potential	-	-	-	-	37	52	66	81	98	119	151	177	198
Technical Potential	-	-	-	-	57	92	125	163	203	242	288	326	359
Cumulative Savings % of Baseline													
Achievable Potential Low	0.0%	0.0%	0.0%	0.0%	0.6%	1.1%	1.5%	2.2%	2.9%	3.7%	4.7%	5.4%	6.1%
Achievable Potential High	0.0%	0.0%	0.0%	0.0%	1.4%	2.2%	3.0%	4.1%	5.2%	6.3%	7.8%	8.8%	9.6%
Economic Potential	0.0%	0.0%	0.0%	0.0%	2.5%	3.6%	4.5%	5.5%	6.6%	8.0%	10.0%	11.6%	12.9%
Technical Potential	0.0%	0.0%	0.0%	0.0%	3.9%	6.3%	8.5%	11.0%	13.6%	16.2%	19.0%	21.3%	23.3%
Incremental Savings (GWh)													
Achievable Potential Low	-	-	-	-	9	6	6	10	11	12	15	13	11
Achievable Potential High	-	-	-	-	20	12	12	17	16	18	24	17	13
Economic Potential	-	-	-	-	37	16	14	16	16	21	32	26	21
Technical Potential	-	-	-	-	57	34	33	38	40	39	46	38	33
Incremental Savings % of Baseline													
Achievable Potential Low	0.0%	0.0%	0.0%	0.0%	0.6%	0.4%	0.4%	0.7%	0.7%	0.8%	1.0%	0.8%	0.7%
Achievable Potential High	0.0%	0.0%	0.0%	0.0%	1.4%	0.8%	0.8%	1.2%	1.1%	1.2%	1.6%	1.1%	0.9%
Economic Potential	0.0%	0.0%	0.0%	0.0%	2.5%	1.1%	0.9%	1.1%	1.1%	1.4%	2.1%	1.7%	1.4%
Technical Potential	0.0%	0.0%	0.0%	0.0%	3.9%	2.4%	2.3%	2.6%	2.7%	2.6%	3.0%	2.5%	2.1%

Table F-4 Measure-Level Annual Electric Peak Demand Savings, Residential

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Baseline Forecast	739	739	741	740	734	733	738	744	750	756	764	773	781
Peak Demand Savings (GWh)													
Achievable Potential Low	-	-	-	-	2	4	6	10	14	19	26	33	40
Achievable Potential High	-	-	-	-	5	8	12	18	25	33	45	54	64
Economic Potential	-	-	-	-	9	14	20	27	36	48	63	78	93
Technical Potential	-	-	-	-	26	47	69	94	121	150	182	212	241
Peak Demand Savings % of Baseline													
Achievable Potential Low	0.0%	0.0%	0.0%	0.0%	0.3%	0.6%	0.8%	1.3%	1.9%	2.5%	3.4%	4.3%	5.1%
Achievable Potential High	0.0%	0.0%	0.0%	0.0%	0.7%	1.1%	1.7%	2.4%	3.3%	4.4%	5.8%	7.0%	8.2%
Economic Potential	0.0%	0.0%	0.0%	0.0%	1.3%	2.0%	2.7%	3.7%	4.8%	6.3%	8.2%	10.1%	12.0%
Technical Potential	0.0%	0.0%	0.0%	0.0%	3.5%	6.4%	9.3%	12.6%	16.1%	19.8%	23.8%	27.4%	30.9%
Peak Demand Incremental Savings (GWh)													
Achievable Potential Low	-	-	-	-	2	2	2	3	4	5	7	7	7
Achievable Potential High	-	-	-	-	5	3	4	6	7	9	11	10	10
Economic Potential	-	-	-	-	9	5	6	7	9	11	15	15	15
Technical Potential	-	-	-	-	26	21	22	25	27	29	32	30	29
Peak Demand Incremental Savings % of Baseline													
Achievable Potential Low	0.0%	0.0%	0.0%	0.0%	0.3%	0.2%	0.3%	0.5%	0.6%	0.7%	0.9%	0.9%	0.9%
Achievable Potential High	0.0%	0.0%	0.0%	0.0%	0.7%	0.5%	0.5%	0.8%	0.9%	1.1%	1.5%	1.2%	1.2%
Economic Potential	0.0%	0.0%	0.0%	0.0%	1.3%	0.7%	0.8%	1.0%	1.2%	1.5%	2.0%	2.0%	1.9%
Technical Potential	0.0%	0.0%	0.0%	0.0%	3.5%	2.9%	3.0%	3.3%	3.6%	3.8%	4.2%	3.9%	3.7%

