2018 Integrated Resource Plan

Stakeholder Workshop #5





May 30, 2019

Plainfield, IN

Welcome

- Safety message
- Technology
  - Call-in # 866-385-2663
  - Wi-Fi provided as in previous meetings
- Opening Comments
- Introductions

Why are we here today?

- Recap December stakeholder meeting and respond to comments/questions
- Provide a general update on activities done since the Dec meeting
- Review modeling results

Agenda

Time	Topic
9:00	Registration & Continental Breakfast
9:30	Welcome, Introductions, Agenda
9:50	Review of December Meeting; Responses to Questions/Feedback
10:15	Update since December Meeting
10:30	Review Scenarios & Optimized Portfolios
11:15	Initial Sensitivities and Development of Alternate Portfolios
12:00	Lunch
1:00	Modeling results (Market purchases, CO2 and cost)
2:00	Risk Analysis Sensitivities (Market Purchases & Social Cost of Carbon)
2:45	Next Steps and Closing Comments

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Scott Park, Director IRP Analytics - Midwest

Review of December Meeting, Comments and Overall Update

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Recap of December Meeting

- Review of previous meeting
- Update on EE
- Scenario & Sensitivity discussion
- Optimized portfolios
- Alternate portfolios
- Stakeholder portfolio exercise

Comments from December Meeting

STAKEHOLDER QUESTIONS/COMMENTS	RESPONSES
Stakeholders would like more time to review model inputs	Much of the time since the December meeting has been spent working with stakeholders discussion model inputs as well as model outputs
Duke should model capacity on a UCAP basis	Duke currently models on an ICAP basis (nameplate MW for a generator) and a reserve margin of 15%. Modeling on a UCAP basis is feasible but would also require the long term estimation of outage rates for each generator as well as the MISO planning reserve margin.
EE should be modeled using the decrement approach	We are very willing to discuss alternate ways to model EE, but have concerns about the decrement approach. For example, calculating the cost reduction due to a given decrement in load is straight forward but will be different for each scenario. Additionally, in order to realize those dollar savings, a basket of EE programs must be put together that mimics the shape of the decrement.
Duke should limit the amount of market purchases	We agree that higher levels of market purchases are cause for concern, but do not believe that imposing a constraint on the model is the best approach since that would not happen during actual operations of the system. Based on conversations with stakeholders, we have talked Duke's dispatch team and included a hurdle rate on market purchases that approximates their risk adjusted decision making process. This results in a general reduction in market purchases.

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Activities since December meeting

- Worked with CAC and EMCC to develop their own portfolios
  - Made numerous model runs with CAC and EMCC provided inputs, such as
    - Load forecasts and EV charging profiles, solar costs, wind profiles, UCAP basis, EE decrements and CO_2 mass cap
  - Provided portfolio development spreadsheet
- Performing analysis of portfolios in each of the 5 scenarios
- Performed sensitivity analysis

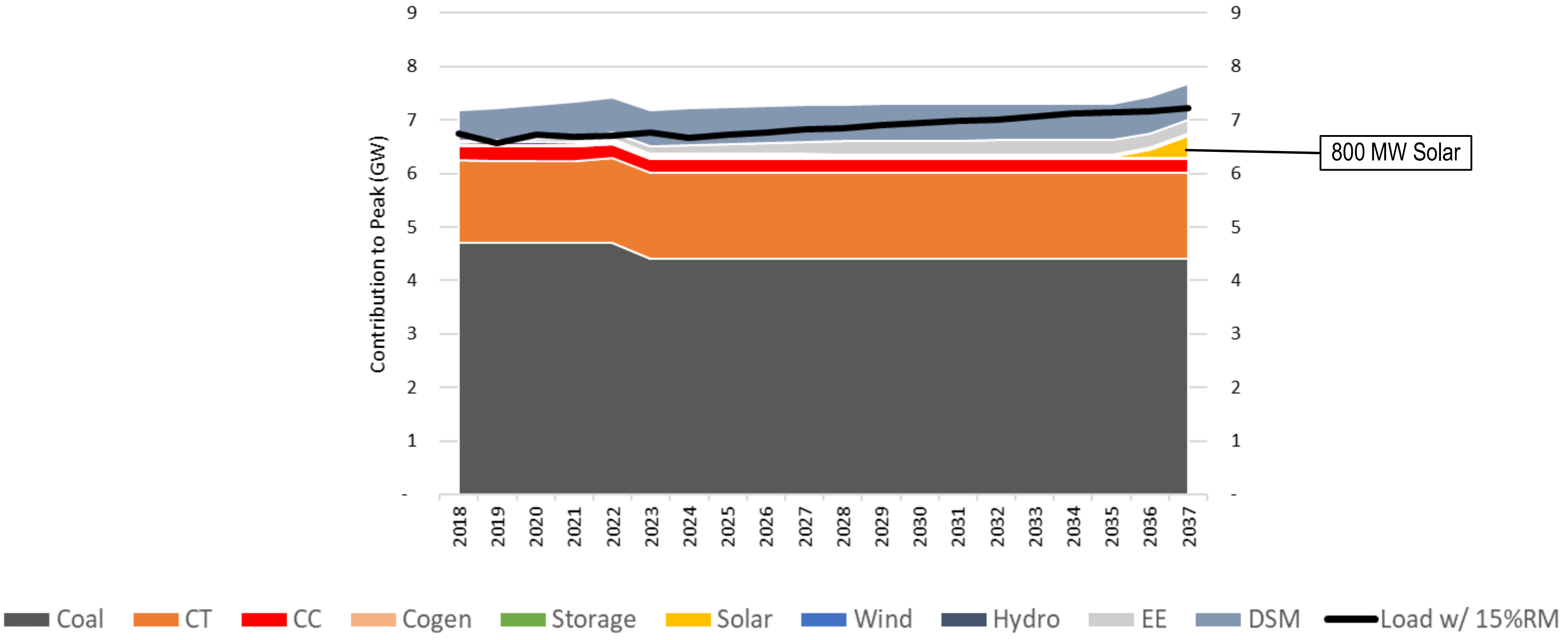
Nate Gagnon – Lead Planning Analyst

Review of Scenarios & Optimized Portfolios

Scenario Summary

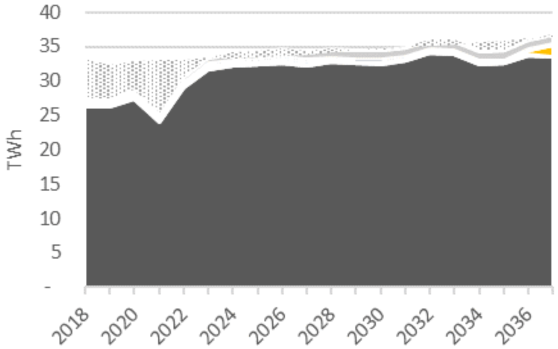
Scenario	Gas Price	Coal Price	Load Forecast	Carbon Price	Cost of Solar & Wind	Cost of EE	PTC & ITC
1) Slower Innovation (High prices)	High	High	Low	None	High	High	Renewed
2) Reference Case (Mid prices)	Mid	Mid	Mid	Mid	Mid	Mid	Expire
3) High Tech Future (Low prices)	Low	Low	High	High	Low	Low	Expire
4) Current Conditions	Market	Market	Mid	None	Mid	Mid	Expire
5) Reference Case, No Carbon	Mid	Mid	Mid	None	Mid	Mid	Expire

Slower Innovation Portfolio

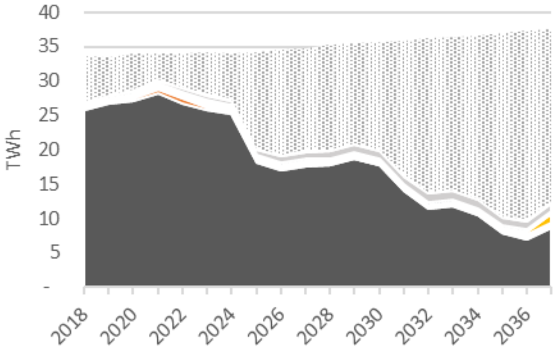


Slower Innovation Energy Mixes

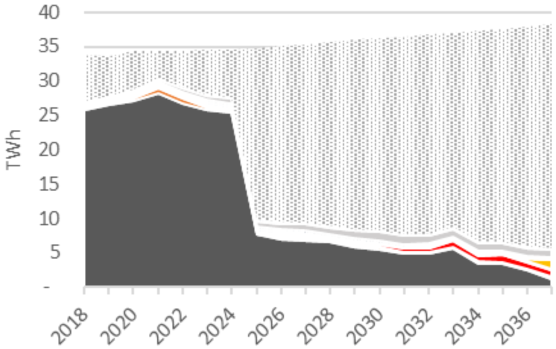
Slower Innovation Scenario



Reference Scenario



High Tech Scenario



Coal | CT | CC | Cogen | Solar | Wind | Hydro | EE | DSM | Net Mkt Purchase

Observations
- Portfolio is optimized for this scenario
- Coal units very competitive in the energy market, leading to net sales in several years

Observations
- Stable gas prices, addition of price on carbon emissions, shift competitive advantage to market energy

Observations
- Coal capacity factors fall dramatically with introduction of high price on carbon emissions in 2025
- Low gas prices contribute to market energy being low cost in most hours

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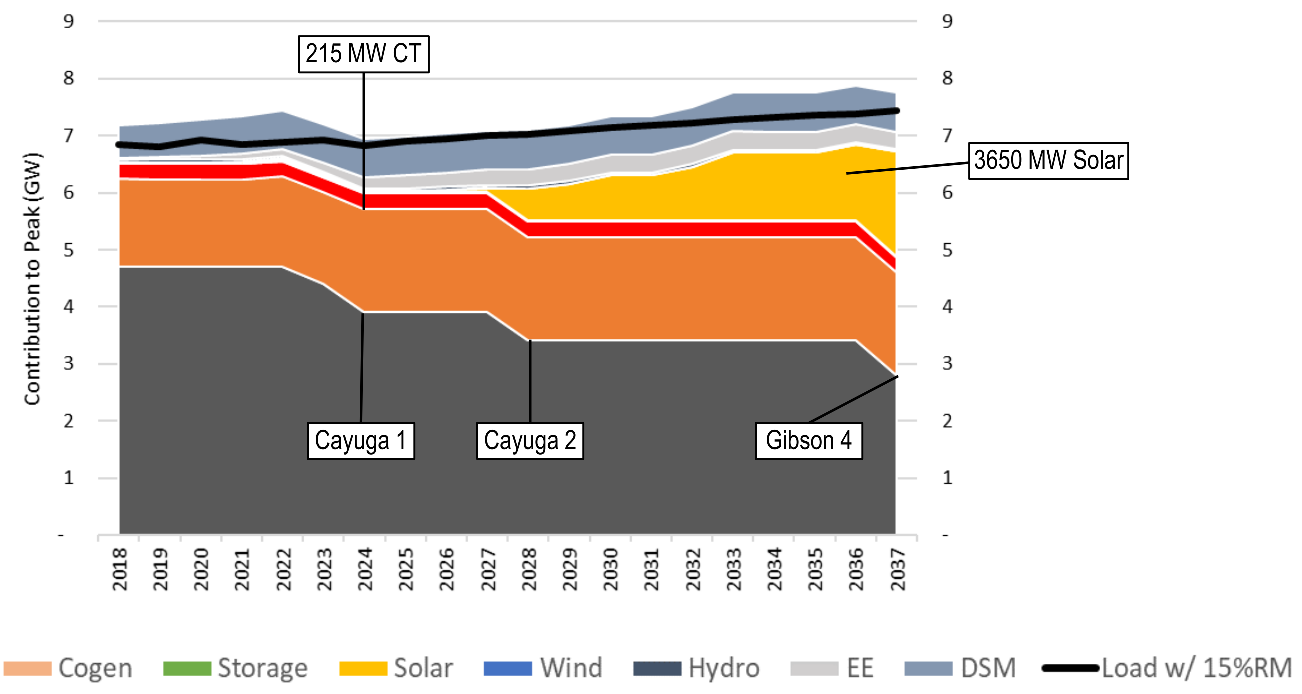
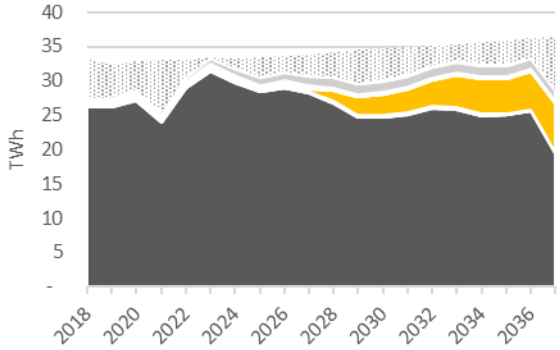
Reference Case Portfolio

