2018 Integrated Resource Plan

Stakeholder Workshop #4





December 18, 2018
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 April stakeholder meeting and respond to comments/questions
- Review desired characteristics of preferred resource plan
- Review scenarios and sensitivities
- Discuss optimized and hybrid portfolios
- Conduct Stakeholder Portfolio Exercise

Agenda

Time	Topic
8:30	Registration & Continental Breakfast
9:00	Welcome, Introductions, Agenda
9:20	Review of April Meeting; Responses to Questions/Feedback
9:45	Update on EE
10:00	Break
10:15	Scenario & Sensitivity Review; Optimized Portfolios
10:45	Portfolios Analysis Discussion
11:30	Lunch
12:30	Hybrid Portfolios
1:00	Stakeholder Portfolio Exercise
2:30	Closing Comments

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Scott Park, Director IRP Analytics - Midwest

Review of April Meeting

Recap of April Meeting

- Review of February meeting
- Desired portfolio characteristics
- Scenario discussion
  - Duke proposed
  - Stakeholder proposed

Comments from April Meeting

STAKEHOLDER QUESTIONS/COMMENTS	RESPONSES
Is AMI in the load forecast?	The detailed, granular data provided by AMI is intended for integration into the load forecasting process over time and will improve accuracy as well as enable new load modifying technologies
Have you considered modeling the IRP on an UCAP basis?	Due to the features and functionality of the dispatch models, modeling on an ICAP basis provides a more accurate representation of actual system operations with full unit capacity available during most hours and zero during both scheduled and random, unplanned outages.
What has historical load looked like?	Over the past 10 years, actual DEI retail MWh have a Compound Annual Growth Rate (CAGR) of -0.4% and system load has a CAGR of -0.1% (Note: these are actual figures, not weather-normalized)
How is smart grid technology included in the IRP?	Smart grid technology is included primarily in the form of EE and DR technologies. Integrated Volt-VAR control is a specific example currently being implemented on the DEI system which we account for in the IRP
How are ancillary services being modeled in the IRP?	We do not explicitly model ancillary services in the capacity expansion or dispatch models; however, for resources which may affect ancillary services, we account for this by adjusting associated variable O&M costs.
What are the assumption for capacity values?	Capacity is not explicitly valued on a $/MW-day basis in the resource planning models. The model can select a short-term capacity PPA based on the levelized cost of a CT rather than construct a new unit.

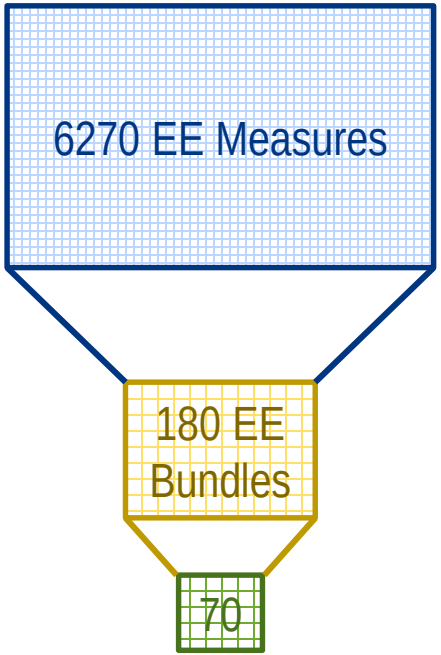
Brian Bak– Lead Planning Analyst

Modeling Energy Efficiency

Energy Efficiency Bundling Process

- Grouped 6270 EE measures from the MPS into 6 residential and 6 non-residential load shapes
- Subdivided those 12 load shapes into 5 different time buckets across the modeling term of the IRP
- Added data from the MPS for the Achievable, Incremental and Technical Subset
- Creates 180 Energy Efficiency bundles

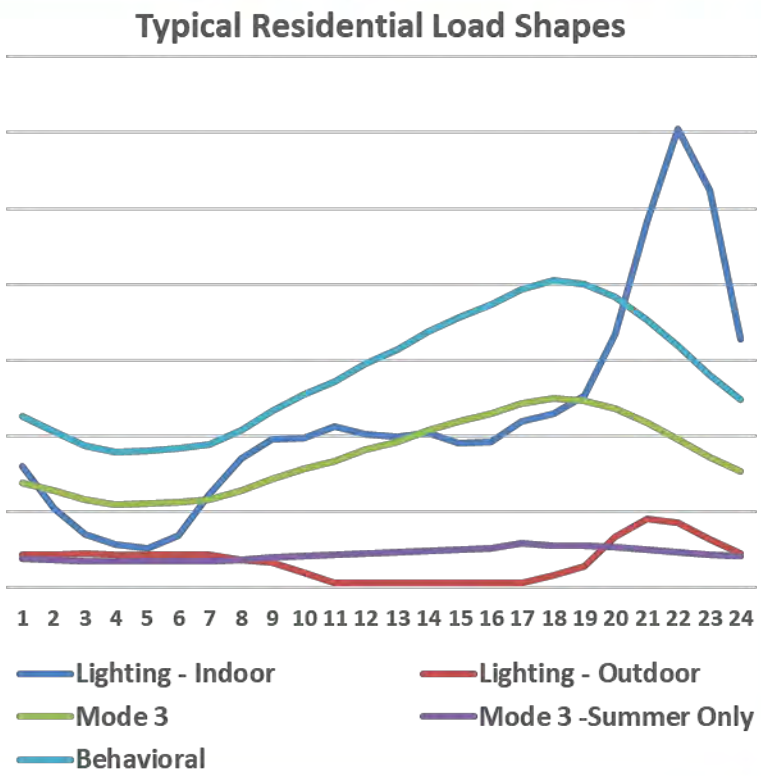
- In order to make the modeling more manageable, we consolidated bundles when the average annual savings of a bundle was less than .1% of the total system's annual energy
- After the consolidations were made, we relabeled the resulting bundles as Tiers 1, 2 & 3.
- Both of these efforts brought the number of EE bundles down to a more manageable 70
  - For comparison purposes, the 2015 IRP had 10 EE bundles



70 EE Bundles modeled in IRP

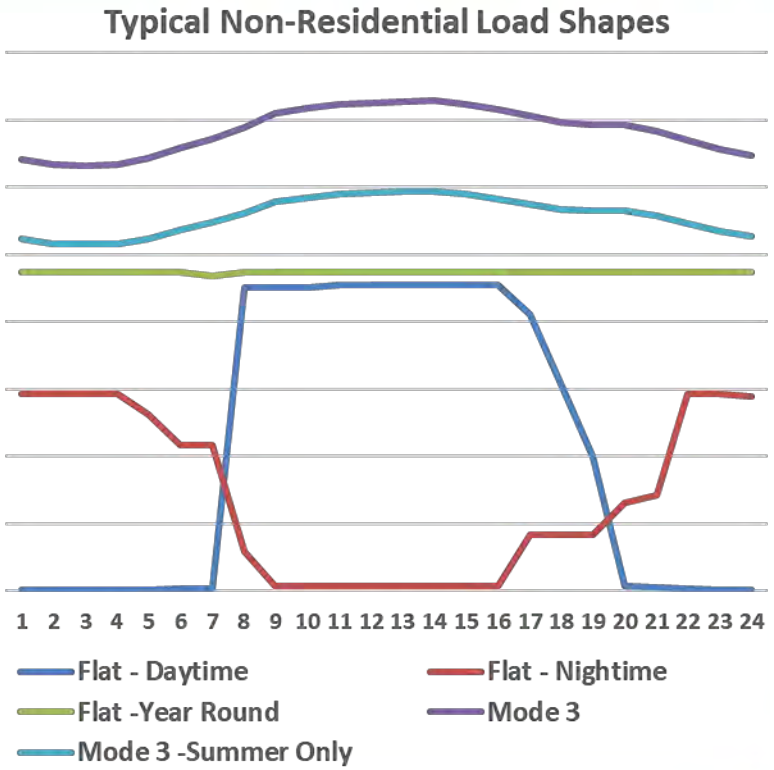
EE Bundle Shapes - Residential

- Residential Lighting – Indoor
  - Shape follows load profile of average residential indoor lighting use
  - Example: LED Light Bulbs
- Residential Lighting – Outdoor
  - Shape follows load profile of average residential outdoor lighting use (primarily nighttime savings).
  - Example: LED Light Bulbs or fixtures for outdoor nighttime use
- Residential Mode 3
  - Shape follows average residential class load shape based on Duke load research data.
  - Example: High Efficiency Heat Pumps
- Residential Mode 3 - Summer Only
  - Same shape as above, but primarily during summer months.
  - Example: High Efficiency Central AC units, Pool Pumps
- Behavioral programs (Old + New)
  - Shape similar to other Mode 3 measures
  - Example: My Home Energy Report



EE Bundle Shapes – Non Residential

- Non-Residential Flat Daytime
  - Flat shape primarily during daytime hours.
  - Example: High efficiency lighting for office spaces
- Non-Residential Flat Nighttime
  - Flat shape primarily during nighttime hours.
  - Example: High Efficiency outdoor lighting
- Non-Residential Flat Year-Round
  - Flat shape during all hours of the year - measures that operate 24x7
  - Example: High efficiency refrigeration/freezer measures, Icemakers, LED Exit Signs
- Non-Residential Mode 3 + Behavioral programs
  - Average non-residential class load shape based on Duke load research data.
  - Example: High Efficiency Heat Pumps
- Non-Residential Mode 3 - Summer Only
  - Same as Non-Res Mode 3 load shape listed above with savings primarily during summer months
  - Example: High Efficiency A/C units or Chillers



Nate Gagnon – Lead Planning Analyst

Scenarios & Sensitivities Review

Scenario Summary

Scenario	Gas Price	Coal Price	Load Forecast	Carbon Price	Cost of Solar & Wind	Cost of EE	PTC & ITC
1) Reference Case (Mid prices)	Mid	Mid	Mid	Mid	Mid	Mid	Expire
2) Reference Case, No Carbon	Mid	Mid	Mid	None	Mid	Mid	Expire
3) High Tech Future (Low prices)	Low	Low	High	High	Low	Low	Expire
4) Slower Innovation (High prices)	High	High	Low	None	High	High	Renewed
5) Current Conditions	Market	Market	Mid	None	Mid	Mid	Expire
6) Social Cost of Carbon	To be addressed in sensitivity analysis as a high cost of carbon						
7) Beneficial Electrification	EV and BTM solar largely offset one another; resulting load forecast similar to Slow Innovation						
8) Load Growth, Economy Decouple	To be addressed in sensitivity analysis with no load growth						
9) Global Carbon Constraint	Not specified						
10) Utility of the Future	Outside of scope; not specified						

Sensitivity Analysis

- Purpose: identify factors that have large influence on portfolio optimality, in terms of desired characteristics, relative to other model inputs
- Steps
  1. Evaluate performance of each portfolio in scenarios other than the one for which it is optimized
  2. Change individual variables while holding all others constant (load, gas price, etc.), evaluate impact on portfolio performance
- Proposed sensitivities
  1. Portfolios run through scenarios for which they are not optimized
  2. High and low load forecasts
  3. Lower cost of solar
  4. Other suggestions?