Table F-5 Measure-Level Annual Electric Energy Savings, Commercial

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Baseline Forecast (GWh)	1,318	1,299	1,293	1,288	1,286	1,296	1,313	1,339	1,368	1,399	1,429	1,457	1,486
Cumulative Savings (GWh)													
Achievable Potential Low	-	-	-	-	12	23	36	53	72	100	128	152	170
Achievable Potential High	-	-	-	-	25	46	69	98	127	169	204	235	262
Economic Potential	-	-	-	-	42	70	99	136	173	221	263	302	337
Technical Potential	-	-	-	-	49	86	125	170	216	271	318	362	400
Energy Savings (% of Baseline)													
Achievable Potential Low	0.0%	0.0%	0.0%	0.0%	0.9%	1.8%	2.7%	4.0%	5.3%	7.2%	9.0%	10.4%	11.5%
Achievable Potential High	0.0%	0.0%	0.0%	0.0%	2.0%	3.5%	5.3%	7.3%	9.3%	12.0%	14.3%	16.1%	17.6%
Economic Potential	0.0%	0.0%	0.0%	0.0%	3.2%	5.4%	7.6%	10.2%	12.7%	15.8%	18.4%	20.7%	22.7%
Technical Potential	0.0%	0.0%	0.0%	0.0%	3.8%	6.6%	9.5%	12.7%	15.8%	19.3%	22.3%	24.8%	27.0%
Incremental Savings (GWh)													
Achievable Potential Low	-	-	-	-	12	11	13	17	19	29	28	24	19
Achievable Potential High	-	-	-	-	25	20	24	29	29	41	36	31	27
Economic Potential	-	-	-	-	42	28	30	37	37	48	42	39	34
Technical Potential	-	-	-	-	49	37	39	46	45	55	47	44	39
Incremental Savings (% of Baseline)													
Achievable Potential Low	0.0%	0.0%	0.0%	0.0%	0.9%	0.8%	1.0%	1.3%	1.4%	2.0%	1.9%	1.6%	1.2%
Achievable Potential High	0.0%	0.0%	0.0%	0.0%	2.0%	1.6%	1.8%	2.1%	2.1%	3.0%	2.5%	2.1%	1.8%
Economic Potential	0.0%	0.0%	0.0%	0.0%	3.2%	2.2%	2.3%	2.8%	2.7%	3.4%	2.9%	2.7%	2.3%
Technical Potential	0.0%	0.0%	0.0%	0.0%	3.8%	2.9%	3.0%	3.4%	3.3%	3.9%	3.3%	3.0%	2.6%

Table F-6 Measure-Level Annual Electric Peak Demand Savings, Commercial

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Baseline Forecast (GWh)	783	772	771	725	711	696	703	725	746	772	795	811	828
Cumulative Savings (GWh)													
Achievable Potential Low	-	-	-	-	5	8	13	22	31	45	58	69	77
Achievable Potential High	-	-	-	-	10	11	18	34	48	69	87	100	110
Economic Potential	-	-	-	-	5	(4)	4	26	45	71	94	108	122
Technical Potential	-	-	-	-	9	6	19	47	72	103	129	147	165
Energy Savings (% of Baseline)													
Achievable Potential Low	0.0%	0.0%	0.0%	0.0%	0.8%	1.2%	1.8%	3.1%	4.2%	5.8%	7.3%	8.5%	9.3%
Achievable Potential High	0.0%	0.0%	0.0%	0.0%	1.4%	1.6%	2.5%	4.7%	6.5%	8.9%	11.0%	12.3%	13.3%
Economic Potential	0.0%	0.0%	0.0%	0.0%	0.7%	-0.6%	0.5%	3.5%	6.1%	9.3%	11.8%	13.4%	14.7%
Technical Potential	0.0%	0.0%	0.0%	0.0%	1.3%	0.9%	2.7%	6.5%	9.7%	13.4%	16.3%	18.2%	19.9%
Incremental Savings (GWh)													
Achievable Potential Low	-	-	-	-	5	3	5	10	9	14	13	11	8
Achievable Potential High	-	-	-	-	10	1	7	17	14	21	18	12	11
Economic Potential	-	-	-	-	5	(9)	8	22	20	26	22	15	14
Technical Potential	-	-	-	-	9	(3)	13	28	25	31	26	18	17
Incremental Savings (% of Baseline)													
Achievable Potential Low	0.0%	0.0%	0.0%	0.0%	0.8%	0.4%	0.6%	1.4%	1.2%	1.8%	1.7%	1.3%	1.0%
Achievable Potential High	0.0%	0.0%	0.0%	0.0%	1.4%	0.2%	0.9%	2.3%	1.9%	2.7%	2.3%	1.5%	1.3%
Economic Potential	0.0%	0.0%	0.0%	0.0%	0.7%	-1.3%	1.1%	3.1%	2.6%	3.4%	2.8%	1.8%	1.7%
Technical Potential	0.0%	0.0%	0.0%	0.0%	1.3%	-0.5%	1.9%	3.8%	3.3%	4.0%	3.3%	2.2%	2.1%