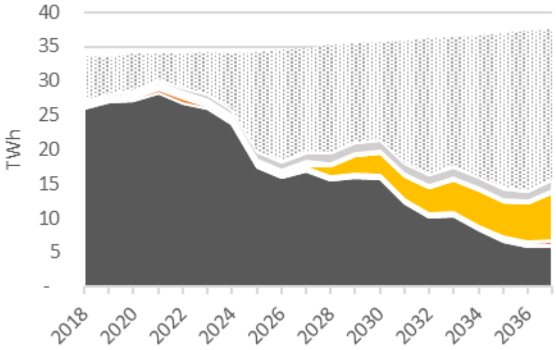


Reference Case Energy Mixes

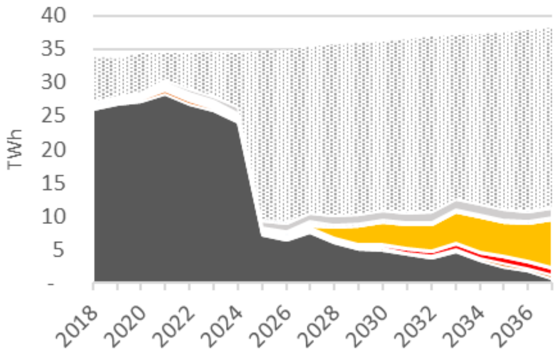
<u>Slower Innovation Scenario</u>



<u>Reference Scenario</u>



<u>High Tech Scenario</u>



■ Coal ■ CT ■ CC ■ Cogen ■ Solar ■ Wind ■ Hydro ■ EE ■ DSM ░ Net Mkt Purchase

<u>Observations</u>

- Coal retirements lead to greater market purchases compared with previous portfolios
- Solar replaces some eliminated coal

<u>Observations</u>

- Market continues to be economic source of energy in scenarios with carbon price, stagnant gas prices
- Solar displaces some purchases and coal generation

<u>Observations</u>

- Portfolio retains substantial coal capacity leading to reliance on market when carbon price is high
- Solar mitigates impact to a small degree

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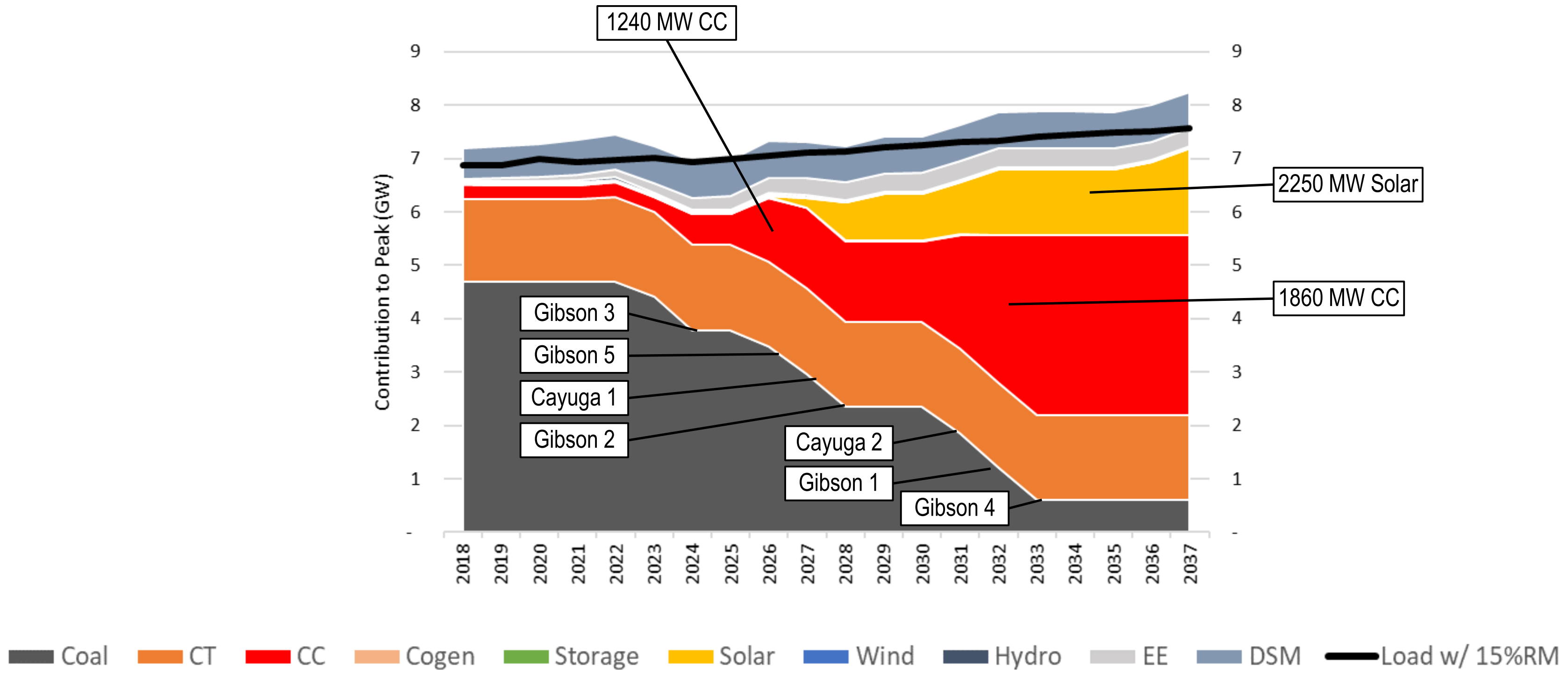
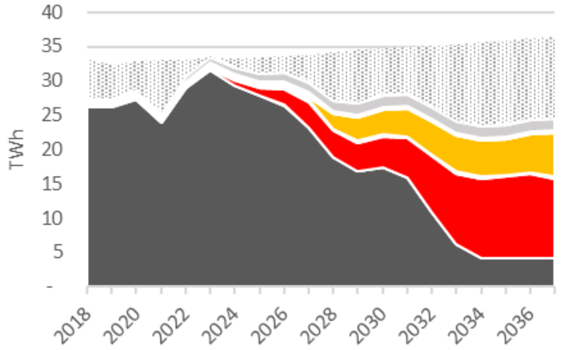
High Tech Future Portfolio



High Tech Future Energy Mixes

Slower Innovation Scenario



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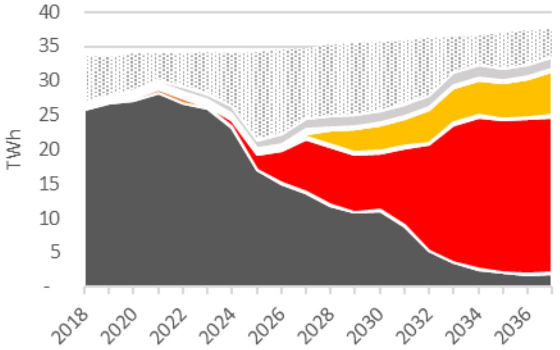
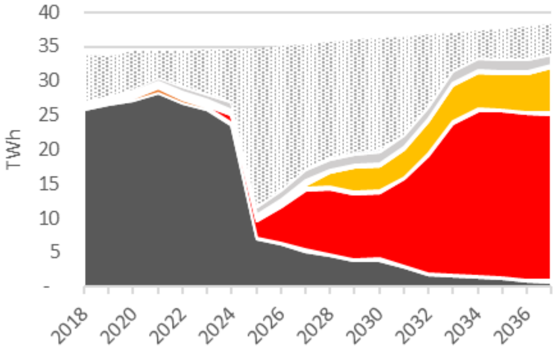


High Tech Scenario



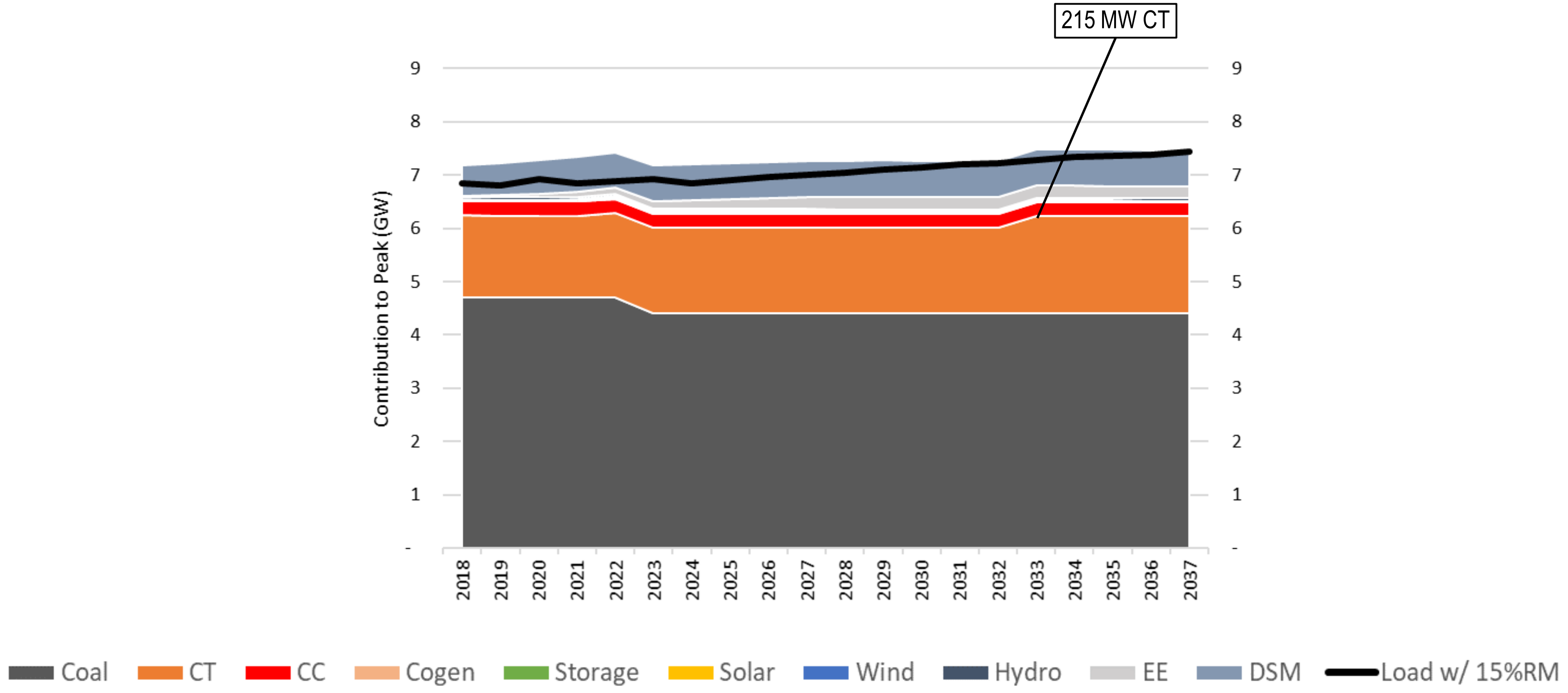
Coal | CT | CC | Cogen | Solar | Wind | Hydro | EE | DSM | Net Mkt Purchase

Observations
- High gas prices challenge economics of energy from new CCs
- Market purchases higher than other portfolios in this scenario

Observations
- New CC and solar generation competitive in energy market
- Market purchases increase when carbon price is enacted, fall as CC and solar capacity comes online