Nate Gagnon– Lead Planning Analyst

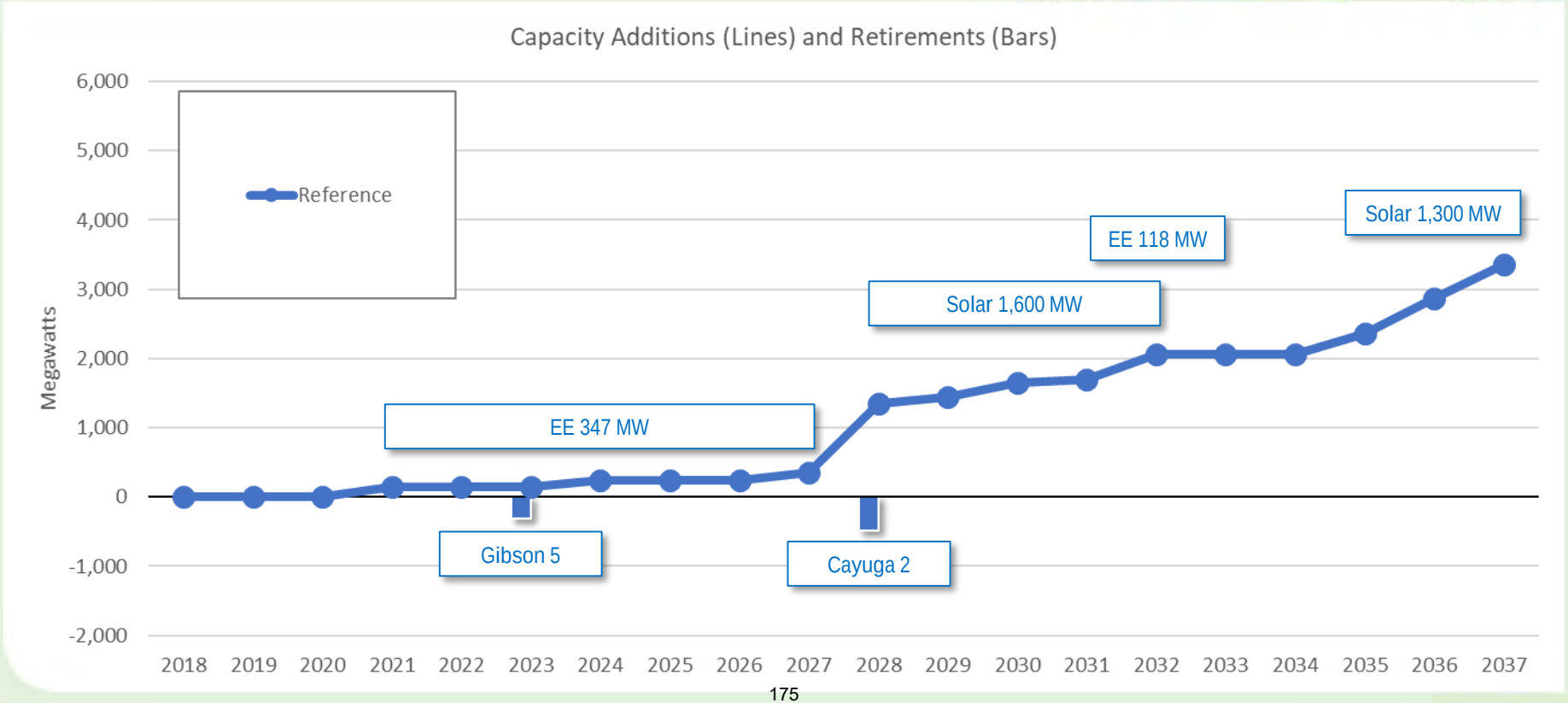
Optimized Portfolios

Characteristics and Metrics

CHARACTERISTIC	METRIC
Low Cost	5-yr PVRR, 20-yr PVRR
Low Risk	Cost Variability Across Scenarios & Sensitivities
Flexible	Frequency, Size, Timing of Irreversible Decisions
Low Environmental Impact	Annual CO_2 Emissions
Reliable	Meets Long-Term Planning Reserve Margin Each Year

Note: It is important that, regardless of the ultimate composition of the preferred portfolio, resources are selected through a transparent process in which a comprehensive set of supply- and demand-side resources is considered and resources are assessed on an even playing field

Optimized Portfolios: Reference Case



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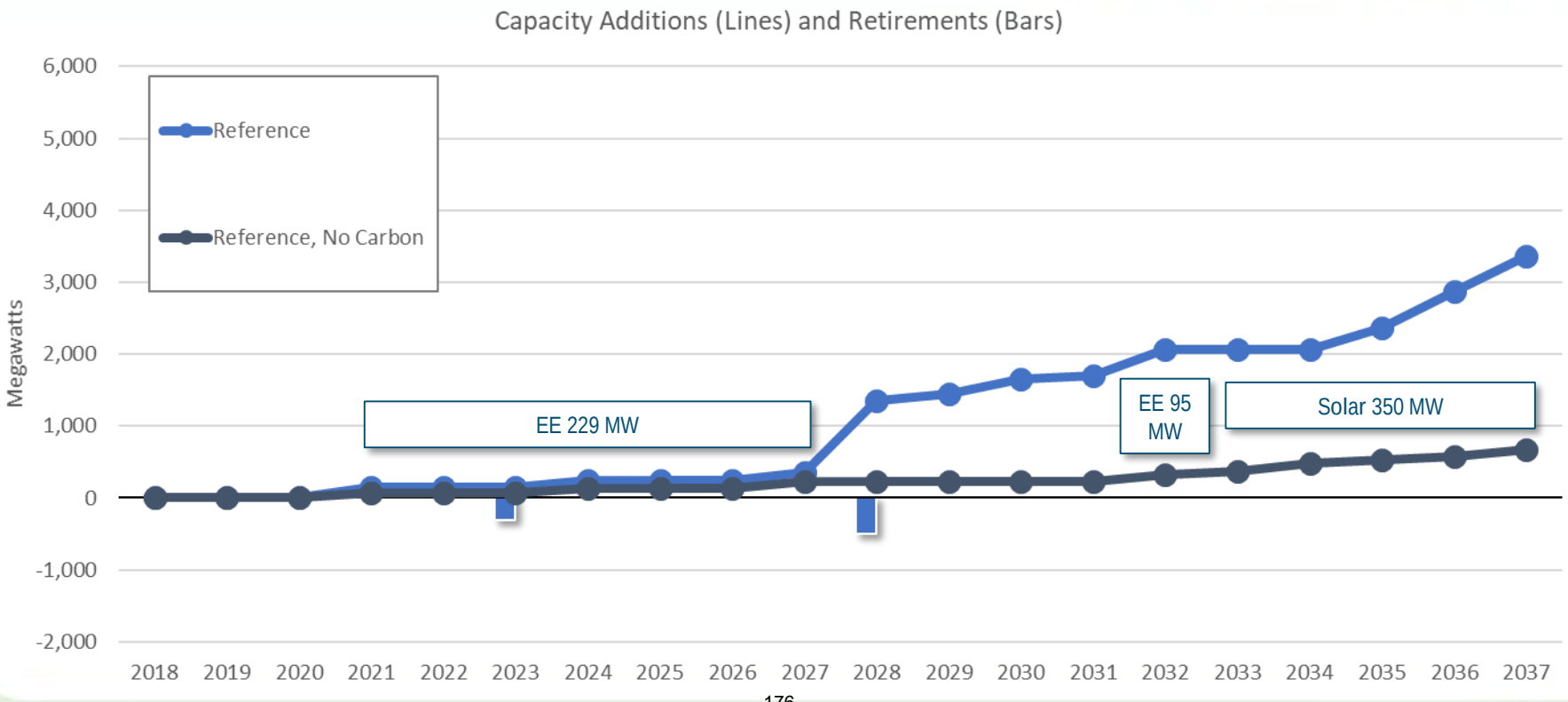
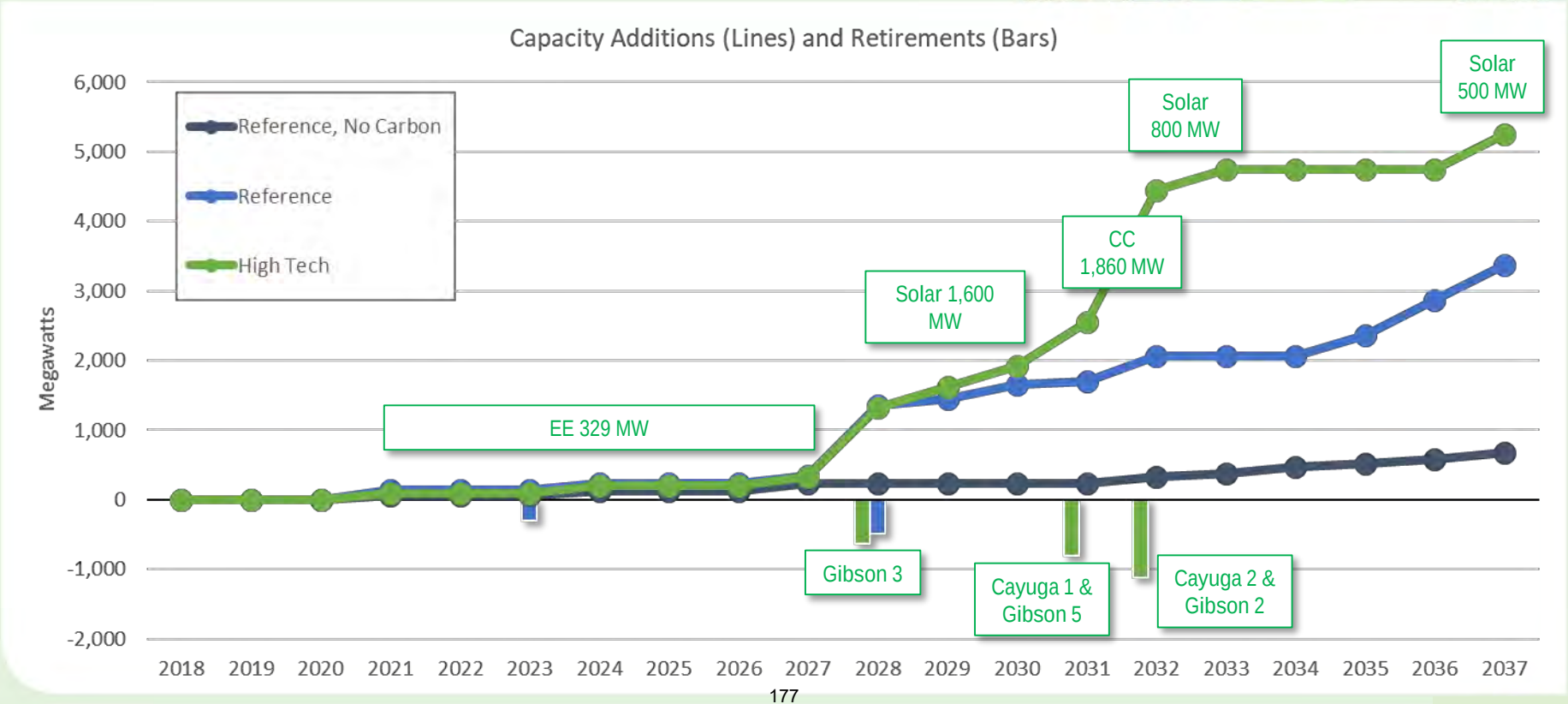
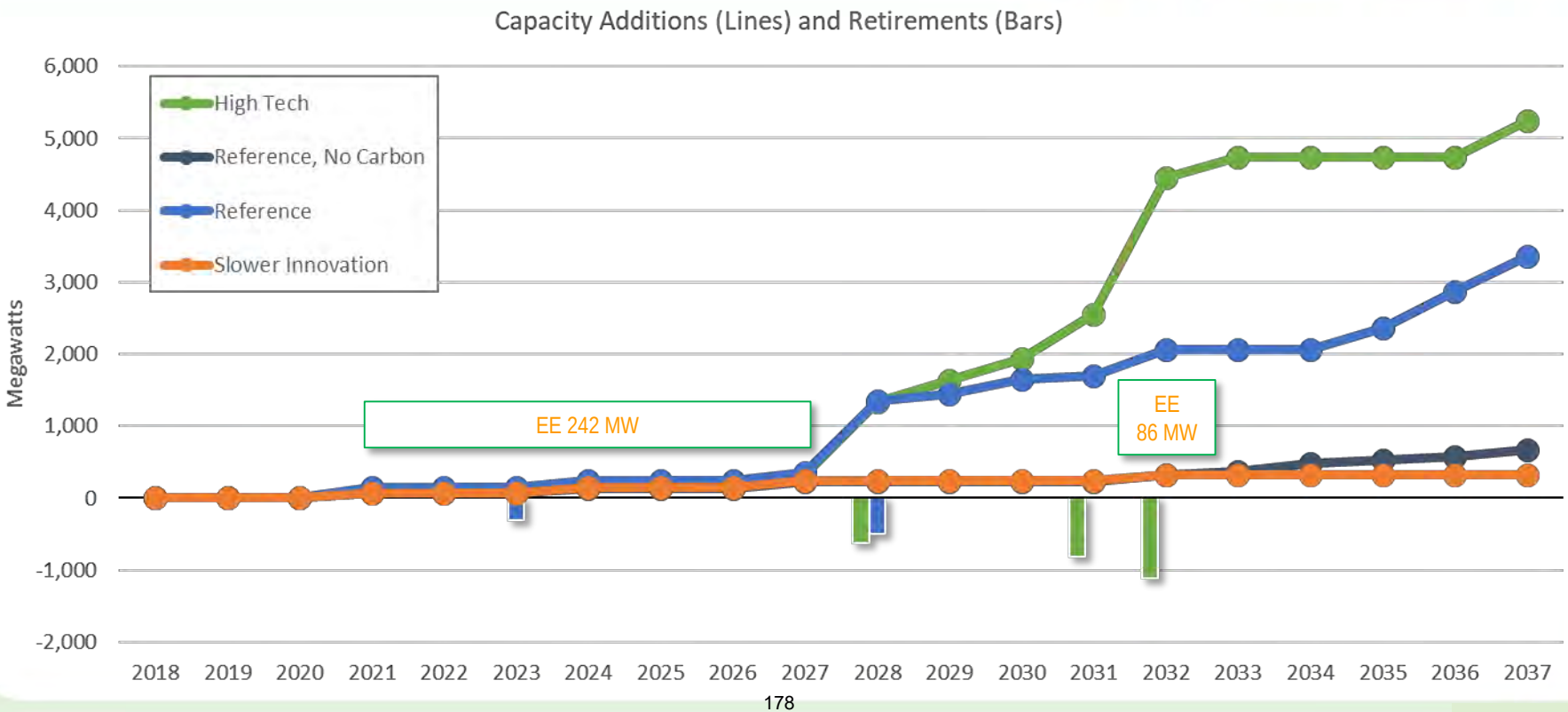
Optimized Portfolios: Add Reference, No Carbon