Table F-7 Measure-Level Annual Electric Energy Savings, Industrial

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Baseline Forecast (GWh)	2,845	2,824	2,848	2,861	2,863	2,877	2,896	2,922	2,943	2,964	2,979	2,991	3,007
Cumulative Savings (GWh)													
Achievable Potential Low	-	-	-	-	11	24	42	65	87	114	139	170	191
Achievable Potential High	-	-	-	-	22	47	79	119	153	192	226	267	300
Economic Potential	-	-	-	-	34	69	109	160	207	262	310	367	412
Technical Potential	-	-	-	-	36	74	117	171	221	278	329	387	433
Cumulative Savings (% of Baseline)													
Achievable Potential Low	0.0%	0.0%	0.0%	0.0%	0.4%	0.8%	1.5%	2.2%	3.0%	3.8%	4.7%	5.7%	6.4%
Achievable Potential High	0.0%	0.0%	0.0%	0.0%	0.8%	1.6%	2.7%	4.1%	5.2%	6.5%	7.6%	8.9%	10.0%
Economic Potential	0.0%	0.0%	0.0%	0.0%	1.2%	2.4%	3.8%	5.5%	7.0%	8.8%	10.4%	12.3%	13.7%
Technical Potential	0.0%	0.0%	0.0%	0.0%	1.3%	2.6%	4.0%	5.8%	7.5%	9.4%	11.0%	12.9%	14.4%
Incremental Savings (GWh)													
Achievable Potential Low	-	-	-	-	11	14	18	23	22	27	25	30	21
Achievable Potential High	-	-	-	-	22	26	32	39	34	40	34	40	33
Economic Potential	-	-	-	-	34	35	40	51	47	55	48	56	45
Technical Potential	-	-	-	-	36	38	43	54	51	57	51	58	46
Incremental Savings													
Achievable Potential Low	0.0%	0.0%	0.0%	0.0%	0.4%	0.5%	0.6%	0.8%	0.7%	0.9%	0.8%	1.0%	0.7%
Achievable Potential High	0.0%	0.0%	0.0%	0.0%	0.8%	0.9%	1.1%	1.3%	1.2%	1.3%	1.1%	1.4%	1.1%
Economic Potential	0.0%	0.0%	0.0%	0.0%	1.2%	1.2%	1.4%	1.7%	1.6%	1.9%	1.6%	1.9%	1.5%
Technical Potential	0.0%	0.0%	0.0%	0.0%	1.3%	1.3%	1.5%	1.8%	1.7%	1.9%	1.7%	1.9%	1.5%

Table F-8 Measure-Level Annual Electric Peak Demand Savings, Industrial

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Baseline Forecast (GWh)	3,229	3,195	3,206	3,202	3,190	3,191	3,200	3,216	3,228	3,240	3,247	3,253	3,264
Cumulative Savings (GWh)													
Achievable Potential Low	-	-	-	-	15	35	61	91	120	153	186	223	249
Achievable Potential High	-	-	-	-	31	68	114	166	210	259	304	353	392
Economic Potential	-	-	-	-	49	101	157	224	286	355	418	485	539
Technical Potential	-	-	-	-	52	106	166	235	301	373	438	507	563
Cumulative Savings (% of Baseline)													
Achievable Potential Low	0.0%	0.0%	0.0%	0.0%	0.5%	1.1%	1.9%	2.8%	3.7%	4.7%	5.7%	6.9%	7.6%
Achievable Potential High	0.0%	0.0%	0.0%	0.0%	1.0%	2.1%	3.6%	5.2%	6.5%	8.0%	9.4%	10.8%	12.0%
Economic Potential	0.0%	0.0%	0.0%	0.0%	1.5%	3.1%	4.9%	7.0%	8.9%	11.0%	12.9%	14.9%	16.5%
Technical Potential	0.0%	0.0%	0.0%	0.0%	1.6%	3.3%	5.2%	7.3%	9.3%	11.5%	13.5%	15.6%	17.3%
Incremental Savings (GWh)													
Achievable Potential Low	-	-	-	-	15	20	26	31	29	34	33	37	25
Achievable Potential High	-	-	-	-	31	37	46	52	44	49	45	49	39
Economic Potential	-	-	-	-	49	52	56	67	62	69	63	67	55
Technical Potential	-	-	-	-	52	55	60	69	66	72	66	69	56
Incremental Savings													
Achievable Potential Low	0.0%	0.0%	0.0%	0.0%	0.5%	0.6%	0.8%	1.0%	0.9%	1.0%	1.0%	1.1%	0.8%
Achievable Potential High	0.0%	0.0%	0.0%	0.0%	1.0%	1.2%	1.4%	1.6%	1.4%	1.5%	1.4%	1.5%	1.2%
Economic Potential	0.0%	0.0%	0.0%	0.0%	1.5%	1.6%	1.8%	2.1%	1.9%	2.1%	1.9%	2.1%	1.7%
Technical Potential	0.0%	0.0%	0.0%	0.0%	1.6%	1.7%	1.9%	2.1%	2.0%	2.2%	2.0%	2.1%	1.7%

PROGRAM POTENTIAL SAVINGS AND BUDGETS

Table G-1 shows the detailed budgets and net savings (on an annual or incremental basis) for the Recommended Portfolio. Table G-2 and Table G-3 show the Achievable Low and Achievable High portfolios.