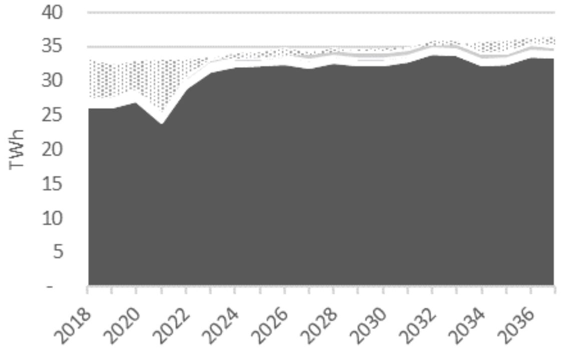
Observations
- CC and solar additions lag carbon price, resulting in substantial market purchases in mid-2020s
- Market reliance diminished as CC capacity ramps up

Current Conditions Portfolio

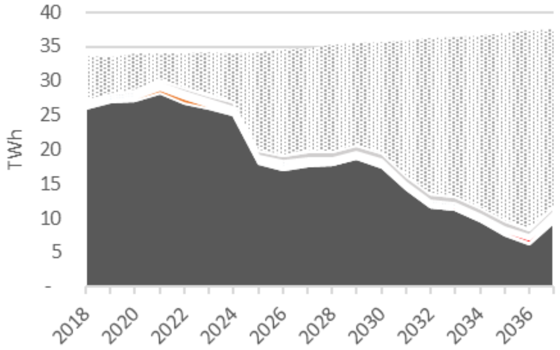


Current Conditions Energy Mixes

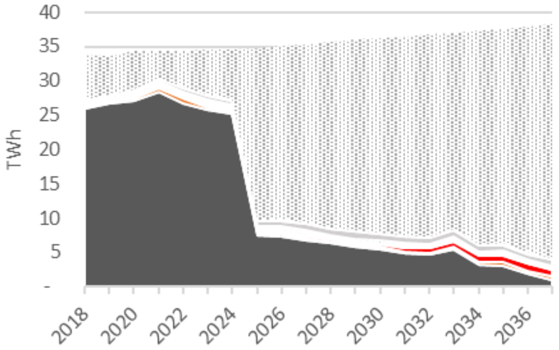
Slower Innovation Scenario



Reference Scenario



High Tech Scenario



Coal | CT | CC | Cogen | Solar | Wind | Hydro | EE | DSM | Net Mkt Purchase

Observations

- High gas prices, lack of carbon regulation make coal competitive in the energy market
- Portfolio is net seller in several years

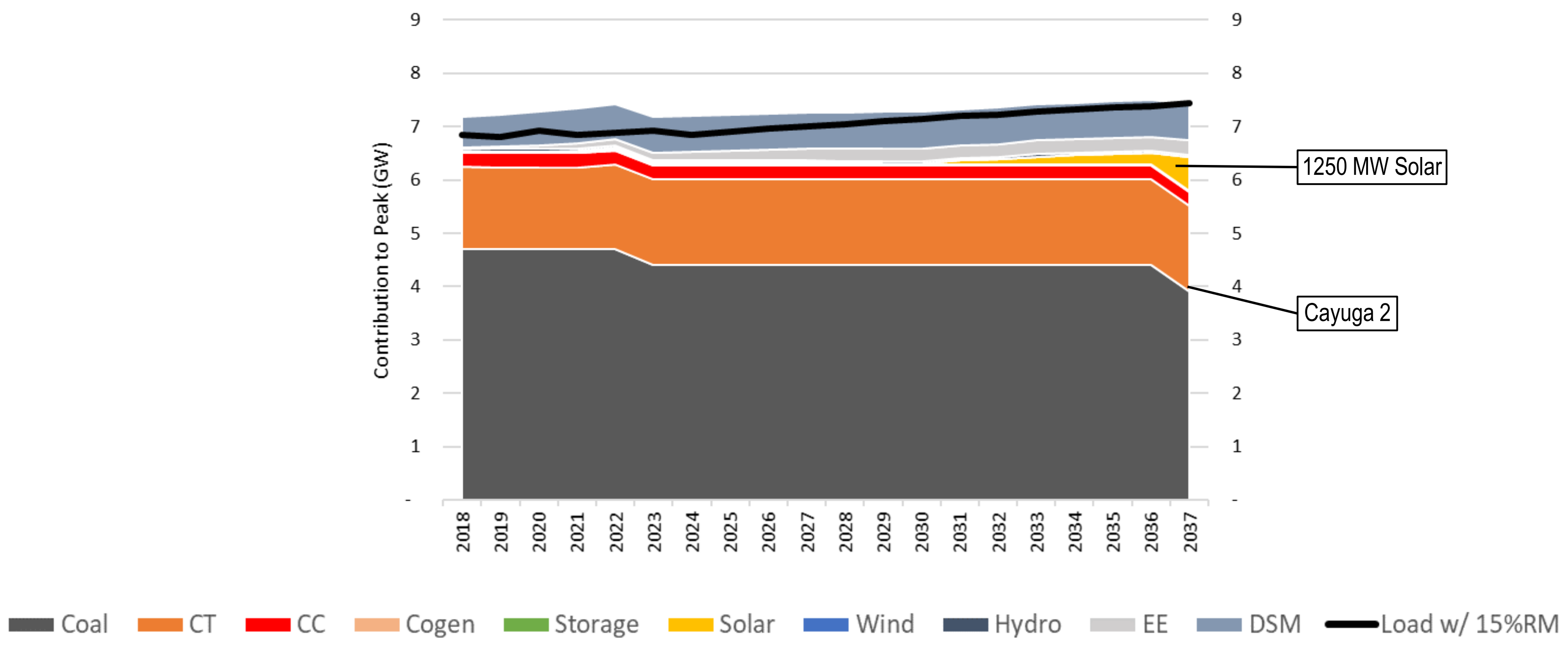
Observations

- Stagnant gas prices, introduction of carbon regulation challenge economics of energy from coal
- Economics dictate increasing market purchases over time

Observations

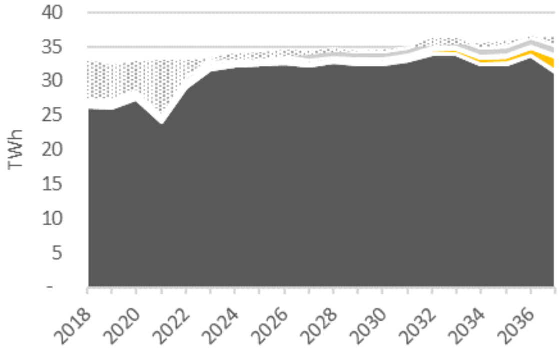
- Introduction of high cost to carbon emissions in 2025 dramatically cuts coal unit capacity factors
- Portfolio relies on the market for low-cost energy

Reference w/o CO2 Reg Portfolio

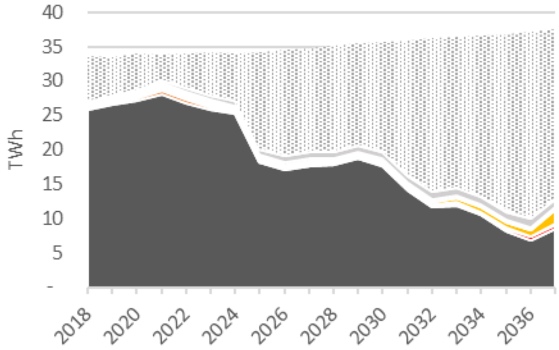


Reference w/o CO_2 Reg Portfolio Energy Mixes

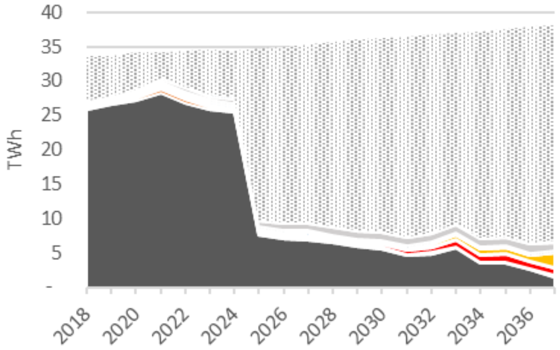
Slower Innovation Scenario



Reference Scenario



High Tech Scenario



■ Coal ■ CT ■ CC ■ Cogen ■ Solar ■ Wind ■ Hydro ■ EE ■ DSM ░ Net Mkt Purchase

Observations

- With high gas prices and no regulation of carbon emissions, energy need is met with generation from the portfolio
- Net market sales in many years

Observations

- Portfolio is optimized for Reference Scenario without price on carbon. Introducing carbon price reduces portfolio competitiveness, results in increasing reliance on market energy

Observations

- Similar to other portfolios optimized for scenarios with no carbon price, high price on emissions drives native generation out of mix in favor of market purchases

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Take-aways from Optimized Portfolios

- The optimized portfolio remains nearly unchanged from the status quo in scenarios with no carbon regulation
- Lower gas prices lead to greater volumes of energy purchased from the market but do not drive portfolio turnover
- Introducing a price on carbon emissions dramatically impacts coal competitiveness, leading to substantial portfolio change
- Even with a high price on carbon, combined-cycle capacity is selected to replace coal, and energy from CCs is competitive in the market
- In solving for the least cost portfolio, the model consistently selects solar over wind. There is no dynamic feedback loop for hourly power prices to change as the capacity mix changes

Brian Bak– Lead Planning Analyst

Initial Sensitivity Analysis & Development of Alternate Portfolios

Discussion of Modeling Results

Why do we create optimized portfolios?

- Optimized portfolios are a collection of resource decisions that minimize cost, but ignores unless additional constraints are added
  - CO2 emissions
  - Market purchase levels
  - Resource/fuel diversity
  - Plan Flexibility
- Optimized portfolios are instructive in that they give insights on the trade off between certain resource decisions and cost

Why do we create alternate portfolios?

- Recognize that optimized portfolios are only optimal for a specific set of assumptions that define the presumed scenario
- Take lessons learned for modeling optimized portfolios to create a more robust portfolio that performs well across the range of scenarios
- Allows for the development of portfolios that consider cost, CO2, market purchase levels and resource/fuel diversity as well as other important considerations such as annual rate impacts

Important Considerations

- With respect to cost, there is no portfolio that is optimal in all 5 scenarios
- Cost and risk matter- the preferred portfolio needs to address cost, cost variability and a number of risk factors
- Decision points for a portfolio are important and represent that flexibility of a portfolio
- Test a number of portfolios (strategies) across the range of scenarios to understand portfolio performance and risks
- Risk analysis and decision thresholds better understood in Sensitivity Analysis
- All portfolios (optimized and alternate) will compete against one another as they are tested in scenario and sensitivity analysis

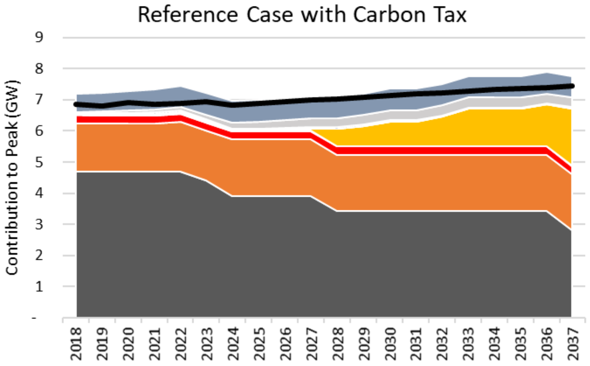
High & Low Load Sensitivity

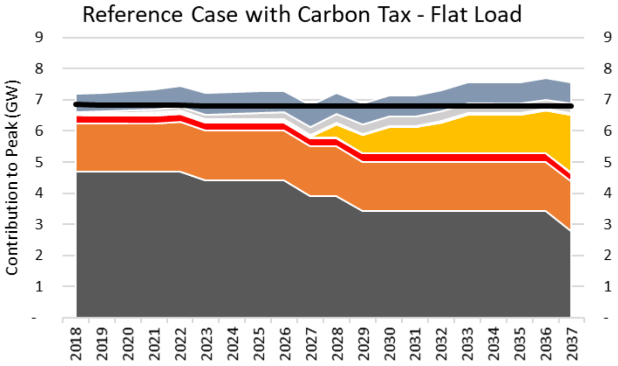
- High and low load sensitivities primarily conducted via scenario analysis:
  - High
    - High Tech Future scenario load forecast CAGR ~15% higher than Reference scenario
    - Slight acceleration of new capacity additions – choices driven by other factors (CO_2 tax, gas prices)
    - Additional energy met via market purchases or higher capacity factors depending on scenario/portfolio combination
  - Low
    - Slow Innovation scenario load forecast CAGR ~15% lower than Reference scenario
    - Minimal change in capacity additions - driven by other factors (CO_2 tax, gas prices)
    - Reduced energy met via reduced market purchases or lower capacity factors depending on scenario/portfolio combination