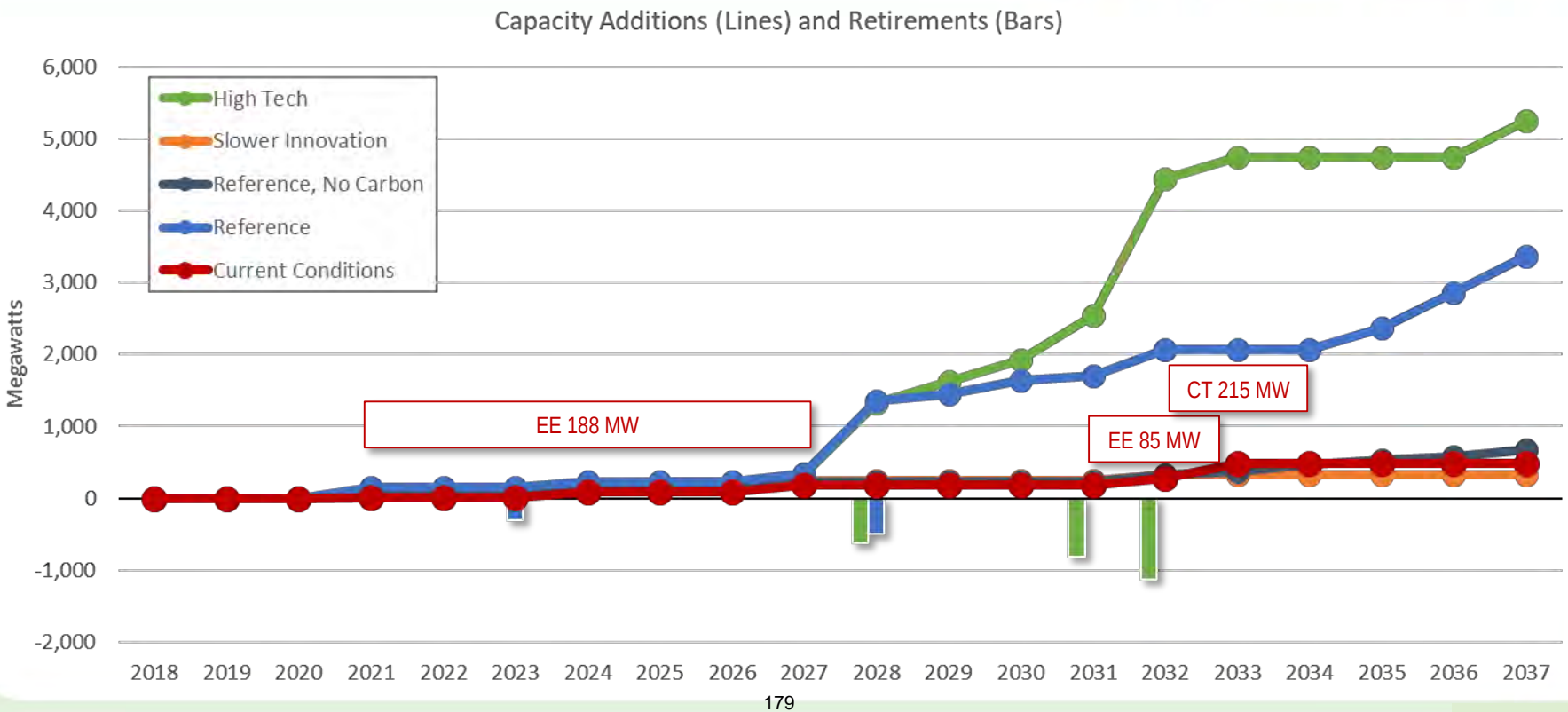
Optimized Portfolios: Add High Tech Future



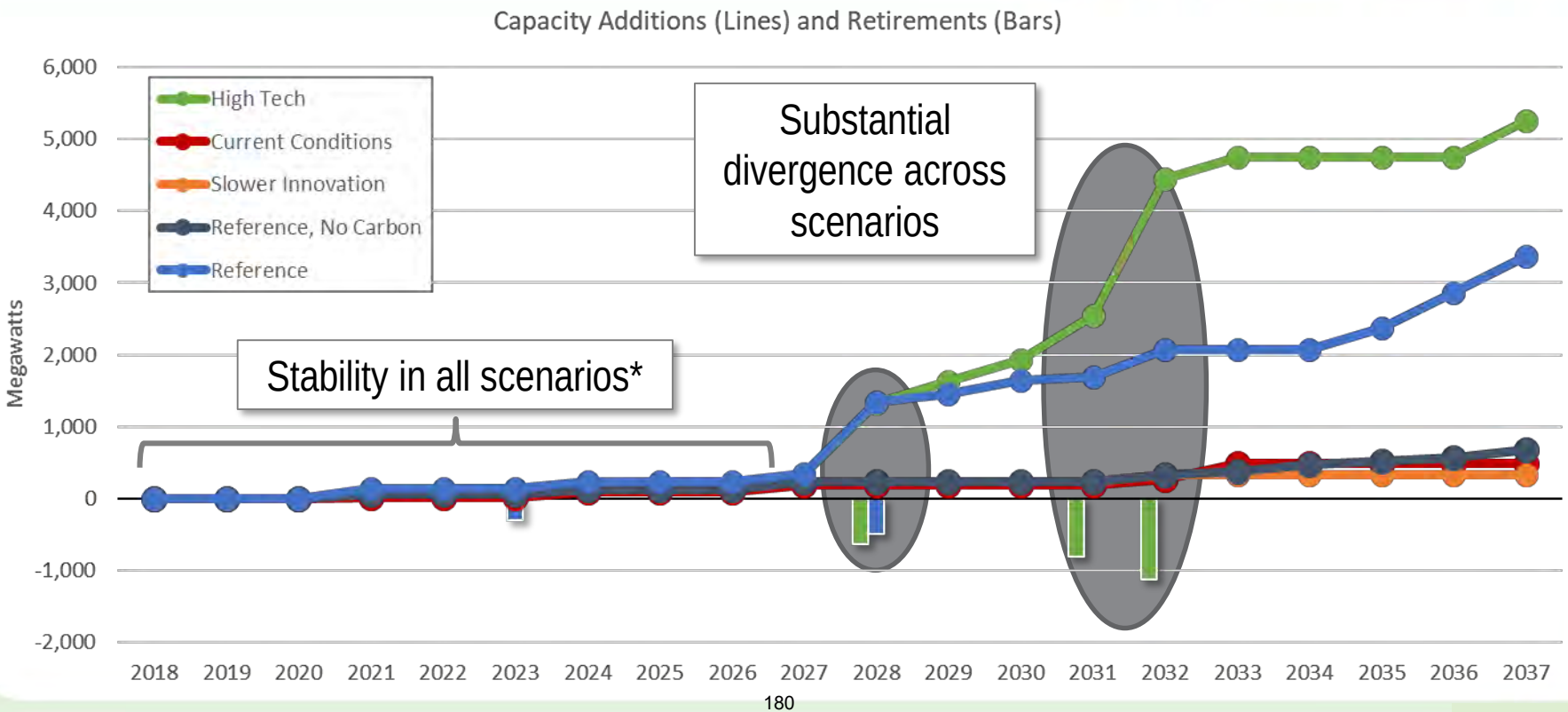
Optimized Portfolios: Add Slower Innovation