Table G-1 Vectren Recommended Electric Energy Efficiency Portfolio Summary

Program	Total Utility Costs (000$)					Total Net Incremental Energy Savings (MWh)					Total Net Incremental Demand Savings (kW)				
	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
Res Lighting	891	924	1,648	1,737	1,619	8,738	8,642	8,696	8,621	8,590	525	520	523	518	516
Res Efficient Products	309	349	406	455	496	2,425	2,957	3,773	4,061	4,096	259	310	385	420	438
Res IQW	491	491	728	712	680	1,876	1,799	1,527	1,517	1,518	116	112	95	94	94
Res IQW Plus	282	282	291	291	291	142	141	144	143	142	88	87	87	86	86
Res NC	57	64	107	116	119	193	193	220	236	248	24	26	29	32	35
Res MF Direct Install	146	115	-	-	-	610	448	-	-	-	44	32	-	-	-
Res HEA	434	452	861	872	855	2,846	2,911	3,092	3,218	3,354	138	140	149	155	161
Res School Kit	252	252	252	252	252	741	726	721	715	711	132	131	130	130	130
Res Whole House Plus	966	1,037	1,105	1,163	1,213	1,343	1,426	1,507	1,579	1,646	936	994	1,049	1,100	1,146
Res Appliance Recycling	174	174	174	165	155	561	561	561	528	495	143	143	143	135	126
Res Behavioral Feedback Tools	300	300	300	300	300	4,659	5,177	5,177	5,177	5,177	1,299	1,443	1,443	1,443	1,443
Bus Prescriptive	2,120	2,660	3,119	3,527	3,510	12,310	13,774	15,438	16,535	17,112	8,088	9,683	11,231	14,842	13,627
Bus Custom Incentives	2,725	3,157	3,578	4,025	4,426	12,906	14,891	16,801	18,698	20,595	8,027	9,329	10,587	11,946	13,206
Bus Schools Program	268	324	372	422	454	719	839	919	938	1,027	110	135	155	174	192
Bus SEM	150	225	298	373	373	832	1,663	2,757	3,589	3,589	141	281	495	635	635
Bus & MF NC	298	364	395	479	493	1,109	1,386	1,530	1,902	2,009	587	725	749	960	939
Bus Direct Install	737	826	908	1,025	1,056	1,977	2,134	2,278	2,399	2,526	648	720	797	925	982
Residential Total:	4,301	4,440	5,872	6,062	5,979	24,134	24,981	25,418	25,795	25,977	3,704	3,938	4,034	4,113	4,175
Business Total:	6,298	7,557	8,669	9,851	10,311	29,851	34,686	39,723	44,060	46,857	17,602	20,873	24,013	29,482	29,581
Portfolio Total:	**10,599**	**11,996**	**14,542**	**15,913**	**16,290**	**53,986**	**59,667**	**65,140**	**69,855**	**72,834**	**21,306**	**24,811**	**28,047**	**33,596**	**33,757**

Table G-2 Vectren Avhievable Low Electric Energy Efficiency Portfolio Summary

Program	Total Utility Costs (000$)					Total Incremental Energy Savings (MWh)					Total Incremental Demand Savings (kW)				
	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
Res Lighting	446	469	1,290	1,394	1,329	4,823	4,885	5,556	5,847	6,021	290	294	334	352	362
Res Efficient Products	182	204	236	264	288	1,444	1,815	2,380	2,671	2,794	158	194	245	277	297
Res IQW	137	137	206	202	194	373	362	365	362	357	24	23	23	23	23
Res IQW Plus	349	349	360	360	360	114	113	115	114	114	71	70	70	69	69
Res NC	113	126	209	228	233	565	564	656	708	737	69	75	87	96	103
Res MF Direct Install	122	89	-	-	-	571	374	-	-	-	41	27	-	-	-
Res HEA	274	274	533	518	488	2,091	2,035	2,045	2,029	2,000	133	129	130	129	127
Res School Kit	176	176	176	176	176	494	484	481	477	473	88	87	87	87	86
Res Whole House Plus	389	443	501	558	613	428	480	540	601	658	333	370	408	445	482
Res Appliance Recycling	228	228	228	216	204	951	951	951	895	839	148	148	148	139	130
Res Behavioral Feedback Tools	300	300	300	300	300	5,695	6,212	6,730	7,248	7,766	1,588	1,732	1,876	2,021	2,165
Bus Prescriptive	1,224	1,503	1,711	1,879	1,961	7,572	8,277	9,014	9,562	10,460	5,850	6,679	7,534	9,521	9,170
Bus Custom Incentives	2,719	3,138	3,565	3,983	4,387	12,889	14,816	16,787	18,574	20,562	8,398	9,691	11,017	12,351	13,682
Bus Schools Program	190	216	242	266	288	543	604	658	665	739	91	105	119	132	148
Bus SEM	281	349	393	462	462	2,495	3,326	4,158	4,989	4,989	422	563	703	844	844
Bus & MF NC	187	217	229	272	269	700	838	939	1,125	1,201	481	573	585	738	701
Bus Direct Install	244	275	305	333	369	506	569	629	672	747	224	255	287	321	357
Residential Total:	2,715	2,795	4,040	4,216	4,186	17,548	18,275	19,817	20,950	21,758	2,942	3,148	3,407	3,636	3,844
Business Total:	4,934	5,800	6,570	7,336	7,890	24,804	28,547	32,335	35,762	38,895	15,539	17,950	20,347	24,023	25,030
Portfolio Total:	**7,650**	**8,594**	**10,610**	**11,552**	**12,076**	**42,352**	**46,822**	**52,152**	**56,712**	**60,653**	**18,481**	**21,098**	**23,754**	**27,658**	**28,873**