CAGR	Reference	High Tech Future
MW (Peak)	0.47%	0.55%
MWh (Energy)	0.58%	0.66%

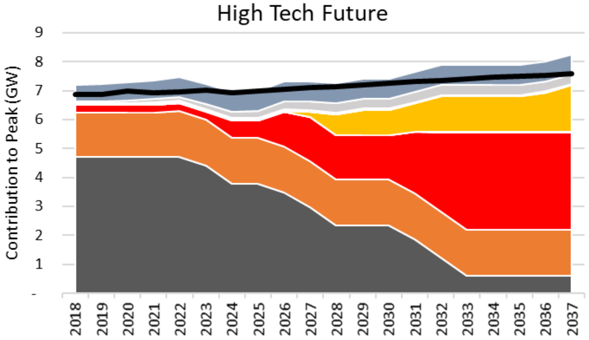
CAGR	Reference	Slow Innovation
MW (Peak)	0.47%	0.39%
MWh (Energy)	0.58%	0.49%

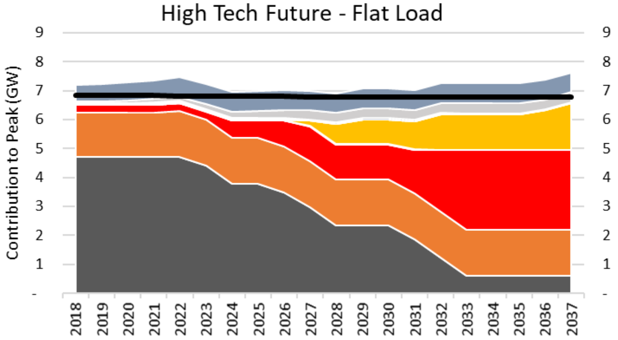
Flat Load Sensitivity





- Delays Cayuga 1 & 2 retirements by 3 and 1 year respectively
- Removes CT
- Adds 50MW additional solar (3700MW total)





- No change in retirements
- Lower CC build – 2480MW vs. 3100MW
- Same total solar build (3200MW) with slight timing changes in 2028-2030

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Low Gas Cost Sensitivity

- Low cost gas sensitivities demonstrated through scenario analysis:
  - High-Tech Future: Low cost gas in a carbon constrained future
    - Gas price 28% lower than in Reference Case by 2037
    - Increases combined cycle build relative to Reference Case with CO_2 Regulation
  - Current Conditions: Low cost gas in a future without carbon regulation
    - Gas price 39% lower than in Reference Case by 2037
    - Lower coal generation and increased market purchases relative to Reference Case without CO_2 Regulation

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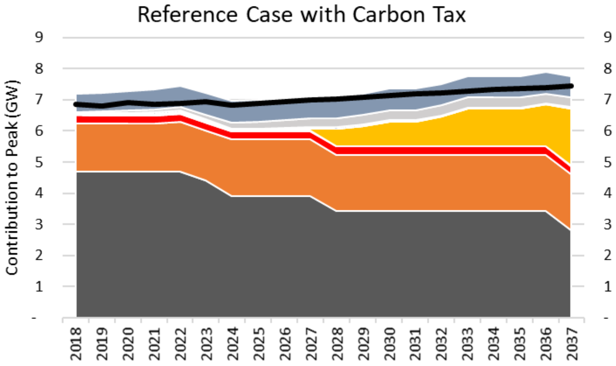
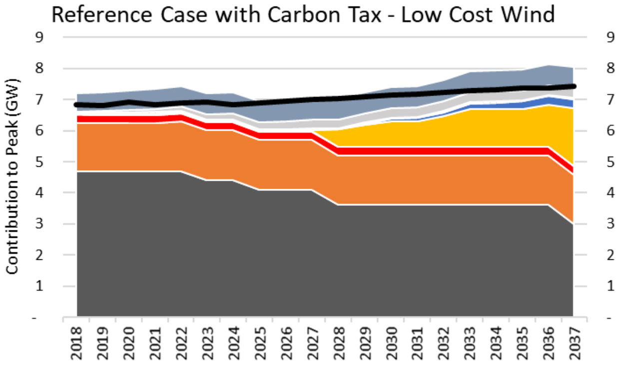
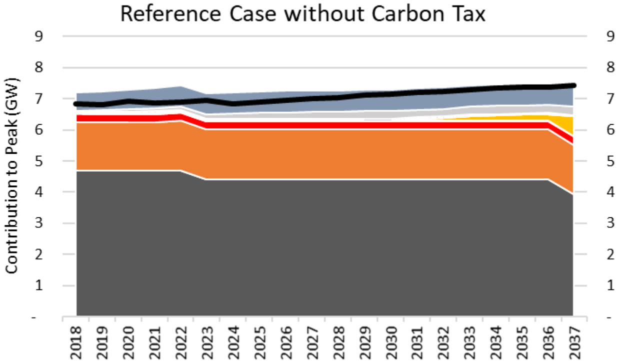
Low Cost of Wind Sensitivity

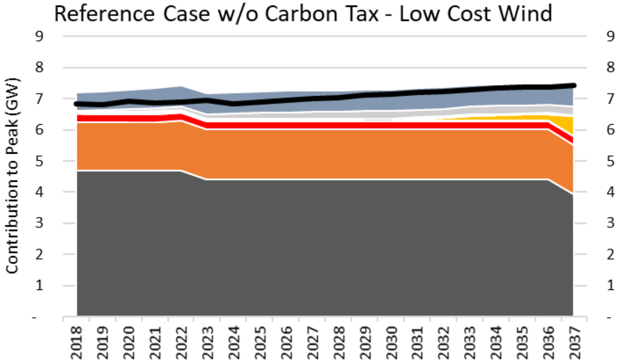




- Adds 2250 MW wind from 2029-2037
- Slight change in coal retirements
- Solar build reduced by 50MW

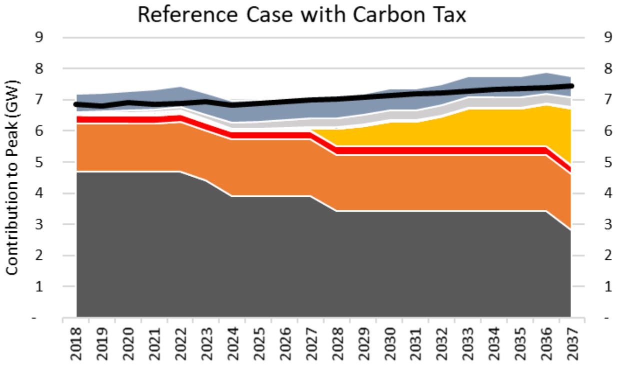
Wind capital cost reduced by 25% from base assumption

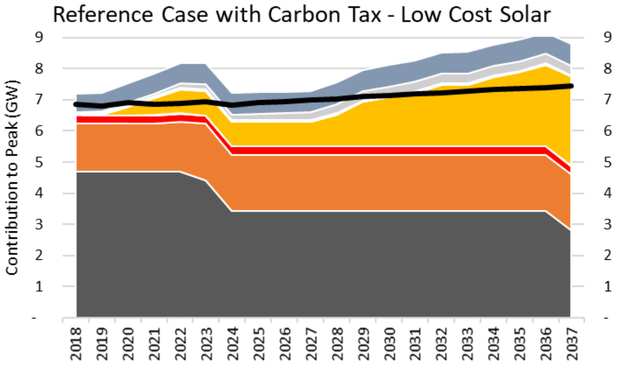




- No change

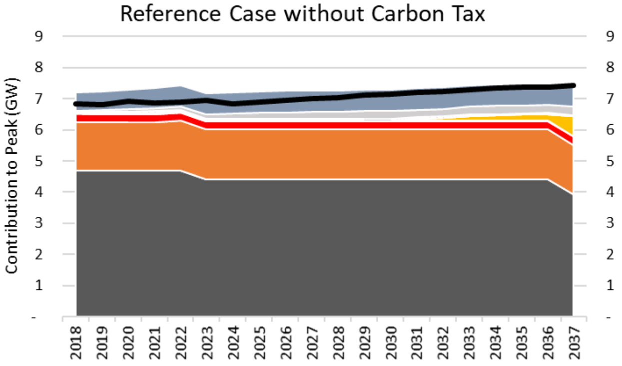
Low Cost of Solar Sensitivity

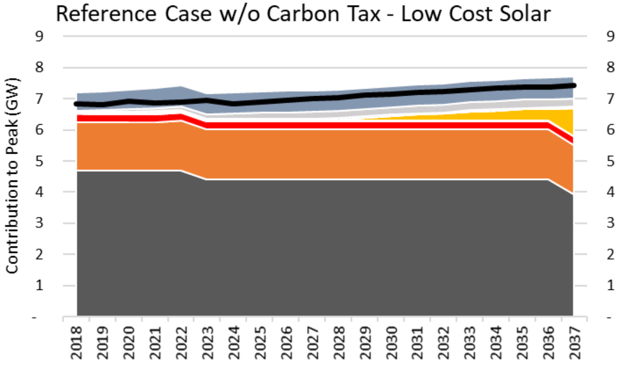




- Solar build increases from 3650MW to 5700MW
- Accelerates solar build from 2026 to 2020
- Accelerates Cayuga 2 retirement by 4 years

All-in solar cost reduced to $1,250/kW for first 10 years



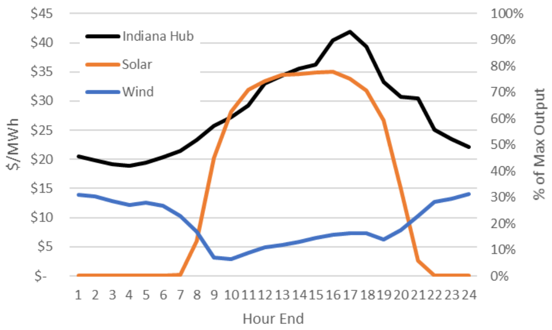


- Solar build increases from 1250MW to 1800MW
- First build in 2028 vs. 2031
- No change in retirements

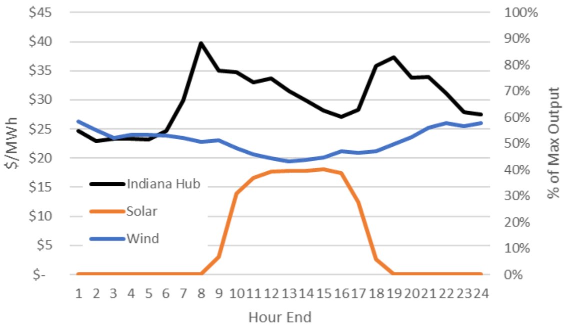
Economics of Wind vs. Solar

Output vs Power Price, Hourly Averages

Summer



Winter



Definitions	
Summer	June – August
Winter	December – February
Power Price	Indiana Hub, 2017 actual
Wind, Solar Output	Forecasts in IRP

CHARACTERISTIC	WIND	SOLAR
Realized Market Power Price	$29/MWh	$35/MWh
Contribution to peak	13%	50%
Useful Life	20 years	30 years
Fixed O&M	$34/kW-yr	$18/kW-yr
Capacity Factor	39% (increases over time)	24%