Optimized Portfolios: Add Current Conditions



Optimized Portfolios



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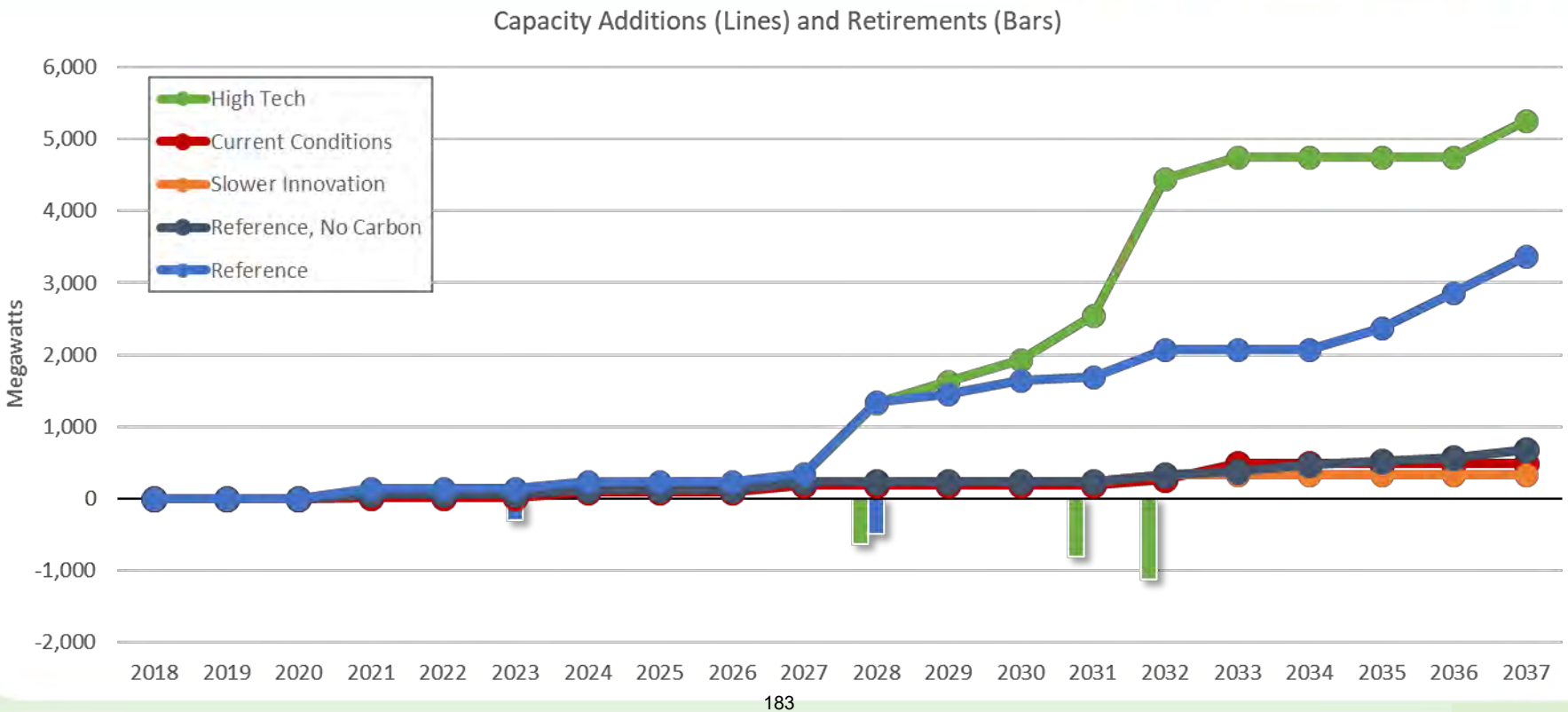
Brian Bak– Lead Planning Analyst

Portfolio Analysis Discussion

Performance Against Desired Characteristics

CHARACTERISTIC	Reference	Ref. No CO_2	High Tech Future	Slower Innovation	Current Conditions
Low Cost					
Low Risk					
Flexible					
Low Environmental Impact					
Reliable					

Optimized Portfolios



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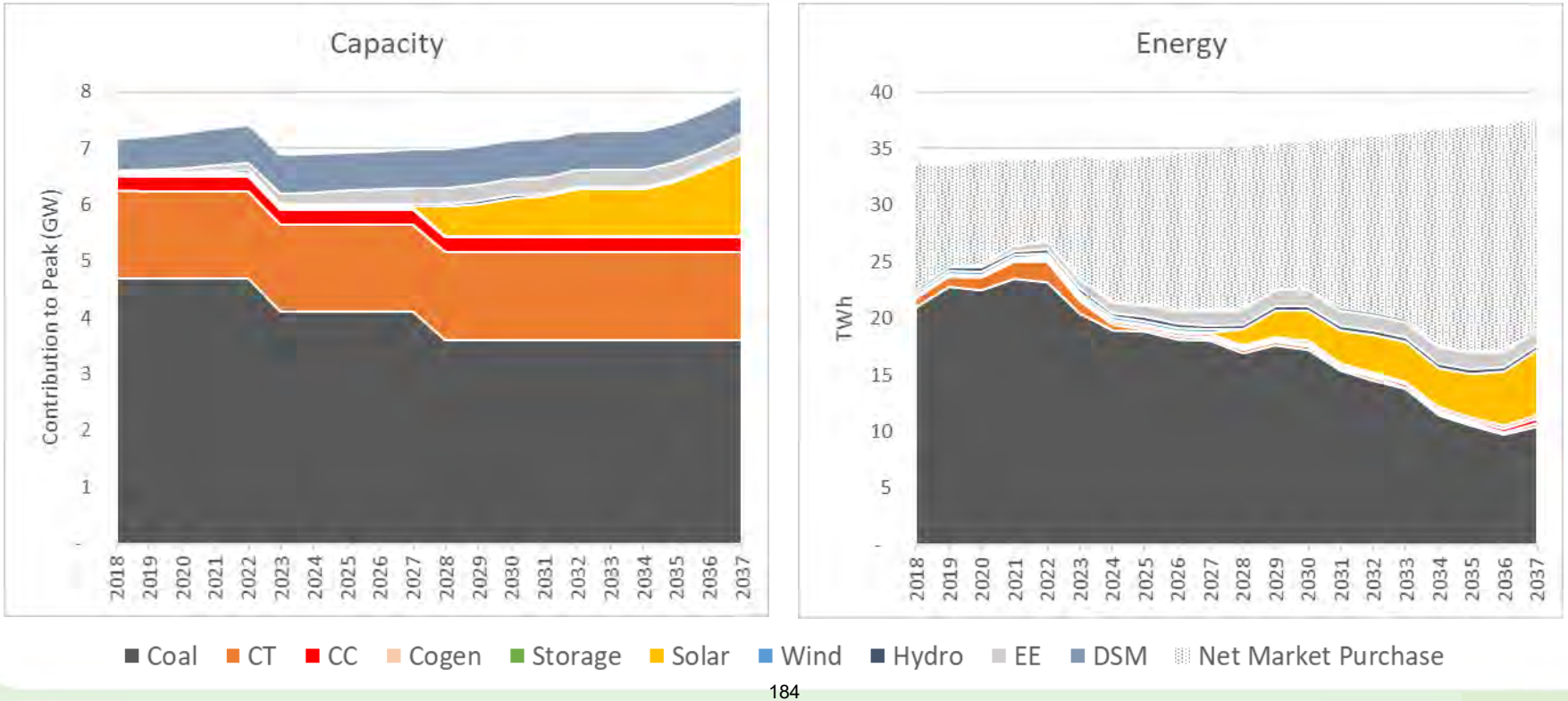
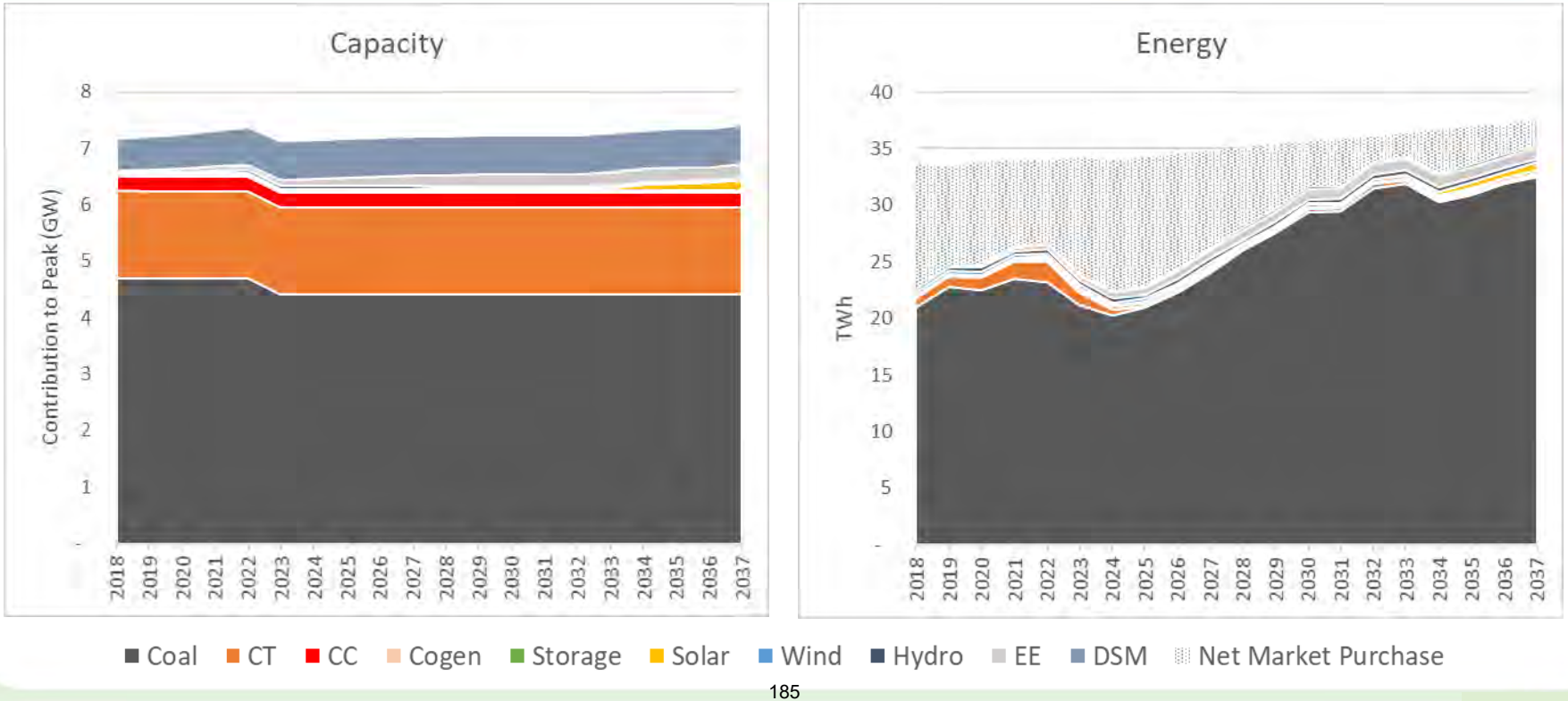
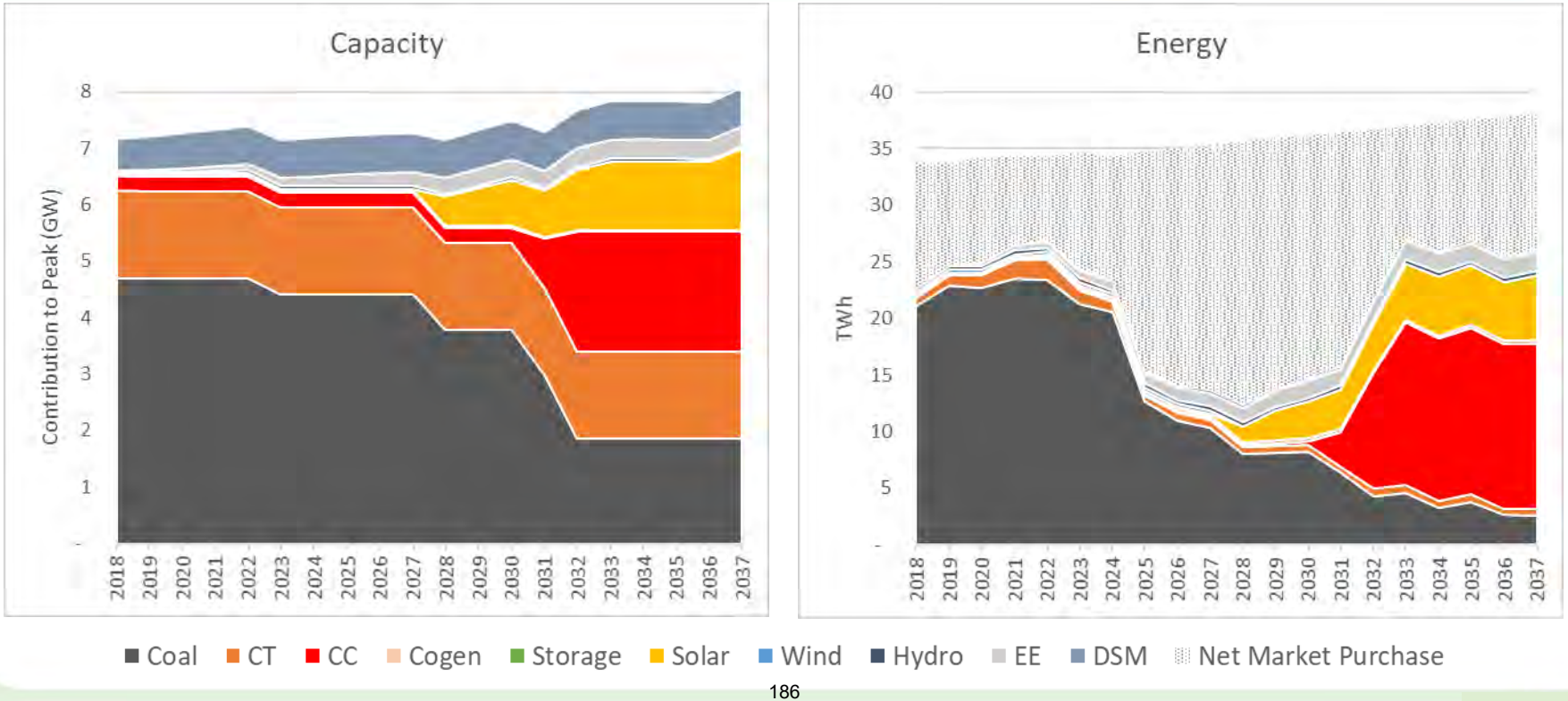
Capacity & Energy Mixes: Reference Case