Table G-3 Vectren Achievable High Electric Energy Efficiency Portfolio Summary

Program	Total Utility Costs (000$)					Total Incremental Energy Savings (MWh)					Total Incremental Demand Savings (kW)				
	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
Res Lighting	945	999	2,633	2,788	2,674	9,198	9,292	9,995	10,386	10,874	553	559	601	624	654
Res Efficient Products	378	428	500	563	615	3,023	3,687	4,691	5,044	5,083	324	388	481	525	548
Res IQW	152	152	239	234	224	467	453	456	452	450	29	29	29	29	28
Res IQW Plus	433	433	447	447	447	142	141	144	143	142	88	87	87	86	86
Res NC	234	264	451	491	505	1,072	1,072	1,222	1,310	1,375	132	143	164	180	196
Res MF Direct Install	135	108	-	-	-	610	448	-	-	-	44	32	-	-	-
Res HEA	50	75	178	222	256	209	407	613	811	1,008	13	26	39	51	64
Res School Kit	290	290	290	290	290	865	847	841	834	829	153	152	152	151	151
Res Whole House Plus	786	921	1,067	1,209	1,348	652	761	883	1,007	1,124	460	540	622	702	782
Res Appliance Recycling	415	415	415	393	370	1,828	1,828	1,828	1,720	1,613	284	284	284	268	251
Res Behavioral Feedback Tools	850	850	850	850	850	10,553	11,513	12,472	13,432	14,391	2,942	3,210	3,477	3,745	4,012
Bus Prescriptive	3,141	3,833	4,297	4,636	4,752	14,841	15,785	16,798	17,298	18,620	11,047	12,779	14,140	17,424	16,720
Bus Custom Incentives	6,532	7,532	8,548	9,546	10,508	23,947	27,326	30,770	33,823	37,271	15,240	17,541	19,893	22,245	24,591
Bus Schools Program	460	524	588	647	700	1,057	1,153	1,233	1,217	1,333	174	199	223	244	270
Bus SEM	349	418	462	530	599	3,326	4,158	4,989	5,821	6,652	563	703	844	985	1,125
Bus & MF NC	458	530	549	649	629	1,358	1,605	1,764	2,083	2,182	980	1,134	1,121	1,381	1,275
Bus Direct Install	431	490	545	597	662	974	1,077	1,175	1,237	1,361	420	474	530	590	651
Residential Total:	4,668	4,935	7,071	7,487	7,578	28,619	30,449	33,144	35,139	36,889	5,024	5,450	5,935	6,362	6,772
Business Total:	11,550	13,529	15,249	16,901	18,176	45,682	51,309	56,993	61,785	67,762	28,552	32,979	36,930	43,070	44,857
Portfolio Total:	**16,218**	**18,465**	**22,320**	**24,388**	**25,754**	**74,301**	**81,758**	**90,137**	**96,924**	**104,651**	**33,576**	**38,429**	**42,866**	**49,432**	**51,629**

About EnerNOC

EnerNOC's Utility Solutions Consulting team is part of EnerNOC's Utility Solutions, which provides a comprehensive suite of demand-side management (DSM) services to utilities and grid operators worldwide. Hundreds of utilities have leveraged our technology, our people, and our proven processes to make their energy efficiency (EE) and demand response (DR) initiatives a success. Utilities trust EnerNOC to work with them at every stage of the DSM program lifecycle – assessing market potential, designing effective programs, implementing those programs, and measuring program results.

EnerNOC's Utility Solutions deliver value to our utility clients through two separate practice areas – Implementation and Consulting.

- Our Implementation team leverages EnerNOC's deep "behind-the-meter expertise" and world-class technology platform to help utilities create and manage DR and EE programs that deliver reliable and cost-effective energy savings. We focus exclusively on the commercial and industrial (C&I) customer segments, with a track record of successful partnerships that spans more than a decade. Through a focus on high quality, measurable savings, EnerNOC has successfully delivered hundreds of thousands of MWh of energy efficiency for our utility clients, and we have thousands of MW of demand response capacity under management.
- The Consulting team provides expertise and analysis to support a broad range of utility DSM activities, including: potential assessments; end-use forecasts; integrated resource planning; EE, DR, and smart grid pilot and program design and administration; load research; technology assessments and demonstrations; evaluation, measurement and verification; and regulatory support.

The team has decades of combined experience in the utility DSM industry. The staff is comprised of professional electrical, mechanical, chemical, civil, industrial, and environmental engineers as well as economists, business planners, project managers, market researchers, load research professionals, and statisticians. Utilities view EnerNOC's experts as trusted advisors, and we work together collaboratively to make any DSM initiative a success.