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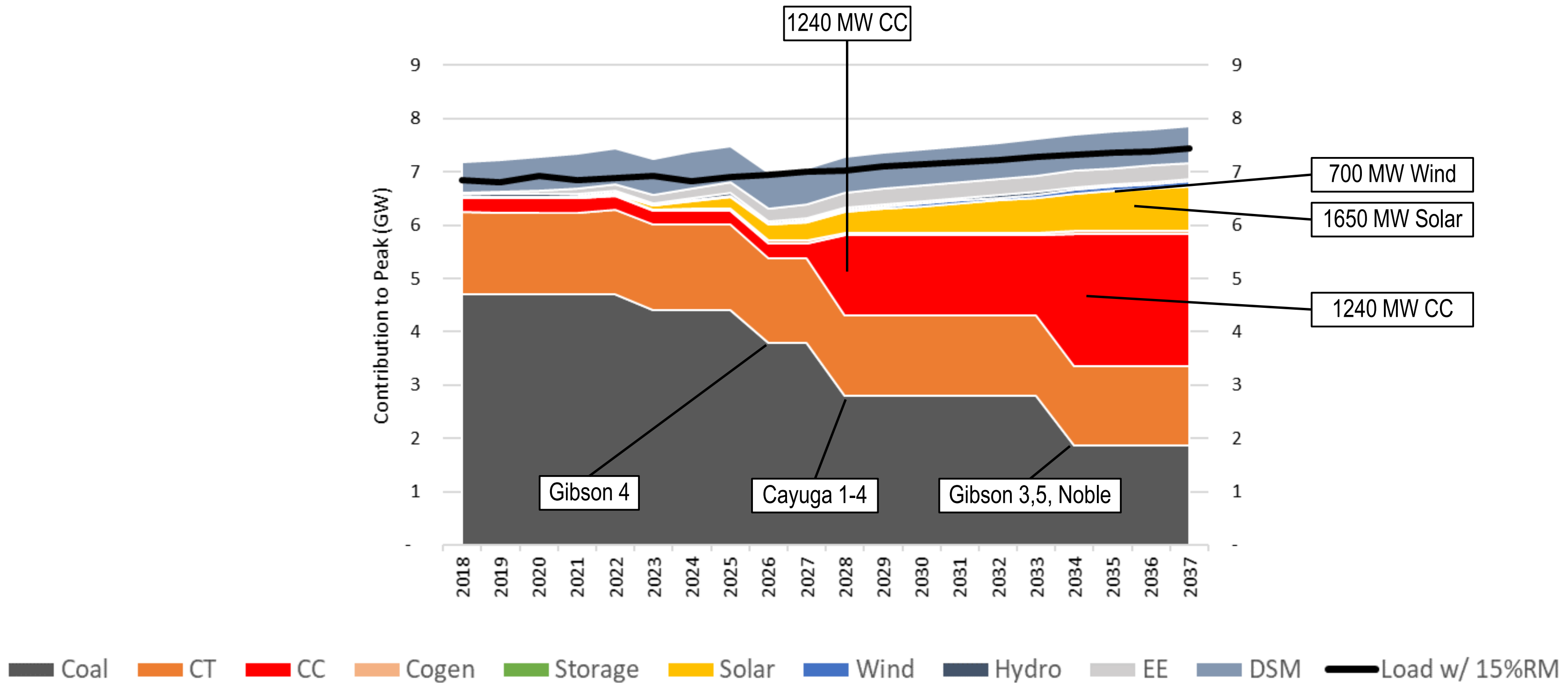
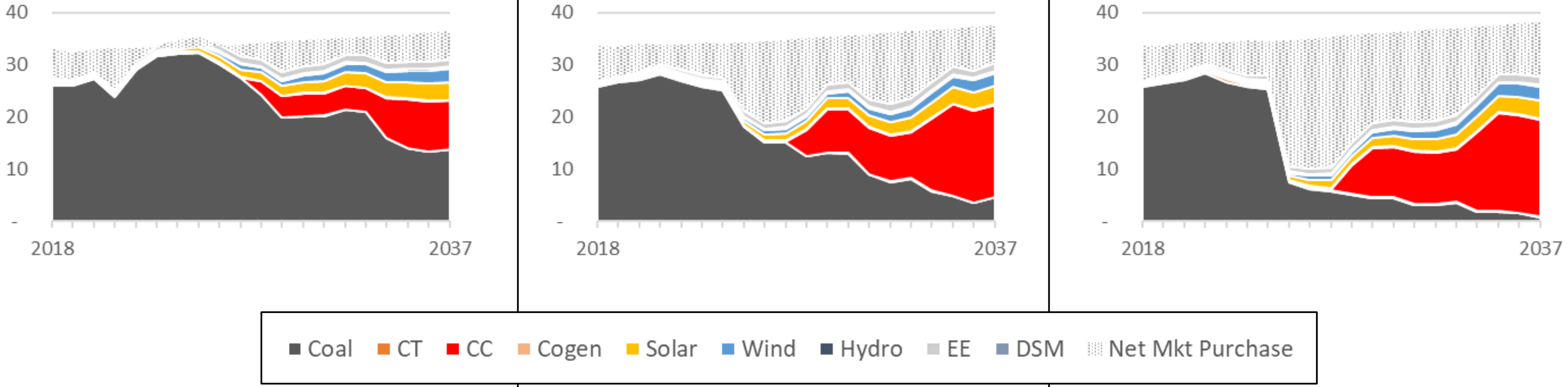
Moderate Transition Portfolio



Moderate Transition Energy Mixes

Slower Innovation Scenario | Reference Scenario | High Tech Scenario



Slower Innovation Scenario

Observations
- Higher gas prices and lack of carbon tax slow the reduction in coal generation
- Market purchases remain low

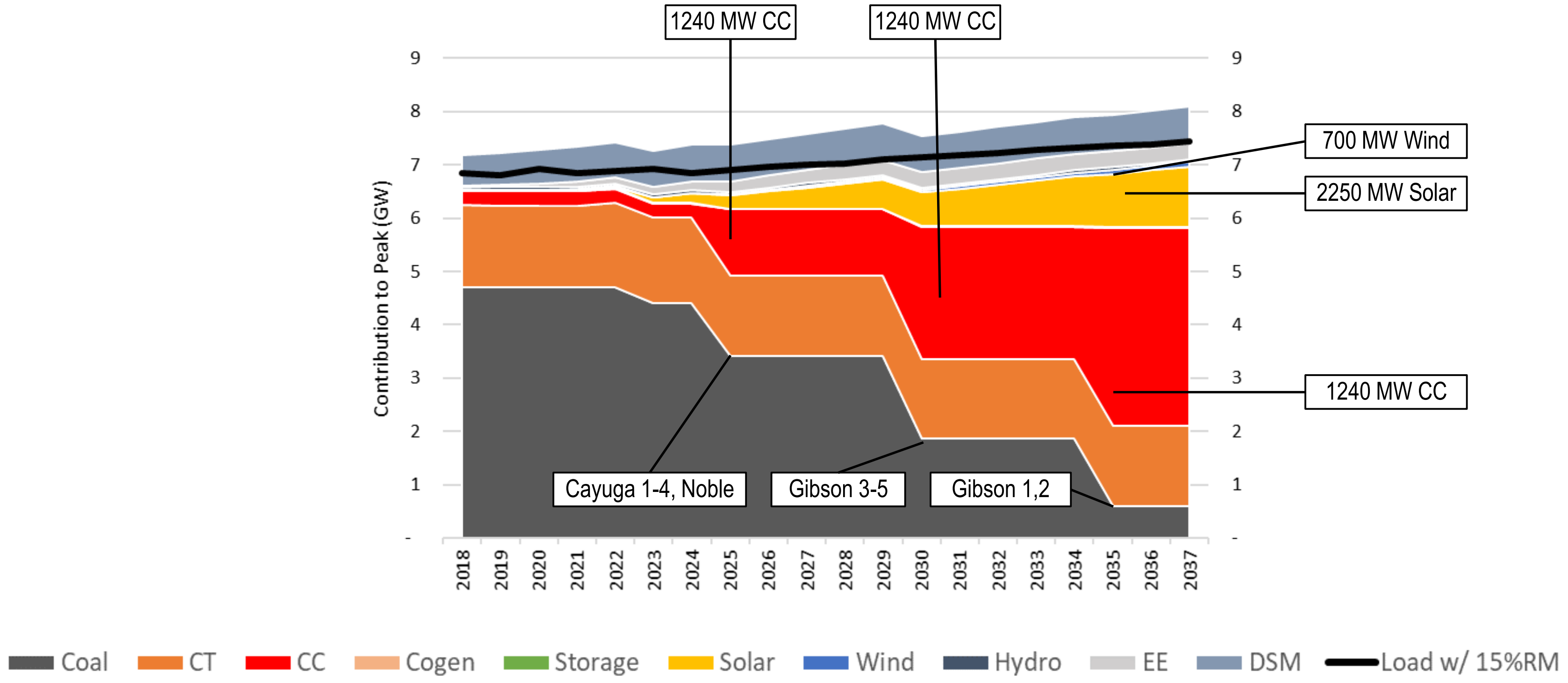
Reference Scenario

Observations
- Increase in market purchases to offset coal due to 2025 CO_2 tax
- CC and renewables build increasingly displaces market purchases through 2030s

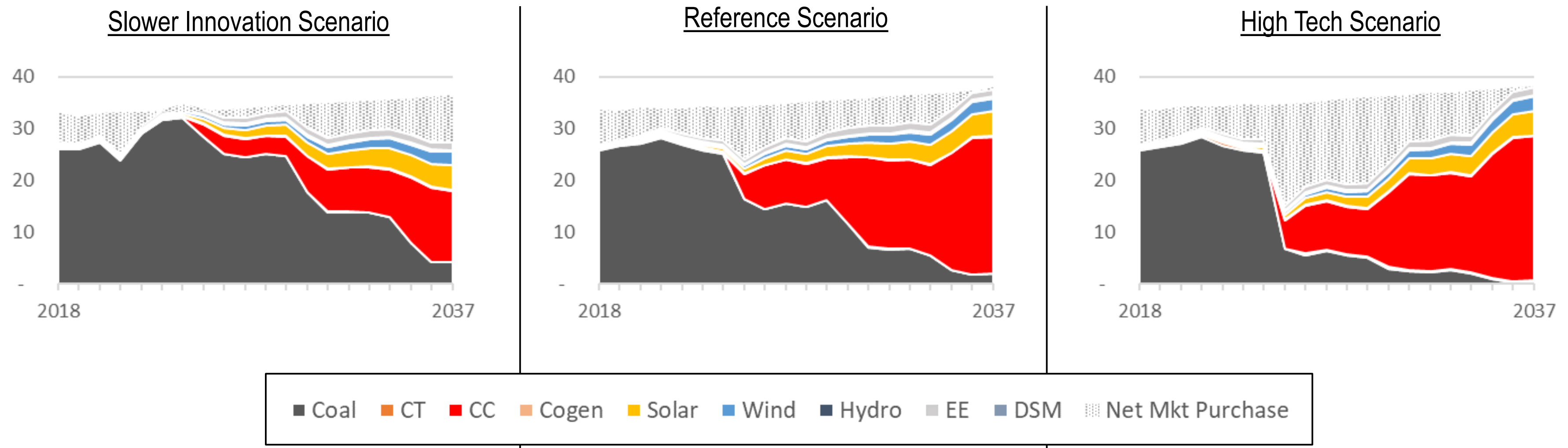
High Tech Scenario

Observations
- Significant rise in market purchases to offset coal due to 2025 CO_2 tax
- CC and renewables build increasingly displaces market purchases through 2030s