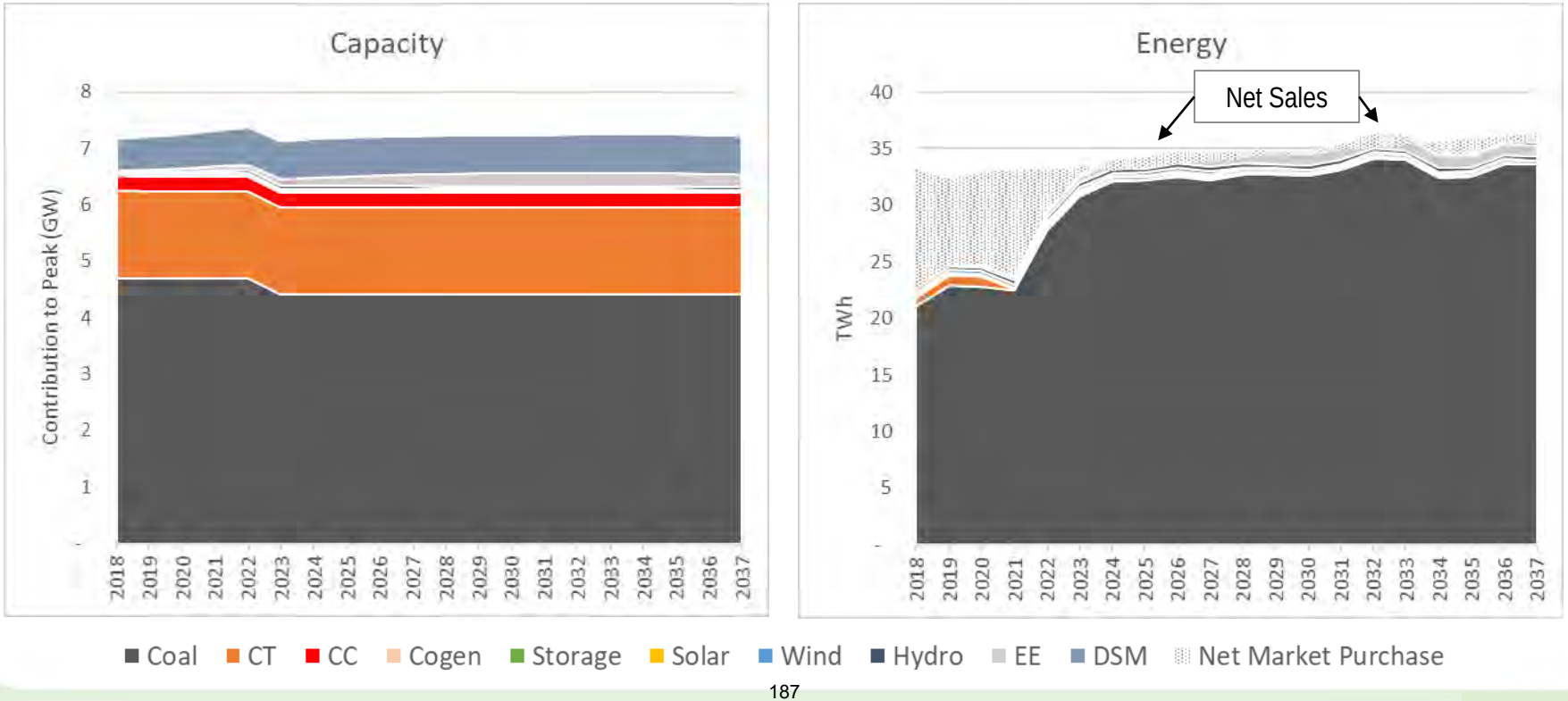
Capacity & Energy Mixes: Ref. – No Carbon Tax



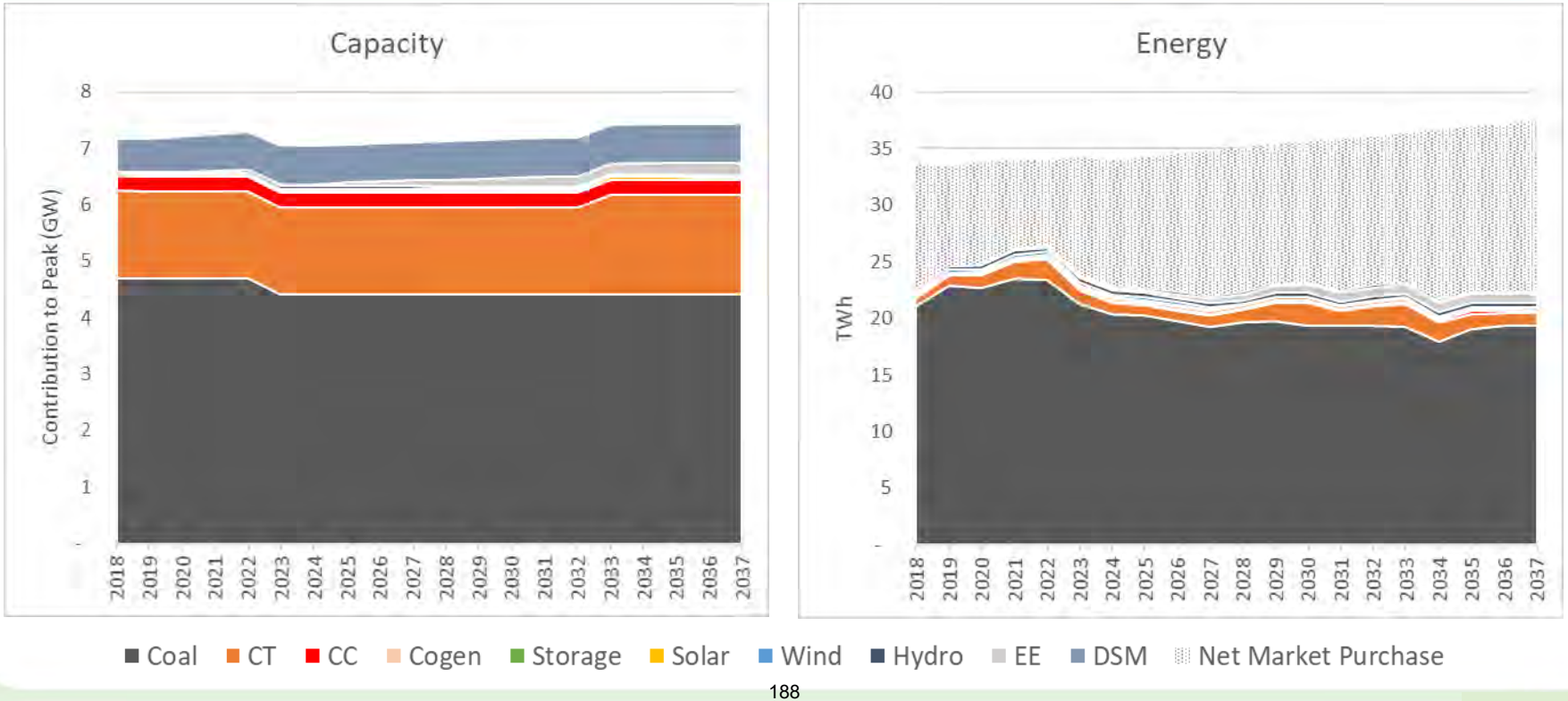
Capacity & Energy Mixes: High Tech Future



Capacity & Energy Mixes: Slower Innovation



Capacity & Energy Mixes: Current Conditions



Lunch

Scott Park, Director IRP Analytics - Midwest

Hybrid Portfolios & Portfolio Development Exercise

Hybrid Portfolios

- Why do we create hybrid 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 the evaluation of trade-offs between portfolios

- How will hybrid portfolios be modeled compared to the optimized portfolios
  - Hybrid portfolios, as well as the portfolios developed be stakeholders, will compete alongside the optimized portfolios as they are tested in scenario and sensitivity analysis