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SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
d/b/a VECTREN ENERGY DELIVERY OF INDIANA, INC.

("VECTREN SOUTH")

I.U.R.C. CAUSE NO. 44495

DIRECT TESTIMONY

OF

RICHARD A. MORGAN

PRESIDENT, MORGAN MARKETING PARTNERS, LLC,

ON

DEMAND SIDE MANAGEMENT POLICY

SPONSORING PETITIONER'S EXHIBIT RAM-1

VERIFIED DIRECT TESTIMONY OF RICHARD A. MORGAN

INTRODUCTION

Q. Please state your name, title and business address.

A. My name is Richard A. Morgan. I am President of Morgan Marketing Partners, LLC ("MMP"). My business address is 6205 Davenport Drive, Madison, Wisconsin, 53711-2447. I am submitting this testimony on behalf of Southern Indiana Gas and Electric Company d/b/a Vectren Energy Delivery of Indiana, Inc. ("Vectren South" or the "Company").

Q. Please describe MMP.

A. MMP is a professional services firm formed in 1995 that partners with utility and governmental clients to provide energy efficiency consulting services including program design and development, cost-effectiveness modeling, strategic marketing consulting, implementation and operations assistance, new product and service development, management assistance, and evaluation and assessments. MMP has worked with clients including but not limited to DTE Energy, Consumer's Energy, Duke Energy, California Public Utility Commission, Energy Trust of Oregon, Missouri River Energy Services, Kansas City Power & Light, Jacksonville Electric Authority, Rochester Public Utilities, MidAmerican Energy, Hawaii Electric, Northwest Energy Efficiency Alliance, the State of Indiana, and Wisconsin Focus on Energy administered by Wisconsin Energy Conservation Corporation ("WECC"). One of MMP's longest-term clients is Duke Energy. Since MMP was formed, I have worked with Duke Energy on program planning and design. One of these programs was recognized by The American Council for an Energy Efficient Economy ("ACEEE") as an award-winning program for low-income customers. From 2001 to 2011, MMP served as planner and advisor to

WECC and the State of Wisconsin on the statewide residential and business public benefits efficiency program, *Wisconsin Focus on Energy*. MMP has also developed comprehensive energy efficiency program portfolios for Detroit Edison, Michigan Consolidated Gas, Kansas City Power & Light and Missouri River Energy Services. I served as one of two principal auditors to complete a management audit for the Energy Trust of Oregon to review all aspects of the Trust including organizational structure, program design/delivery, support systems, public involvement, and overall management. The California Public Utility Commission retained MMP to participate on an independent review team to provide advice regarding the portfolio of utility energy efficiency programs developed for 2006-2008. Also for California, I recently worked with a team of evaluators to assess all the energy efficiency programs offered by the California utilities. One of MMP's specialties is cost benefit analysis utilizing the DSMore modeling tool. MMP has completed cost benefit analysis for all the utilities in Michigan as well as many other clients including Missouri River Energy, KCP&L, Northern Indiana Public Service Company ("NIPSCO"), Ameren, Central Minnesota Municipal Power Authority and assisted Duke Energy and ComED.

Q. Can you summarize your educational background and professional qualifications?

A. I earned a Bachelor of Science degree in Resource Management from Ohio State University, School of Natural Resources in 1976. I am the Past President of the American Marketing Association, Madison Chapter, and a past Board Member and Vice President, Business Development for the Association of Energy Services Professionals ("AESP"). I am currently on the Board of the Midwest Energy Efficiency Alliance. I have had numerous papers and research published at AESP and ACEEE as well as general articles in energy literature and marketing articles in *The Capital Times* newspaper in Madison. I am also the winner of the 2002 AESP *B.H. Prasad Outstanding Contributor of the Year*.

Q. Can you describe your professional background and experience?

A. I have over thirty-five years of management, planning, program design, implementation, and marketing experience in the energy field. Prior to starting MMP in 1995, I spent four years as a manager and consultant with A&C Enercom, a leading energy services and consulting company. I was also Marketing Manager for EWI Engineering, a one hundred person engineering consulting firm. Before joining EWI Engineering, I spent over eleven years with Wisconsin Power & Light Company in its marketing and energy efficiency department. I held numerous positions managing many different services including low-income programs, residential services, commercial and industrial gas services, demand-side management programs, and marketing/sales initiatives. Within my various positions, my responsibilities included program planning, evaluation oversight, new product/service development, program design, market research, advertising/promotion planning, implementation and operations management, evaluation, budgeting, tracking, training, government interface, sales, field customer service support, quality control, and business center operations. Prior to joining Wisconsin Power and Light, I worked for the Oregon

Department of Energy and the Western SUN, a federally funded regional solar center.

Q. Have you ever provided expert testimony in the State of Indiana?

A. Yes. I have provided expert testimony for NIPSCOfor their DSM filing. I have also provided testimony for Detroit Edison, Michigan Consolidated Gas and Consumer's Energy in Michigan and for Duke Energy in North Carolina.