Aggressive Transition Portfolio



Aggressive Transition Energy Mixes

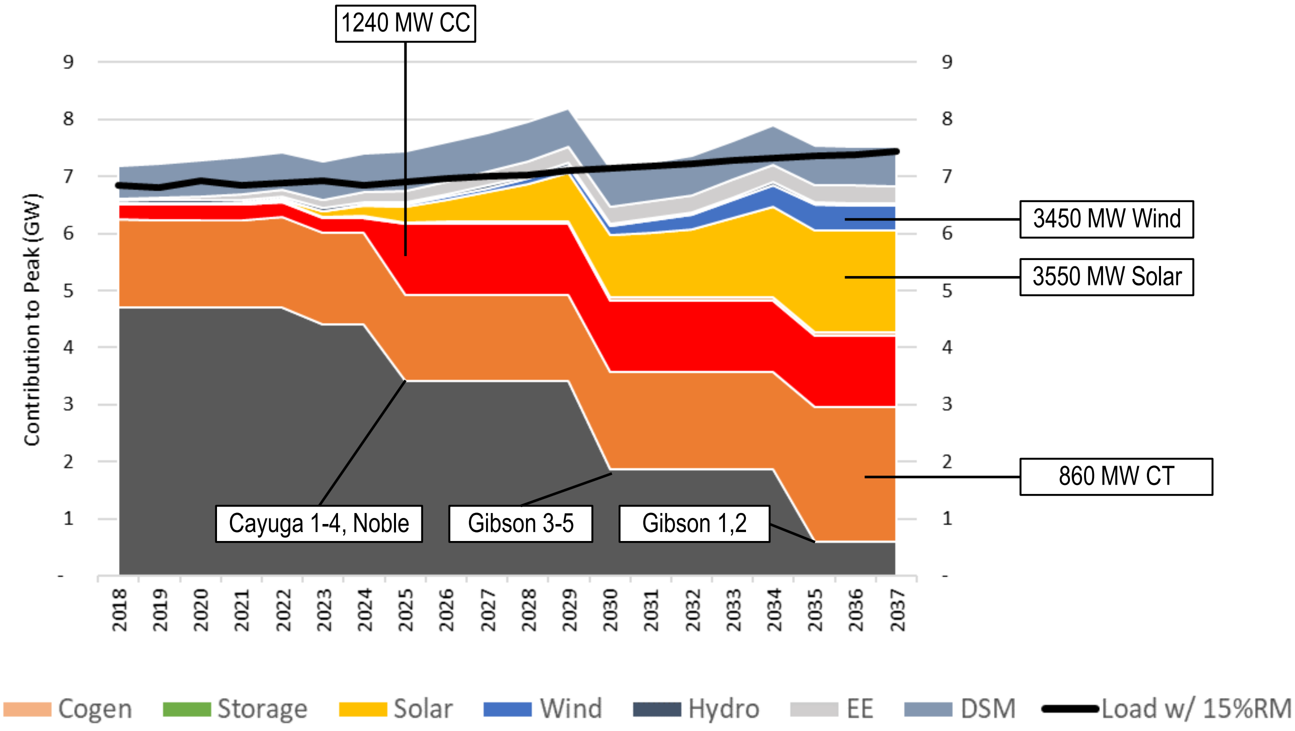


Observations
- Decline in coal generation follows retirements, not driven by outside factors (CO_2 tax or fuel prices)
- Market purchases remain low

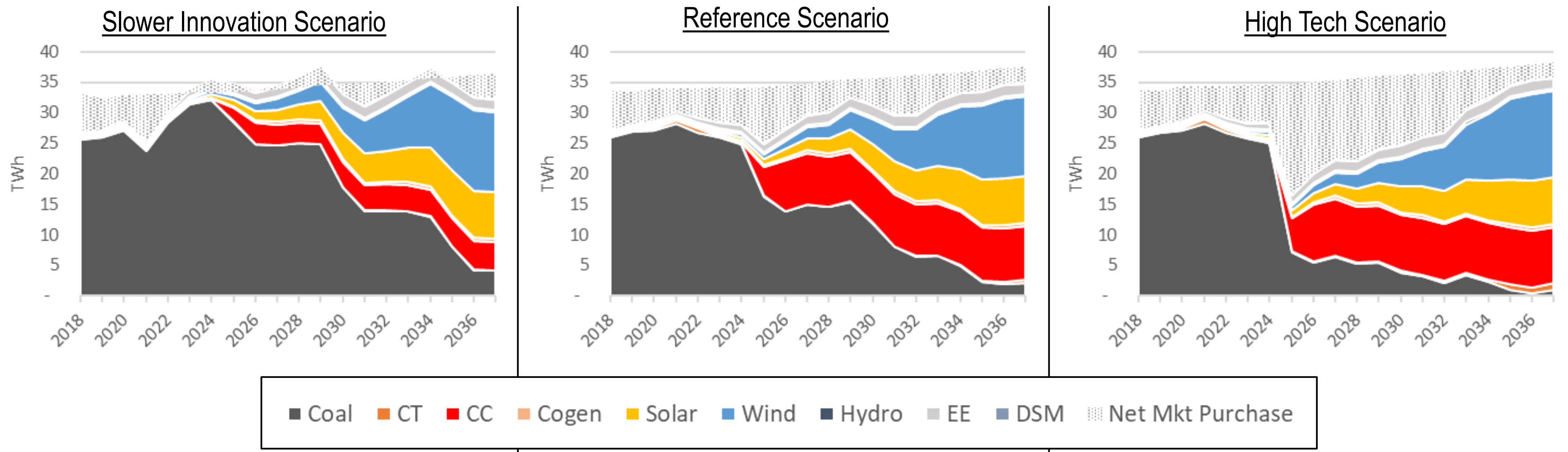
Observations
- Market purchase increase due to 2025 CO_2 tax is mitigated by 2025 CC build
- CC and renewables build increasingly displaces market purchases through 2030s

Observations
- Marked rise in market purchases due to higher 2025 CO_2 tax
- CC and renewables build increasingly displaces market purchases through 2030s

Rapid Decarbonization: CT Portfolio



Rapid Decarbonization: CT Energy Mixes



Observations (Slower Innovation Scenario)
- Decline in coal generation generally follows unit retirements
- Additions of solar and wind lead to net market sales in years just prior to coal unit retirements

Observations (Reference Scenario)
- Coal Generation declines markedly with 2025 CO_2 tax and continues to decline through unit retirements
- Loss of coal generation largely replaced with renewables and CC

Observations (High Tech Scenario)
- Coal Generation declines sharply upon enactment of higher CO_2 tax
- Loss of coal generation replaced initially with market purchases and CC. Renewables displace market by mid 2030s

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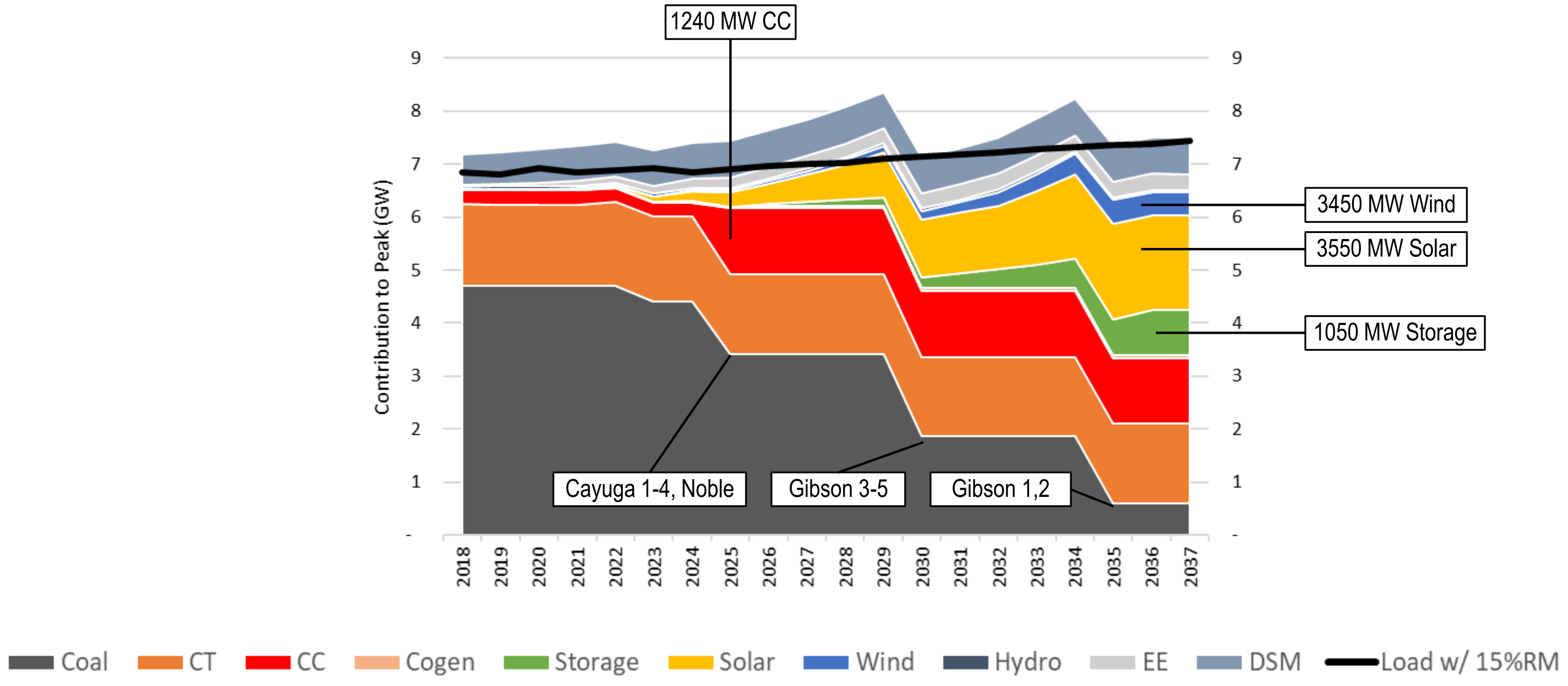
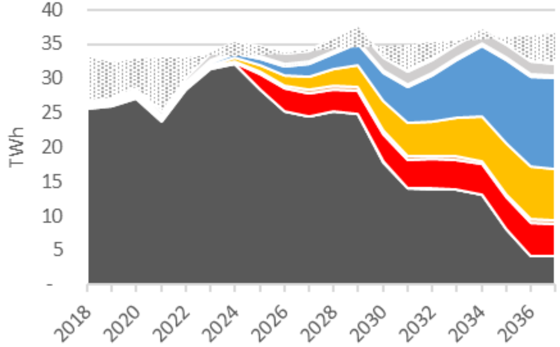
Rapid Decarbonization: Storage Portfolio

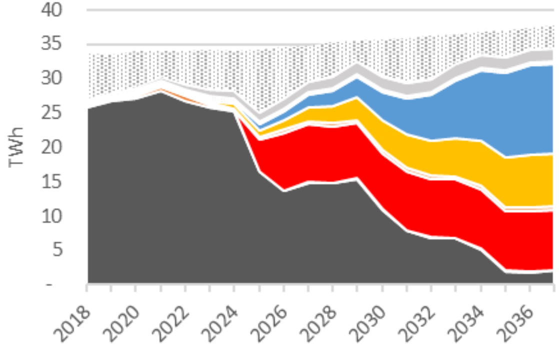


Rapid Decarbonization: Storage Energy Mixes

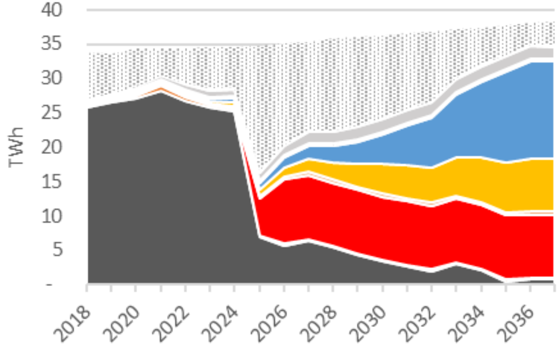
Slower Innovation Scenario



Reference Scenario



High Tech Scenario



Observations

- Decline in coal generation generally follows retirements
- Additions of solar and wind lead to net market sales in years just prior to coal retirements

Observations

- Coal Generation declines markedly with 2025 CO_2 tax and continues to decline through retirements
- Loss of coal generation largely replaced with renewables and CC

Observations

- Coal Generation declines sharply upon enactment of higher CO_2 tax
- Loss of coal generation replaced initially with market purchases and CC. Renewables displace market by mid 2030s