Portfolio Development Exercise

Purpose

- Give stakeholders an opportunity to describe their respective preferred energy mix of DEI's future portfolio

Things to remember

- Consider other stakeholders (800,000 customers but only 1 system)
- System flexibility and fuel diversity
- Tradeoffs between different technologies

Follow-up

- Stakeholders may provide additional input by Dec 31st
- Duke Energy will specify resources that match stakeholders' preferred energy mix
- Model results will be presented in meeting #5

Next Steps

- As was done in 2015, we will take the energy mixes over time to specify the stakeholder portfolios
- These stakeholder portfolios will then compete alongside the optimized and hybrid portfolios
- Results of this analysis will be presented in the next stakeholder meeting

Heather Quinley, Director Energy Affairs & Stakeholder Engagement

Closing Comments, Stakeholder Comments

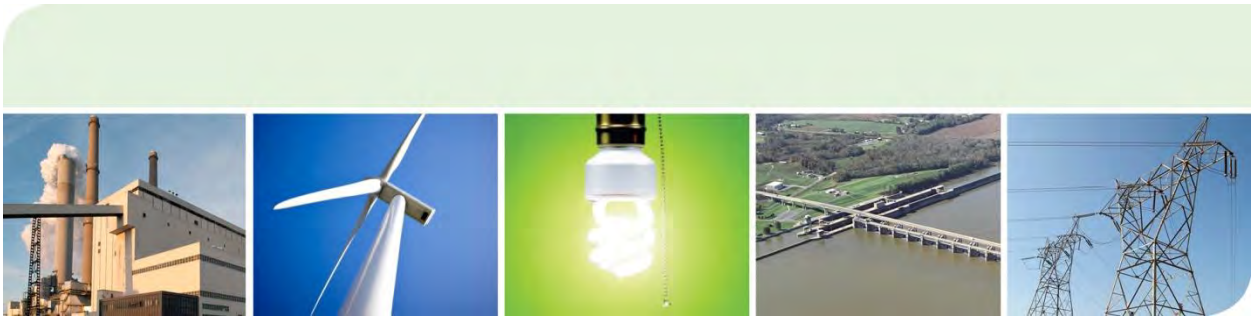
Closing Comments

- Please complete comment cards or send by Dec 27th to Scott at:

  scott.park@duke-energy.com

- Meeting summary and other materials will be posted on website by Dec 28th
  - (http://www.duke-energy.com/indiana/in-irp-2018.asp)

- Next workshop in the late January time frame



Duke Energy Indiana 2018 Integrated Resource Plan

Stakeholder Workshop #4 Summary
December 18, 2018

Meeting Begins at 9:00am

Welcome and Introductions
Scott Park, Director IRP Analytics – Midwest
Stan Pinegar, State President – Indiana
Heather Quinley, Director of Energy Affairs & Stakeholder Engagement

Scott welcomes everyone to the third stakeholder meeting that will be focused primarily on portfolios. He goes over safety and how to evacuate in case of emergency in the new venue. He goes over Wi-Fi and instructions on how to get logged in correctly.

Stan welcomes everyone and thanks everyone for coming. The goal is to have an open, honest, and respectful discussion. Lastly, he thanks everyone again for attending and turns it over to Heather Quinley for introductions and to state why we are here today.

Heather welcomes everyone to the fourth stakeholder meeting. She asks the participants in the room to introduce themselves, followed by introductions on the phone. Attendees introduce themselves and state the organization they are representing.

Why are we here today?
Scott Park, Director IRP Analytics – Midwest

Scott moves to slide 3 to go over the reasons we are here today. Scott explains the challenge with vendor data coordination. Today's agenda will start with a recap of the April meeting and responses to the comments/questions. There will be a review of the main topics from the last meeting, scenarios and sensitivities. There will also be an update on EE modeling. The main topics to be covered during this meeting are updates on modeling of EE, Optimized Portfolios, and the Hybrid Portfolio stakeholder exercise.

Stakeholder question: This stakeholder expressed concern that they have not had time to review the model inputs and settings in advance. For this reason, it might be difficult to have a productive meeting. The stakeholder encourages Duke to support stakeholders in the process, stating that without the data, this is a frustrating process and the stakeholder group is inhibited. The stakeholder was under the impression that data would be provided two (2) weeks in advance. The stakeholder states that their group did request the data in the previous meeting, but wasn't contacted to follow up. Additionally, this stakeholder group would like a meeting to clarify their stakeholder proposed scenarios, but they also need to see the model set up so they can verify Duke's Optimized Portfolio results.
Response: Duke stated that we would try to have this data available two (2) weeks in advance, but that was not achievable for this meeting. Scott states that not a lot of modeling has been done thus far. Scott reiterates that the purpose of today is not for stakeholders to pick fully optimized portfolios, but to develop hybrids plans that could be successful across a range of scenarios. Scott says Duke would be glad to work with this stakeholder group to arrange a meeting to clarify additional stakeholder scenarios.

Stakeholder comment: Everyone on the phone and in the room, needs to identify themselves when they speak.

Stakeholder comment: The commission staff would also like to see the data.
Response: Kelly has been working on this topic for the commission staff and the process is underway.

Agenda
Scott Park, Director IRP Analytics – Midwest

Scott goes over the agenda on slide 4 and the timeline of the day. There are no questions on what will be covered in this meeting.

Review of April Meeting: Scenario Development
Scott Park, Director IRP Analytics – Midwest

Scott recaps the third stakeholder meeting held in April on slide 6. He touches on the difficulties in defining and specifying some scenarios. He stresses that the process should not be hamstrung by the short time to review modeling inputs, but should focus on addressing the issues that each of the modeled scenarios raises. Scott goes through the questions from the previous meeting on slides 7 and the responses from Duke Energy.

Stakeholder question: The stakeholder states that the stakeholder proposed scenario of Global Carbon Constrained scenario should be modeled to be consistent with Duke Energy's Climate Report. The stakeholder recommends using the carbon cap to come up with a portfolio. As for an additional stakeholder proposed scenario, the Utility of the Future scenario, Duke has worked with the University of Arizona on these types of scenarios in the past and the stakeholder has sent that information.
Response: The climate report is more of a portfolio, a single path forward, that could result in significant carbon reductions. Scott suggests we asses each of the optimized portfolios and its performance relative to carbon reduction targets. Scott states this is another way to be responsive to the concern and grading each of the portfolios.

Stakeholder question: The stakeholder references the stakeholder proposed Social Cost of Carbon scenario. The stakeholder would like a continued dialog with Duke and for Duke to participate in a back and forth conversation to get this scenario modeled the way it was intended. The stakeholder stresses how important it is for the stakeholder group to see the modeling files. They did not see those files in the data they did receive. At this point in the process the stakeholder group would like their group's name removed from the scenario as it does not reflect what was originally intended. Further discussion is required to clarify and correct the assumptions around the scenario.
Response: Scott stresses the point that a lot of the modeling has not been done yet. Not all of the scenarios have been completely specified. Additionally, none of the hybrid portfolios, stakeholder or company proposed, have been developed or run through the model. All of that work remains to be completed.

Stakeholder question: The stakeholder asks whether Duke has reviewed the last IGCC testimony, that shows how MISO actually works. The stakeholder states that this testimony shows that the only capacity that will be run in MISO is the self-scheduled by vertically integrated.
Response: The IRP team has not had a chance to review this testimony. The team will review.

Stakeholder question: The stakeholder requests the modeling be done on a UCAP basis. The stakeholder states this can be done. The stakeholder thinks it is easier for stakeholders to assess as it corresponds to MISO Reporting. The stakeholder states that Duke is the only utility in MISO that models on ICAP. The stakeholder states modeling capacity reserve relative to capacity position in MISO is preferable because that is how is it reported to MISO.
Response: Duke does not think the change is warranted.

Stakeholder question: Stakeholder requests confirmation that the VOM solar tranche method used in the model to address ancillary service costs was not developed based on costs in the Carolinas. The stakeholder states that the ancillary costs associated with 50 MW facilities (modeled in Indiana) would not be the same as those resulting from 5 MW or 10 MW sites (typical size in Carolinas).
Response: This method is based less on the size of the site and more on the total penetration of variable resources and the additional costs that will be incurred due to congestion and variable energy resources on the system.

Modeling Energy Efficiency
Brian Bak, Lead Planning Analyst

Brian covers slide 9, the Energy Efficiency Bundling Process. The MPS had 6,270 EE measures grouped into six (6) residential and six (6) non-residential load shapes. Each load shape is subdivided into 5 time-buckets across the modeling term of the IRP. The Achievable, Incremental, and Technical Subset data were added from the MPS to create 180 energy efficiency bundles.

To make the modeling more manageable, the bundles were further consolidated when the size of individual bundles was less than 0.1% of the total annual system energy demand. Following the consolidation, the resulting bundles were relabeled Tier 1, 2, and 3 in order of ascending cost. This effort brought the number of EE bundles down to a more manageable 70. Brian draws attention to the granularity of this number relative to the 2015 IRP, which had only 10 EE bundles.

Brian then moves on to slides 10 and 11, explaining the different EE shapes for residential and non-residential bundles and giving an example of what this might correspond to in a real EE measure.

Stakeholder question: This stakeholder group provided comments to Duke with respect to the EE MPS. When this EE data was analyzed by this stakeholder group, they could not match what these graphs depicted. The stakeholder restated their proposal for decrement load for EE modeling. The stakeholder would like to have further conversation on this. The stakeholder group would also like Duke to share their comments on the MPS with the rest of the stakeholders. This stakeholder group does not think the MPS makes sense, and states that Duke should use the decrement approach. Using data that is not accurate from the MPS would be a mistake. One example would be residential lighting. The group also states that the MPS does not include emerging technologies. The stakeholder states that where there is more consumption, there is more opportunity for savings and an EE decrement with the same hourly shape as load could capture the benefit of emerging technology in this space, making the decrement method a potentially more accurate prediction of the future. Stakeholder agrees to disagree on validity of MPS.
Response: The graphs on slides 10 and 11 represent the load on a single peak summer day, based on the MPS hourly data that was sent. These illustrations are meant to be representative of how each looks a little different on a peak day. The Duke Energy EE team is reviewing memos sent by the stakeholder group. One advantage of bundle selection over the proposed decrement method is its link to actual EE measures. Reducing the 6000+ measures down to 70 bundles is difficult, but the result reflects plausible savings shapes. Reducing load by 0.25% would provide an estimate of cost savings, but crafting a set of measures that matches both the shape and the cost of the decrement would be difficult.

After the EE bundling and shapes have been discussed, Brian announces that we will take a short break and we will next review Scenarios and Sensitivities.

Morning Break from 10:26am – 10:36am

Scenarios and Sensitives Review
Nate Gagnon, Lead Planning Analyst

The meeting is reconvened and Nate discusses the scenarios that were developed by Duke and Stakeholders from the previous meeting on slide 13. Nate covers the gas and coal prices, the load forecast, carbon price, cost of solar and wind, cost of EE, and tax credits for renewables and how each fits into a narrative for the scenario. Nate also outlines how each of the Stakeholder suggested scenarios will be modeled or analyzed.

Stakeholder questions: The stakeholder would like to clarify the impacts of ITC safe harbor. The stakeholder states that projects that will be completed in 2023 could still be eligible for the full 30% ITC.
Response: Projects coming online for a couple of years still get ITC in the model. Duke is interested in hearing more about the full ITC for projects through 2023 and requests the stakeholder send this information.