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to describe the efforts undertaken to design the Vectren South 2015 Electric DSM Plan ("2015 Plan"), including a cost benefit analysis, which was developed by MMP under the direction of Vectren South.

Q. Are you sponsoring any exhibits?

A. No.

Q. What are the cost effectiveness tests you performed?

A. As required by the Indiana Utility Regulatory Commission ("IURC" or "Commission"), the 2015 Plan considers the Utility Cost test (also known as the Program Administrator Cost test), the Total Resource Cost test ("TRC test"), the Ratepayer Impact Measure test, and the Participant Test.

Q. Please describe these tests.

A. The various tests can be described as follows:

- **Utility Cost Test**: Defined as the ratio of the net benefits of the programs to the program costs incurred by the utility for the programs. For a program to be cost-effective, this ratio needs to be greater than one.
- **TRCTest**: Defined as the total avoided cost divided by the program costs

plus the participant's costs. Incentives paid to the customer are in both the cost and benefit sides of the equation, so they cancel each other out.

- **Ratepayer Impact Measurement**: Defined as the avoided cost benefits divided by the program costs and lost revenues.
- **Participant Test**: Defined as the participant's benefits in energy savings from their bill plus their incentives divided by their costs to participate.

Q. For what period was the 2015 Plan developed?

A. The 2015Plan was developed for the 2015 program year and closely mirrors Vectren South's current DSM portfolio. Approval of this plan will allow Vectren South to continue offering DSM programs beginning January 1, 2015.

Q. Please describe MMP's overall approach and process used to develop the 2015 Plan.

A. The development of the 2015 Plan was a multi-step process with inputs from many parties. The first step in the process was reviewing the 2013 Vectren Market Potential Study ("MPS") conducted by EnerNOC. EnerNOC conducted a detailed, bottom-up assessment of the Vectren South service territory to deliver forecasts of electric energy use, forecasts of the energy savings achievable through efficiency measures, and program designs and strategies to optimally deliver those savings. The EnerNOC MPS and other study information were used to help guide the plan design. Second, existing program information and data were gathered and reviewed. This information included results and spending to date, evaluation results, and interviews with the existing implementation contractors. Additional inputs on existing programs were received from the

Vectren South program managers currently running the programs. The third step was gathering ideas for new programs or expansions to existing programs from the Vectren South program managers and current implementation contractors. The fourth step was to gather additional ideas for new programs from other programs around the country. MMP also used its 35 years of industry experience to bring its ideas to the table. Program ideas were then screened and reviewed with Vectren South. Final programs for consideration were then developed and the cost benefit analysis I discussed above was completed. For those programs included in the 2015 Plan, savings were estimated and budgets were developed.

Q. What are the goals of the 2015 Plan?

A. Vectren South designed the 2015 Plan to save electric energy and reduce electric demand to cost effectively reduce energy use by approximately 1% of available retail sales. This goal is expressed as a percentage of weather normalized average electric sales for calendar year 2013 and excludes approximately 50% of large customer load, as Vectren South anticipates at least 50% of the large customer load will opt-out of participation in Vectren South energy efficiency programs. For Vectren, the 2015 savings goal number is 42,214,000 kilowatt-hours ("kWh").

The second goal of the 2015 Plan is to provide programs that are cost effective when compared to supply-side options. To determine cost effectiveness, Vectren South reviewed all the tests but focused the TRC and UCT test for program implementation.

Q. Does the 2015 Plan provide Vectren South a path to reach those goals in 2015?

A. Yes. The portfolio total savings is 42,114,912 kWh and passes the TRC test, with the total portfolio TRC scores of 1.98 and TRC scores of 1.38 for residential and 2.25 for commercial and industrial ("C&I"). The 2015 Plan provides further detail on the cost benefit tests.

Q. Which programs are included in the residential portfolio of programs for 2015?

A. Vectren South's residential portfolio includes the following Programs:

- Residential Lighting Program;
- Home Energy Assessment Program;
- Income Qualified Weatherization Program;
- School Education Program (School Kits portion);
- Appliance Recycling Program;
- Energy Efficient Products Program;
- Residential New Construction Program;
- Behavior Program.

Q. Which programs are included in the C&I portfolio of programs for 2014?

A. Vectren's C&I portfolio includes the following Programs:

- Commercial & Industrial Prescriptive Rebate Program;
- Non-Residential New Construction Program;
- Small Business Direct Install Program;
- Commercial & Industrial Custom Incentive Program.

Details of the programs are included in the Plan.

Q. Are the 2015 Plan programs cost effective?

A. As can be seen in Tables RAM-1 below the portfolio as well as the residential and C&I portfolios pass the TRC test. All individual programs included in the residential and C&I portfolios also pass the TRC test.