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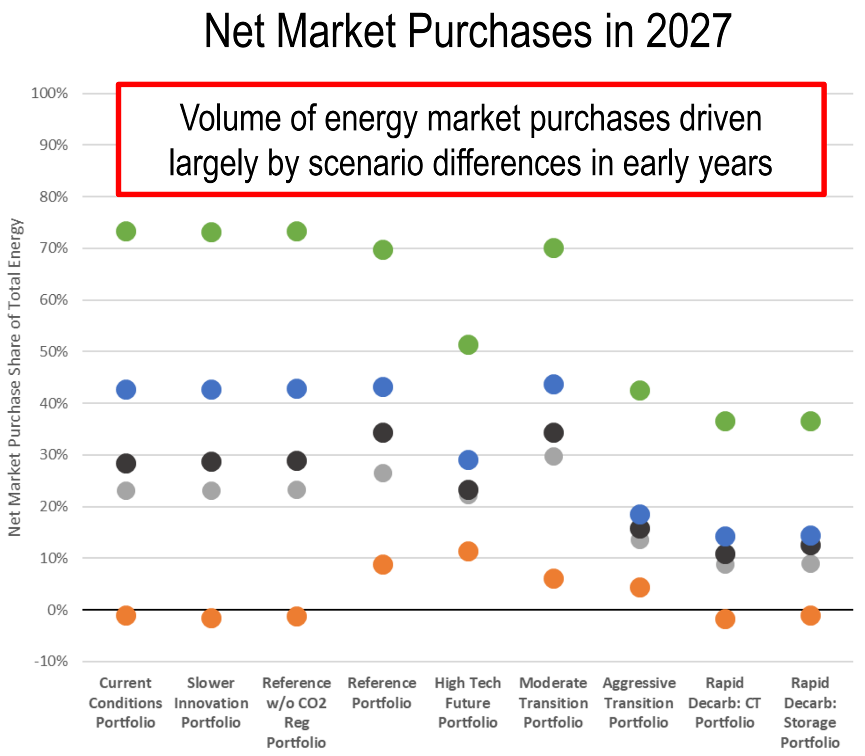
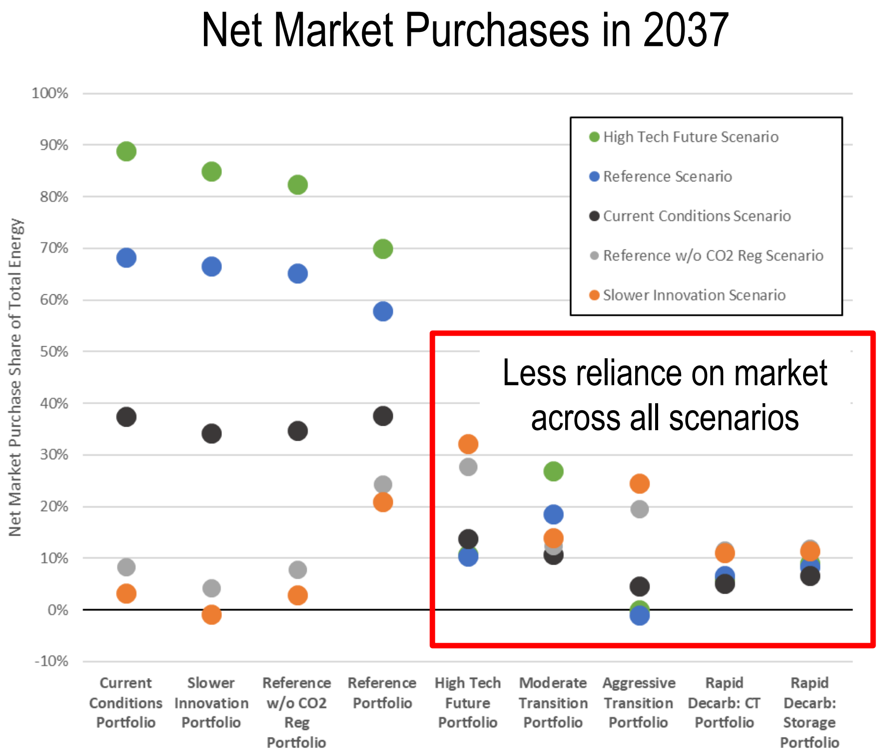
Lunch

Nate Gagnon– Lead Planning Analyst

Modeling Results – Market Purchases, CO2 Emissions & Cost

Market Purchases by Portfolio





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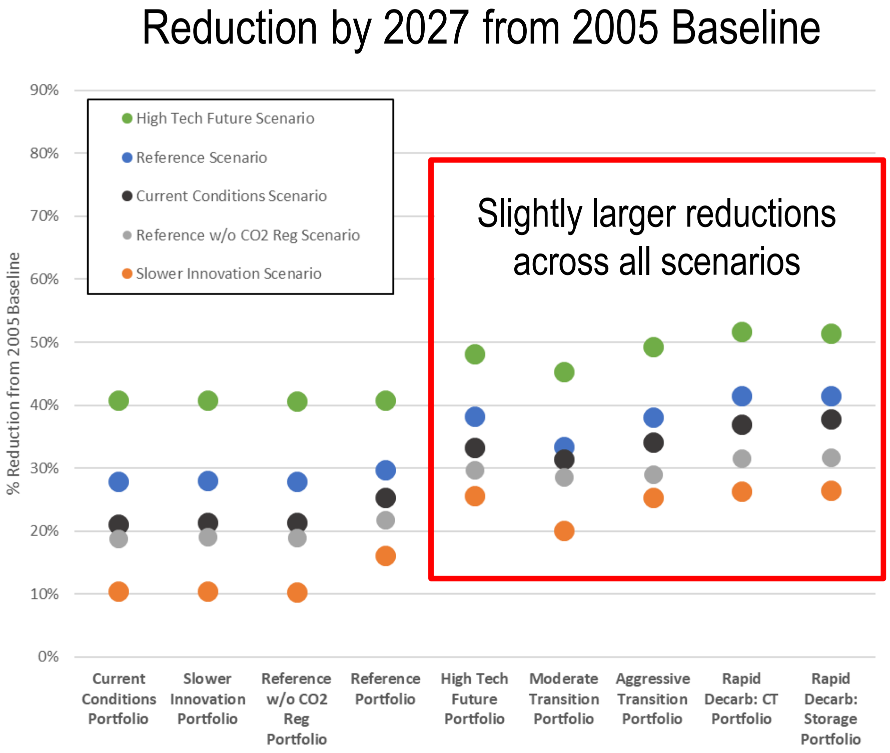
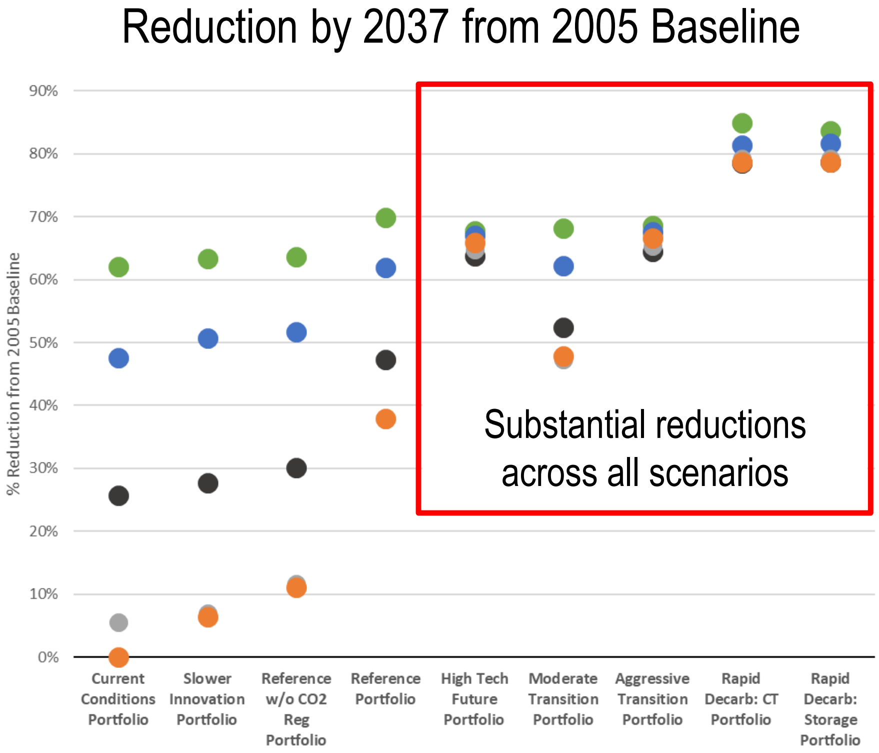
CO_2 Emissions Reduction by Portfolio





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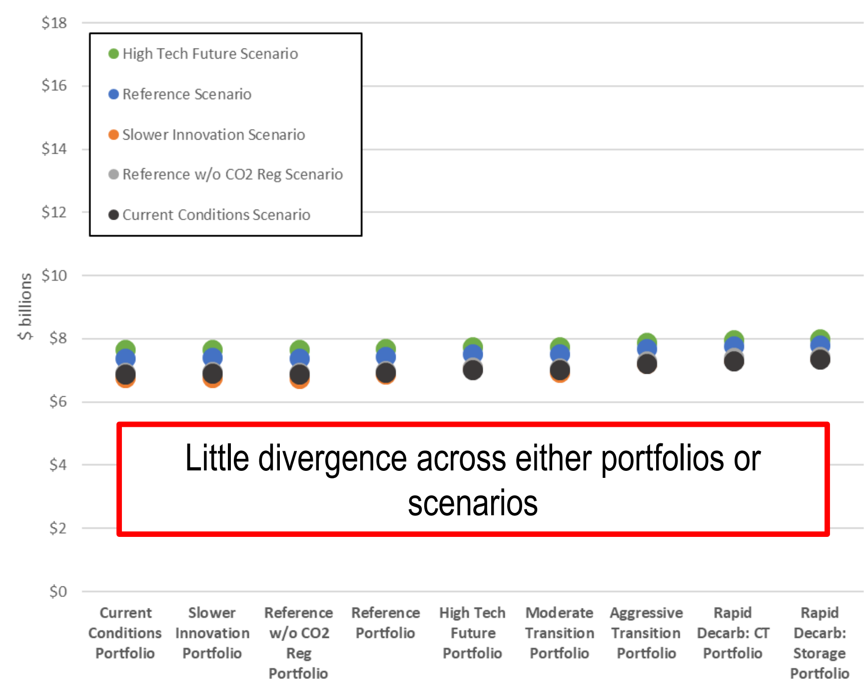
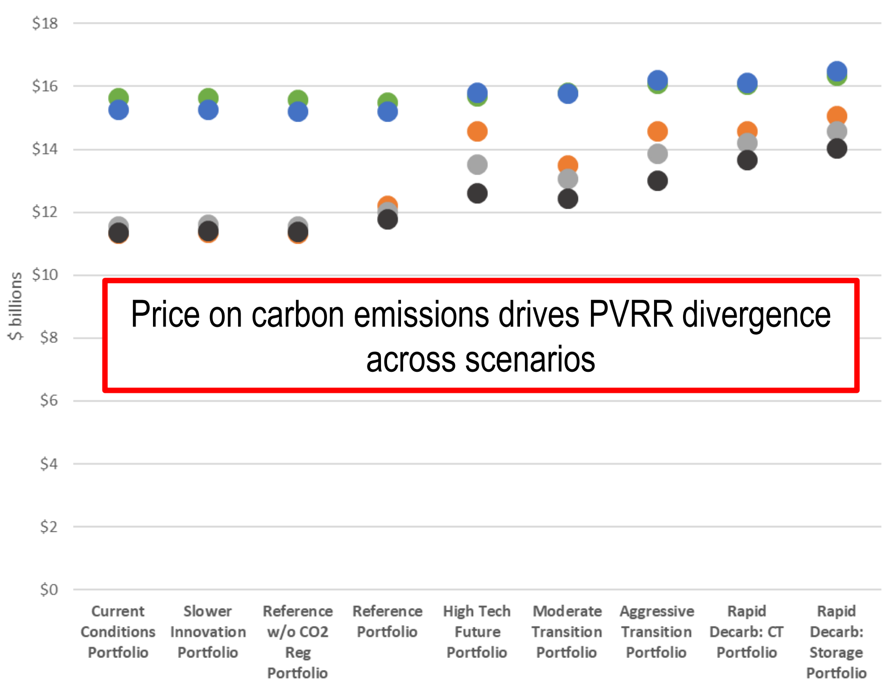
PVRR by Portfolio