Stakeholder questions: Why does the load forecast change in cases 3 and 4?
Response: Nate states that improved technology means economic growth and equates to load growth in the high tech future scenario narrative. Conversely, in a slower innovation scenario, the rise in

commodity prices impact power prices becoming a drag on the economy resulting in a lower load forecast.

On slide 14, Nate covers the process of sensitivity analysis. He describes how sensitivity analysis is used to determine which model inputs have the most significant impacts on the outputs. He describes crossing portfolios into other scenarios and seeing their performance along with performance in the case with a single variable change. Nate describes the steps performed, covers the proposed sensitivities, and solicits other suggestions.

Optimized Portfolios
Nate Gagnon, Lead Planning Analyst

The meeting continues as Nate reviews the characteristics of a preferred portfolio and the Metrics used to measure those characteristics. These have been discussed in previous meetings. Nate then steps through the Optimized Portfolio for each scenario, highlighting the selected retirements, new builds, Energy Efficiency selections, and commonalities among optimized portfolios. Nate points out that the Reference Case is the expected projection for each of the variables, but they are labeled as mid, as they are the middle line when the high and low cases are plotted.

Optimized Portfolios: Reference Case – Slide 17
Nate points out a few notes about the graphs that will be shown on the next 5 slides. The lines are cumulative additions. Bars are capacity retirement and are not cumulative. He explains that there is no net represented on the graph. The text boxes are over the time when resources are added.

Gibson 5 is only half-owned by DEI, so the retirement decision cannot be made unilaterally. Nate stresses that these optimized portfolios are tools for understanding how resource addition and retirement decisions would be made to minimize cost under each scenario, and stakeholders should use these lessons learned when developing their proposed portfolios in the afternoons exercise.

Stakeholder: The stakeholder asks why was Gibson 5 retired instead of Gibson 2? The stakeholder says they can discuss separately, as he was surprised to see this pick due to Gibson 2's operating performance.
Response: The retirements are based on multiple considerations, not just dispatch cost. The size also plays a role as noted previously

Stakeholder question: Why Gallagher 2 and 4 not on here?
Response: Nate reminds the group that anything that is common to all the optimized portfolios is not depicted here. Gallagher 2 and 4 retirements occur in every scenario.

Optimized Portfolios: Reference No-Carbon Case – Slide 18
Nate points out the dramatic shift in the portfolio with the only change from the reference scenario being the lack of a CO2 tax. It is noted that there is very little action in this portfolio.

Stakeholder question: The stakeholder confirms that the retirement bars are not applicable to this case.

Response: Correct. Nate points out that the graphs are layered on top of each other, so the line and bars in the light blue are only applicable to the Reference scenario, and likewise for the dark blue and green going forward for Reference-No Carbon and High Tech Future scenarios.

Optimized Portfolios: High Tech Future Case – Slide 19
Nate points out that for this optimized portfolio, there are EE additions in first ten years, but no other major moves. Once the 2025 CO2 tax is put into effect, the changes start. Nate also notes that this case has low gas prices, so the economics of CC work there. It is also noted as something to think about that, with high levels of solar penetration, the binding constraint becomes winter utility planning, where solar additions will have much less of a contribution to reserve capacity planning margin.

Optimized Portfolios: Slower Innovation Case – Slide 20
Nate notes that in this case with low load and high renewables technology costs, EE is the only resource selected.

Optimized Portfolios: Current Conditions Case – Slide 21
The optimized portfolio for this scenario adds only EE, despite the low market gas extrapolation. Nate does point out the CT capacity need for reference case load growth.

Nate highlights the stability of the generating fleet in all cases over next 10 years. Substantial divergence across scenarios with enactment of a carbon tax and, to a secondary degree, low gas prices.

Stakeholder question: Can Duke present these optimized portfolios, with y-axis in terms of CO2?
Response: The next step in the modeling process will be to do this for all portfolios in all scenarios and show robust metrics for all portfolio in the next meeting.

Stakeholder question: Do these scenarios meet the capacity requirement, or do we have capacity/energy purchase.
Response: The capacity requirement is met without market capacity purchases, but energy is still bought from the wholesale market when economic.

Stakeholder question: Why are the portfolios all the same in the next 10 years. Were there any fixed resources?
Response: The results show that the current portfolio is effective across the range of scenarios and that major changes are costly. Only the Gallagher retirements are fixed, and Edwardsport was not eligible for retirement.

Stakeholder question: Are any capacity additions constrained?
Response: There are lead time restrictions for new construction projects factored into the plan. Renewables are 1 to 2 years. CTs a little longer at 3 years. CCs have a lead time of about 5 years, and Coal and Nuclear are closer to a decade.

Stakeholder question: Is there a cap on additions annually or over the study?
Response: There annual limits on some of the renewables. A certain number of MW for solar and wind per year.

Stakeholder question: Is there a cap on additions on renewables only or on fossil as well?
Response: For the conventional resources, there are limits, but the model never hits them.

Stakeholder question: What is the contribution to peak for each renewable resource?
Response: Solar has a 50% contribution to peak; Wind is 13%; Battery is 80%.

Portfolio Analysis Discussion
Brian Bak, Lead Planning Analyst

Brian has the stakeholders begin thinking about how each optimized portfolio performs in its specific scenario against the desired characteristics discussed earlier. Brian then steps through the Capacity and Energy Mixes from each scenario's optimized portfolio. He highlights the capacity changes and energy make-up as a function of the scenario's model inputs.

Capacity and Energy Mixes: Reference Case – Slide 26
As a guide for the next 5 slides, Brian notes the capacity mix is shown on the left half of each slide and the energy mix on the right. Steps down in capacity are retirements. In the reference case, coal generation continues to drop, but the portions made up from EE and Solar don't totally make up for the coal reduction, so the remainder of the energy comes from MISO market purchases. Reductions in coal generation can be used as close proxy for reductions in CO2 for the portfolio.

Stakeholder question: The Coal steps down correspond to which retirements? Energy mix of coal is declining over time. Just due to capacity change?
Response: The retirements in this case are Gallagher 2 and 4, and Gibson 5 units in 2023 and then Cayuga 2 in 2028. Reducing capacity leads to less coal generation, but capacity factors also fall due to the economics of running those units after implementation of a carbon tax.

Stakeholder question: Why does Gibson 5 retire in 2023, before the carbon tax? And why is Coal generation growing through 2021?
Response: Gibson 5 in this optimized portfolio is just the right size to retire and still meet the reserve margin requirement. Retiring this unit and not carrying extra capacity is the economic decision here. The coal generation increase is likely due to fuel and power price interrelationships; the model decides that it's better to generate with coal from our units in those years rather than buy from the market.

Stakeholder question: It was noted by Brian that this case corresponds to a ~65% CO2 emissions reduction. What is this relative to? What are the CO2 emissions for the baseline year and the final year?
Response: This 65% reduction was relative to 2010 CO2 emissions numbers. The CO2 actuals and projections will be presented in the next meeting

Stakeholder question: Does Duke consider the market purchase as no carbon?
Response: Market purchases here are obviously not carbon free, but we don't count carbon associated with purchases in this number. Something to consider in the hybrid portfolios, limiting market purchases to ensure CO2 reductions overall.

Brian solicits help from the stakeholders on how they would like to see us assess market purchases in terms of environmental impact or if they have a preferred methodology.
Stakeholder comment: The stakeholder will provide proxy carbon value for environmental impacts of market purchases.

Stakeholder question: Is the sidelined generation right on the margin or far out of the money? All the utilities in MISO Indiana can't buy 50% from the market.
Response: Brian cannot state how far out of the money the non-generating capacity is off hand, but this is certainly something to consider in risk analysis in hybrid portfolios.

Stakeholder question: System Optimizer has ability to limit market purchases. The stakeholder recommends we do it, because you don't want to rely on the market for that much energy.
Response: The thought process here is we plan to design hybrid portfolios that will be competitive with the market, limiting exposure that way rather than imposing a modeling constraint. For the optimized portfolios we use as few constraints as possible in SO to learn from what the model selects and the key variables driving changes. We then use what we learn to make changes that align with the characteristics we see as desirable in a preferred portfolio.

Capacity and Energy Mixes: Reference No-Carbon Case – Slide 27
Brian again notes that the only change from the previous scenario is the lack of a carbon tax. Without a carbon tax, gas prices rising faster relative to coal drive coal generation from our fleet up over time.

Stakeholder question: The stakeholder wants clarification that the only change is the elimination of the carbon tax. Does this mean the price of market purchases did not change?
Response: The market prices were changed to reflect the lack of a carbon tax. These power prices were developed based on an Eastern Interconnection expansion plan based on a no carbon tax scenario with all other reference projections.

Capacity and Energy Mixes: High Tech Future Case – Slide 28
This case really shows the impact of the 2025 carbon tax, dramatically driving down generation in the middle of the study. Most of the decrease is filled with market purchases until it is filled back in with solar and CC in the mid-2030s. One way to reduce purchases in a hybrid portfolio would be to accelerate the CC and solar to fill that gap.

Stakeholder question: What carbon assumption and expansion plan is used in this scenario?
Response: An Eastern Interconnection expansion plan developed using the input assumptions for this scenario. The dispatch to develop power prices uses the high carbon tax assumption along with the rest of the variables for the High Tech Future scenario.

Capacity and Energy Mixes: Slower Innovation Case – Slide 29
In this optimized portfolio, coal generation increases as gas prices increase faster than coal prices, similar to the Reference case without the carbon tax.

Capacity and Energy Mixes: Current Conditions Case – Slide 30
This scenario is unique in that, even without a carbon tax, the low market gas prices cause a shift in the energy mix from coal generation to market purchases. The low gas prices are reflected in a lower market power prices which, in turn, drive down the dispatch of the coal units.

As a reminder, Brian states that these are largely unconstrained runs so we can learn how a lowest cost portfolio might be built in each of the IRP Scenarios. Brian reiterates that the largest changes in new capacity builds, retirements, and energy production come from the impact of carbon regulation and fuel pricing.

Stakeholder question: Why are market purchase more significant in the Current Conditions case as compared to Reference-No Carbon and Slower Innovation?
Response: In Current Conditions, the natural gas price stays very low, holding power prices low and making the market more competitive relative to our coal-heavy fleet.

Lunch Break from 11:30am – 12:30pm

Final remarks from Brian on capacity and energy mixes and the impact from Carbon taxes and fuel prices. Brian asks if any questions remained from the previous section. There are no additional comments or questions at this time.

Hybrid Portfolios and Portfolio Development Exercise
Scott Park, Director IRP Analytics – Midwest

Scott opens up the topic by explaining why we create hybrid portfolios. He explains that optimized portfolios are created for a specific scenario, and that it is important that our preferred portfolio be able to achieve success across a range of futures. The hybrid portfolios proposed by stakeholders and Duke Energy will be designed to incorporate the strengths of the optimized portfolios while avoiding their weaknesses. These hybrids will then be tested in each of the scenarios and sensitivities alongside the optimized portfolio to see which performs best.