Table RAM-1 2015 Plan Cost Effectiveness Results

COMMERCIAL	TRC	UCT	TRC NPV $	UCT NPV $
Small Business Direct Install	2.00	2.21	$2,116,270	$2,319,485
Commercial & Industrial Prescriptive	3.97	5.57	$7,415,610	$8,135,889
Commercial & Industrial New Construction	1.09	2.82	$40,440	$311,588
Commercial & Industrial Custom	1.70	4.16	$1,838,430	$3,399,052
Commercial Sector Portfolio	**2.42**	**3.72**	**$11,212,741**	**$13,968,004**

RESIDENTIAL	TRC	UCT	TRC NPV $	UCT NPV $
Residential Lighting	2.18	2.88	$929,179	$1,121,826
Home Energy Assessments	1.02	1.02	$15,690	$15,690
Income Qualified Weatherization	1.14	1.14	$115,688	$115,688
Appliance Recycling	2.52	2.51	$320,800	$319,656
Residential Schools	2.67	2.67	$214,237	$214,237
Efficient Products	1.51	2.02	$352,915	$524,039
Residential New Construction	1.28	1.52	$39,816	$61,965
Residential Behavior Savings	1.64	1.64	$274,885	$274,885
Residential Sector Portfolio	**1.49**	**1.64**	**$1,992,542**	**$2,377,317**

Total Portfolio*	**2.10**	**2.85**	**$13,205,283**	**$16,345,321**

*Total Portfolio includes Outreach and Tracking for benefit/cost runs

Q. How was cost effectiveness determined?

A. MMP used the DSMore cost analysis tool to calculate and report cost-effectiveness for the programs.

Q. Can you describe the DSMore modeling tool?

A. The DSMore modeling tool is award-winning modeling software that is nationally recognized and used in many states across the country to determine cost-effectiveness for energy efficiency programs. Developed and licensed by Integral Analytics (based in Cincinnati, Ohio) the DSMore cost effectiveness modeling tool takes hourly prices and hourly energy savings from the specific measures and technologies being considered for the energy efficiency program, and then correlates both to weather. This tool looks at over 30 years of historic weather variability to get the full weather variances appropriately modeled. In turn, this allows the model to capture the low probability, but high consequence, weather events and apply appropriate value to the measure during those events. In determining the scores of the various tests I discussed earlier, a weighted average price and weather value is used. Thus, a more accurate view of the value of the efficiency measure can be captured in comparison to other alternative supply-side options.

Q. What type of program information do you use for model inputs?

A. Inputs into the model include participation rates, customer incentives paid, measure energy savings, measure life, implementation costs, administrative costs, and incremental costs to the participant of the high efficiency measure.

Q. What costs did you use for the calculation?

A. Costs for 2015 were based on actual 2013 program costs for existing programs. This represents the most realistic expectation of costs based on real field performance and contracts. Costs used include Vectren South administrative costs, implementation costs by contractors, customer incentives, direct installation of measures if required, and evaluation, measurement and verification ("EM&V") costs at the portfolio level.

Q. What energy efficiency measures did you consider for Vectren's programs?

A. Energy efficiency measures considered for the programs were developed using existing Indiana utility program measures (whenever possible) and measures used in other programs in the region. It should be noted that in any plan measures within programs will change and adapt to changing technology and markets. The 2015 Plan shows a framework of measures and programs that can meet the savings goals, however, it is expected that new measures and opportunities will become available during this period and that some measures will phase out as standards change and they are no longer cost effective.

Q. How were the energy and demand savings associated with each of the various measures determined?

A. MMP and Vectren South based the 2015 Plan on known existing measures and technologies. EM&V results were used to support the energy and demand savings assumptions. In addition to the EM&V results, other sources such as core TPA bids, core plus vendor estimates, and the Indiana Technical Resource Manual ("TRM") were utilized to support the 2015 Plan where appropriate.

Q. Please describe the process to determine appropriate customer incentives.

A. Customer incentives are a tool to get the market to respond and take action. As such, they should change over time and as needed to get the necessary participation (but not overpay incentives). However, budgets need to be established with expected incentives. To develop the expected incentives for the budgets and cost benefit analysis, we utilized the existing program incentives. If new measures were added that are not covered in existing programs, then incentives from other programs outside Indiana were reviewed for potential incentive levels. If potential incentive levels were not available through other programs, the analysis tied the incentive to 50% of the incremental cost of the measure.

Q. What type of utility information is used in the DSMore cost analysis tool?

A. For utility information, DSMore utilizes utility rates; escalation rates; discount rates for the utility, society and the participant; and avoided costs.

Q. What is the source of the utility information used for DSMore inputs?

A. Utility inputs were provided by Vectren South.

Q. Did MMP assume any EM&V costs in determining the economic potential of the portfolio?

A. Yes. MMP used a 6% allocation based on program costs (before Vectren South administration costs were included) to determine EM&V budgets. These budgets were then included in the portfolio benefit cost analysis.

Q. Is the portfolio of programs in the 2015 Plan cost effective?

A. Yes.

Q. Does the 2015 Plan provide Vectren South a path to reach its 2014 savings goals?

A. Yes.

Q. Does this conclude your testimony?

A. Yes.

VERIFICATION

I, Richard A. Morgan, President, Morgan Marketing Partners, LLC, affirm under the penalties of perjury that the statements and representations in the foregoing Direct Testimony are true to the best of my knowledge, information and belief.

Richard A. Morgan

Richard A. Morgan
Dated: 5/27/2014