Investments Through 2027



Investments Through 2037



Take-aways from Scenario Analysis

- Putting a price on carbon emissions drives up cost regardless of portfolio. The cost increase is greatest for coal-heavy portfolios
- Portfolios with more gas and renewables show greater emissions reductions in all scenarios and less market exposure in scenarios with a price on carbon
- Coal-heavy portfolios show only small reductions in carbon emissions in scenarios that lack a price on carbon. Reductions are achieved largely by purchasing energy from the market (carbon intensity of market purchases is lower in scenarios with price on carbon as MISO fleet transitions toward gas and renewables)
- Portfolios with more gas and renewables are higher cost in scenarios with mid or high gas prices and no carbon price (Current Conditions, Reference w/o CO_2 Reg)
- Portfolios with the most renewables are most costly in scenarios without a price on carbon

Brian Bak– Lead Planning Analyst

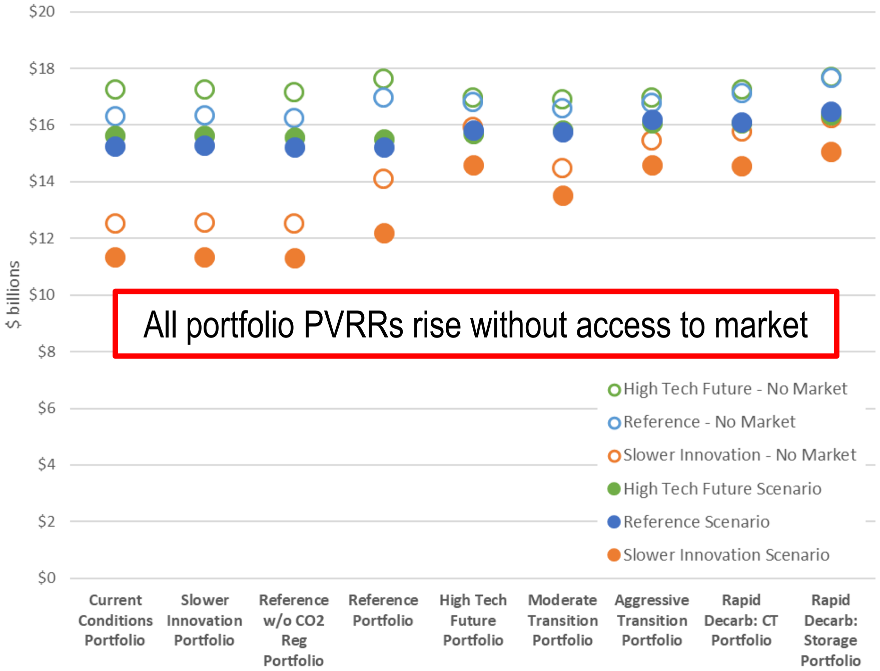
Risk Sensitivity Analysis

Sensitivity Analysis

- In addition to the 45 combinations of portfolios and scenarios analyses, sensitivity analysis was performed to test each of the portfolios on:
  - Market purchase exposure
  - Social Cost of Carbon

Market Risk (20 years)

PVRR With and Without the MISO Energy Market



PVRR Change When Market is Unavailable

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Social Cost of Carbon Sensitivity

- At the request of stakeholders the table below shows the 20 year PVRR's of the portfolios where the cost of each portfolio includes the social cost of carbon for each ton emitted.
  - Social Cost of Carbon figures from Table A1, Appendix A of Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866, August 2016[1]
  - SCC $/ton based on 2.5% discount rate column in Table A1
  - Tons of CO_2 include Duke Energy emissions and estimated emissions associated with market purchases
  - Figures shown below are under the Reference Case without a CO_2 Tax to avoid double-counting of carbon costs

PORTFOLIO PVRR ($MM)								
Current Conditions	Slower Innovation	Reference w/o CO_2 Reg	Reference	High Tech Future	Moderate Transition	Aggressive Transition	Rapid Decarbonization CT	Rapid Decarbonization Storage
$51,815	$51,737	$51,597	$48,769	$44,923	$47,383	$46,546	$45,271	$45,545

1. https://www.epa.gov/sites/production/files/2016-12/documents/sc_co2_tsd_august_2016.pdf

Take-aways from Sensitivity Analysis

- Market purchase exposure
  - All portfolios exhibited higher PVRR when market purchases were unavailable
  - Certain portfolios mitigated market risk more effectively based on the timing and magnitude of resource diversification and types of resources selected.
- Social Cost of Carbon (SCC)
  - Internalizing the EPAs estimated SCC dramatically increases the cost of all portfolios.
  - The portfolios which transition away from coal more completely and rapidly exhibit a lower total cost when SCC is included.

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Next Meeting Thursday, June 20th

- Present Preferred Portfolio
- Time: 2:00 – 4:00 PM
- Location: Plainfield Office Auditorium
- Final IRP document to be submitted on July 1

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Heather Quinley, Director Energy Affairs & Stakeholder Engagement

Closing Comments, Stakeholder Comments

Closing Comments

- Please complete comment cards or send by June 6th to Scott at:

  scott.park@duke-energy.com

- Meeting summary and other materials will be posted on website by June 7th
  - (http://www.duke-energy.com/indiana/in-irp-2018.asp)

- Next workshop on June 20th

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Appendix

Retirement and Addition Summaries

SLOWER INNOVATION	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
RETIREMENTS																				
Unit						Gallagher 2,4														
Nameplate MW						280														
EE - Contribution to Peak																				
EE	27	53	75	98	120	142	165	186	205	225	242	254	259	260	264	269	268	262	255	254
CUMULATIVE ADDITIONS - Nameplate																				
Solar	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	300	800
Wind	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Storage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CHP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Retirement and Addition Summaries

REFERENCE CASE	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
RETIREMENTS																				
Unit						Gall 2,4	Cay 1				Cayuga 2									Gibson 4
Nameplate MW						280	500				495									622
EE - Contribution to Peak																				
EE	27	53	75	101	130	158	189	221	247	273	292	306	312	311	317	324	323	316	310	305
CUMULATIVE ADDITIONS - Nameplate																				
Solar	-	-	-	-	-	-	-	-	50	100	1,100	1,250	1,550	1,550	1,850	2,350	2,350	2,350	2,650	3,650
Wind	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Storage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CHP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CT	-	-	-	-	-	-	215	215	215	215	215	215	215	215	215	215	215	215	215	215

Retirement and Addition Summaries

HIGH TECH FUTURE	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
RETIREMENTS																				
Unit						Gall 2,4	Gib 3		Gib 5	Cay 1	Gib 2			Cay 2	Gib 1	Gib 4				
Nameplate MW						280	630		310	500	630			495	630	622				
EE - Contribution to Peak																				
EE	27	53	75	105	142	177	216	253	283	310	331	345	350	346	350	356	354	346	340	334
CUMULATIVE ADDITIONS - Nameplate																				
Solar	-	-	-	-	-	-	-	-	-	300	1,400	1,700	1,700	1,900	2,400	2,400	2,400	2,400	2,700	3,200
Wind	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Storage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CHP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CC	-	-	-	-	-	-	310	310	930	1,240	1,240	1,240	1,240	1,860	2,480	3,100	3,100	3,100	3,100	3,100
CT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Retirement and Addition Summaries

CURRENT CONDITIONS	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
RETIREMENTS																				
Unit						Gallagher 2,4														
Nameplate MW						280														
EE - Contribution to Peak																				
EE	27	53	75	96	115	134	157	181	202	218	228	233	231	226	226	231	228	223	219	219
CUMULATIVE ADDITIONS - Nameplate																				
Solar	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wind	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Storage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CHP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	215	215	215	215	215

Retirement and Addition Summaries

REFERENCE CASE W/O CO2 TAX	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
RETIREMENTS																				
Unit						Gallagher 2,4														Cayuga 2
Nameplate MW						280														495
EE - Contribution to Peak																				
EE	27	53	75	96	115	134	156	177	196	214	229	238	240	239	246	256	260	259	261	264
CUMULATIVE ADDITIONS - Nameplate																				
Solar	-	-	-	-	-	-	-	-	-	-	-	-	-	100	150	250	300	350	400	1250
Wind	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Storage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CHP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Retirement and Addition Summaries

MODERATE TRANSITION	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
RETIREMENTS																				
Unit						Gallagher 2,4			Gib 4		Cay 1-4					Gib 3,5, Noble				
Nameplate MW						280			622		1085					1204				
EE - Contribution to Peak																				
EE	27	53	75	99	123	147	174	203	226	252	271	286	292	293	300	308	309	304	300	298
CUMULATIVE ADDITIONS - Nameplate																				
Solar	-	-	-	-	-	100	250	400	550	650	750	850	950	1,050	1,150	1,250	1,350	1,450	1,550	1,650
Wind	-	-	-	-	-	-	50	100	150	200	250	300	350	400	450	500	550	600	650	700
Storage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CHP	-	-	-	-	-	-	20	20	40	40	40	40	40	40	40	40	40	40	40	40
CC	-	-	-	-	-	-	-	-	-	-	1,240	1,240	1,240	1,240	1,240	1,240	2,480	2,480	2,480	2,480
CT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Retirement and Addition Summaries

AGGRESSIVE TRANSITION	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
RETIREMENTS																				
Unit						Gallagher 2,4		Cay 1-4; Noble				Gib 3-5						Gib 1-2		
Nameplate MW						280		1349				1562						1260		
EE - Contribution to Peak																				
EE	27	53	75	98	120	142	168	197	220	246	266	281	287	289	297	306	307	303	299	297
CUMULATIVE ADDITIONS - Nameplate																				
Solar	-	-	-	-	-	150	300	450	600	750	900	1,050	1,200	1,350	1,500	1,650	1,800	1,950	2,100	2,250
Wind	-	-	-	-	-	-	50	100	150	200	250	300	350	400	450	500	550	600	650	700
Storage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CHP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CC	-	-	-	-	-	-	-	1,240	1,240	1,240	1,240	1,240	2,480	2,480	2,480	2,480	2,480	3,720	3,720	3,720
CT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Retirement and Addition Summaries

RAPID DECARBONIZATION - CT	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
RETIREMENTS																				
Unit						Gallagher 2,4		Cay 1-4; Noble				Gib 3-5						Gib 1-2		
Nameplate MW						280		1349				1562						1260		
EE - Contribution to Peak																				
EE	27	53	75	109	153	193	233	276	309	338	366	383	390	388	390	394	393	386	377	370
CUMULATIVE ADDITIONS - Nameplate																				
Solar	-	-	-	-	-	150	300	500	700	950	1,250	1,650	2,150	2,250	2,350	2,750	3,150	3,550	3,550	3,550
Wind	-	-	-	-	-	-	100	200	350	500	700	950	1,250	1,600	2,000	2,450	2,950	3,450	3,450	3,450
Storage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CHP	-	-	-	-	-	-	20	20	40	40	40	40	40	40	40	40	40	40	40	40
CC	-	-	-	-	-	-	-	1,240	1,240	1,240	1,240	1,240	1,240	1,240	1,240	1,240	1,240	1,240	1,240	1,240
CT	-	-	-	-	-	-	-	-	-	-	-	-	215	215	215	215	215	860	860	860

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Retirement and Addition Summaries

RAPID DECARBONIZATION - STORAGE	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
RETIREMENTS																				
Unit						Gallagher 2,4		Cay 1-4; Noble				Gib 3-5						Gib 1-2		
Nameplate MW						280		1349				1562						1260		
EE - Contribution to Peak																				
EE	27	53	75	109	153	193	233	276	309	338	366	383	390	388	390	394	393	386	377	370
CUMULATIVE ADDITIONS - Nameplate																				
Solar	-	-	-	-	-	150	300	500	700	950	1,250	1,650	2,150	2,250	2,350	2,750	3,150	3,550	3,550	3,550
Wind	-	-	-	-	-	-	100	200	350	500	700	950	1,250	1,600	2,000	2,450	2,950	3,450	3,450	3,450
Storage	-	-	-	-	-	-	-	-	50	100	150	200	250	350	450	550	700	850	1,050	1,050
CHP	-	-	-	-	-	-	20	20	40	40	40	40	40	40	40	40	40	40	40	40
CC	-	-	-	-	-	-	-	1,240	1,240	1,240	1,240	1,240	1,240	1,240	1,240	1,240	1,240	1,240	1,240	1,240
CT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-