Stakeholder question: The stakeholder asks if Duke has seen the comments on IRPs rulemaking from the Commission. In their last IRP filing, IPL made a hybrid that was never put into the model. Is duke going to run all the portfolios through the model?
Response: The considered portfolios, including all optimized and hybrid portfolios will go through the dispatch model, but not necessarily capacity expansion model, depending on the portfolio.

Stakeholder question: Why run the optimized portfolios through the different scenarios at all?
Response: If Duke starts planning for one scenario and it turns out we are actually in another, we would like to be able to quantify the cost/risk. Hybrids that split the difference between optimized portfolios may diminish the risk and could perform well in multiple scenarios.

Stakeholder question: The use of the term “Hybrid” in this context is confusing. The stakeholder understands that a portfolio is a resource plan. The stakeholder understands that the scenario is the external conditions that define the world. What is meant by “Hybrid” exactly? That does not necessarily mean it is a mix of 2 or more already optimized portfolios, correct?
Response: Correct. Hybrid does not necessarily mean the portfolio is interpolated between two of the optimized portfolios. The hybrid portfolio can be whatever mix the stakeholder wants it to be.

Stakeholder question: How will scenarios that are over or under-built for optimized portfolios be adjusted in lower and higher load forecasts, respectively.
Response: Duke is initially using increased or decreased solar capacity to adjust for load differences because of its low price and the ability to add it in smaller MW blocks.

Stakeholder question: The stakeholder states that Duke's intention of this exercise is to approximate the benefit of SO without using SO. The stakeholder believes it would be better for Duke to limit market purchases, lock in and vary coal retirements, and then run SO to develop new optimized portfolios given those constraints.
Response: Scott states that this is another way to do it, but energy mixes specified by the stakeholders will get to the same place while allowing stakeholders to put more emphasis on the characteristics of a preferred portfolio most important for each stakeholder's interests, including environmental impact, low cost, and flexibility.

Stakeholder question: Is Duke going to be responsive in using SO to meet constraints of this exercise?
Response: Yes, Duke will use SO to ensure constraints are met when translating these energy mixes to portfolios.

Scott then begins to discuss the portfolio development exercise. The purpose of this exercise is to provide input regarding the preferred energy mix for Duke Energy Indiana's portfolio. Stakeholders should consider the broad requirements for a single system that serves many customers with unique needs, while keeping in mind the importance of system flexibility, fuel diversity, and the tradeoffs between different technologies.

The pods work together to develop energy mixes in 2027 and 2037. A representative from each table presents the key points of their portfolio energy mixes. As a follow up, stakeholders can continue to provide additional information through the 31st of December, or another agreed upon time. Duke Energy will specify resources that match stakeholder preferred energy mixes and the model results will be present in meeting #5.

Stakeholder question: This stakeholder feels that they did not have enough time to review model inputs. This group will respectfully not participate in the exercise for this reason. The group will submit a stakeholder proposed portfolio at a later date, once they have had a chance to review the data more closely. The stakeholder also wanted to confirm that they can meet with Duke regarding proposed scenario.
Response: Yes, Duke will work with you to get scenario and portfolios defined.

Stakeholder question: How are the market power prices developed?
Response: The prices are developed in a model called PROMOD through the vendor. The prices represent a MISO Indiana price.

Stakeholder question: Are the Solar prices being use the same as the prices stated in the data from NDA data file?
Response: Yes, the technology costs being used correspond to the prices in the file sent out. Duke is willing to have additional discussion on that cost, but want to make sure were talking about the same technologies and project scale.

1st Stakeholder Portfolio – The stakeholder would like to see an optimized portfolio for the Reference Case using the solar cost implied by the responses to the recent NIPSCO RFP, and capping market purchases at 10%.

Stakeholder question: What is the NIPSCO cost?
Response: The solar cost associated with NIPSCO's RFPs was between $1,150-1,250/kw.

2nd Stakeholder Portfolio – The stakeholder outlines a portfolio that considers increased electrification and sustainability supported by cleaner generation sources. The CT additions are purely to meet capacity requirements. The portfolio generally aligns with a carbon constrained future. Storage and CT are used to fill peaks and valleys, and solar and wind provide the bulk of the energy. There is no capacity (or energy) purchased from the market. Cogen is underutilized in Duke's current portfolio, so this is expected to increase over time.

Duke will develop a portfolio based on these outlines. Duke will follow up with each stakeholder group to verify that the resource plan developed based on the provided energy mix is consistent with the stakeholder's proposal and expectation.

Barring any delay with stakeholder engagement, the next meeting will be late January. This will be set up and communicated in early January.

Stakeholder comment: Note that January 29th is IPL's first IRP stakeholder meeting. Also, NIPSCO field hearings are on the 28th and 30th. Keep these dates in mind as scheduling on the same day may preclude some parties from attending and thus decrease stakeholder engagement. Finally, the stakeholder group which declined to construct a portfolio today will email this week with proposed scenario and portfolio timelines and estimates for completion.

Closing Comments
Heather Quinley, Director of Energy Affairs & Stakeholder Engagement

Heather thanks participants for attending and for their continued active engagement. She states that the next meeting will be very data heavy with reviewing model results. If you would like to propose a scenario or portfolio, please provide this by December 31st or request an extended deadline. Please fill out the comment cards and return them before leaving. The materials will be posted to the website by December 28th.

Meeting Ends at 1:49pm

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

Scott Park, Director IRP Analytics - Midwest

Review of December Meeting, Comments and Overall Update

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.

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

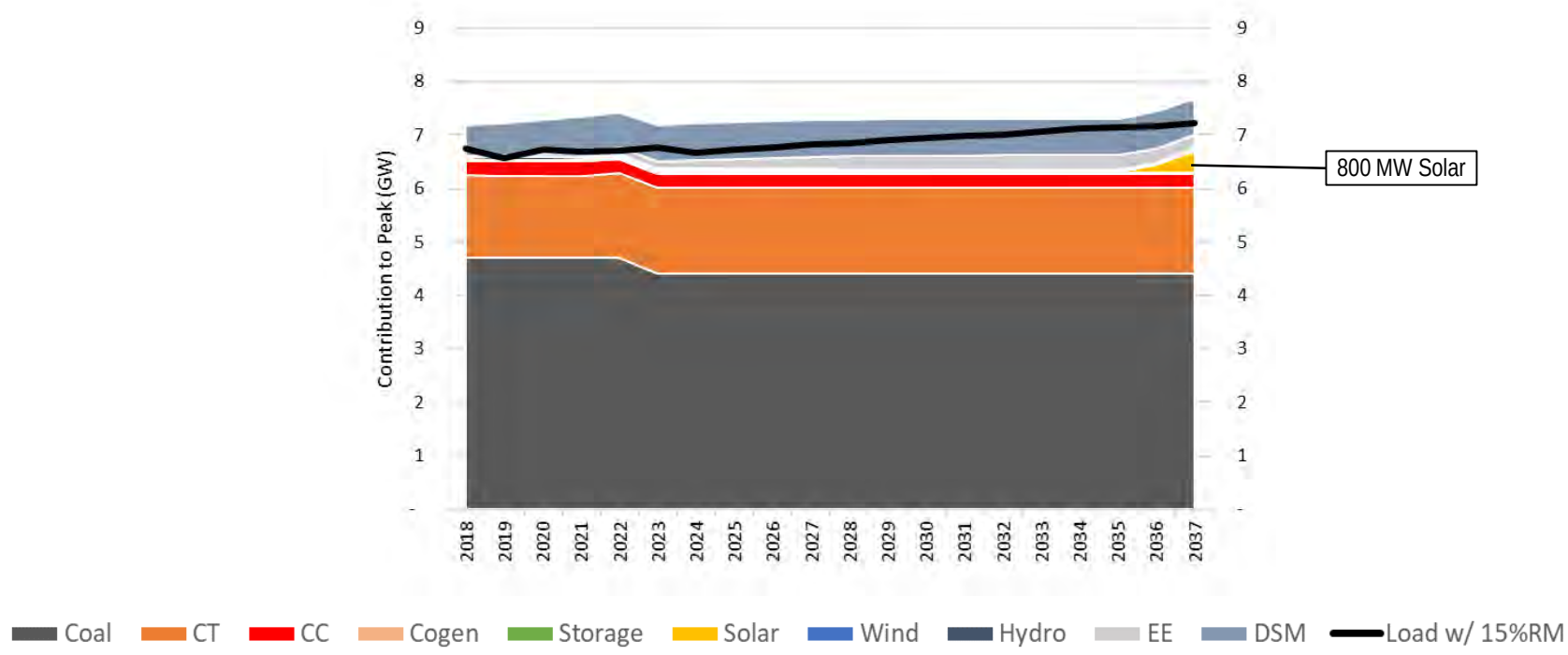
Nate Gagnon – Lead Planning Analyst

Review of Scenarios & Optimized Portfolios

Scenario Summary

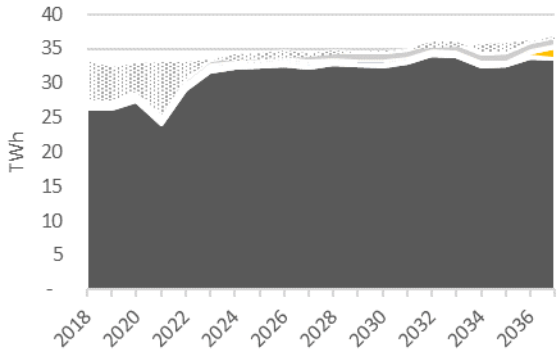
Scenario	Gas Price	Coal Price	Load Forecast	Carbon Price	Cost of Solar & Wind	Cost of EE	PTC & ITC
1) Slower Innovation (High prices)	High	High	Low	None	High	High	Renewed
2) Reference Case (Mid prices)	Mid	Mid	Mid	Mid	Mid	Mid	Expire
3) High Tech Future (Low prices)	Low	Low	High	High	Low	Low	Expire
4)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

Slower Innovation Portfolio

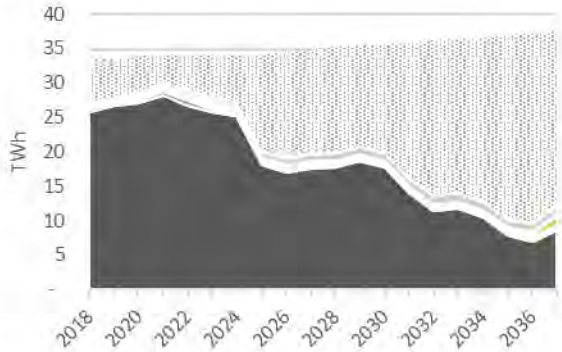


Slower Innovation Energy Mixes

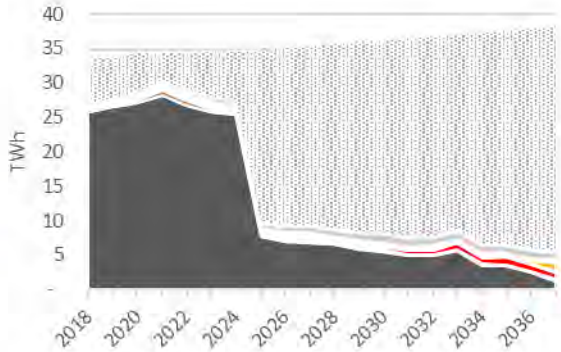
Slower Innovation Scenario



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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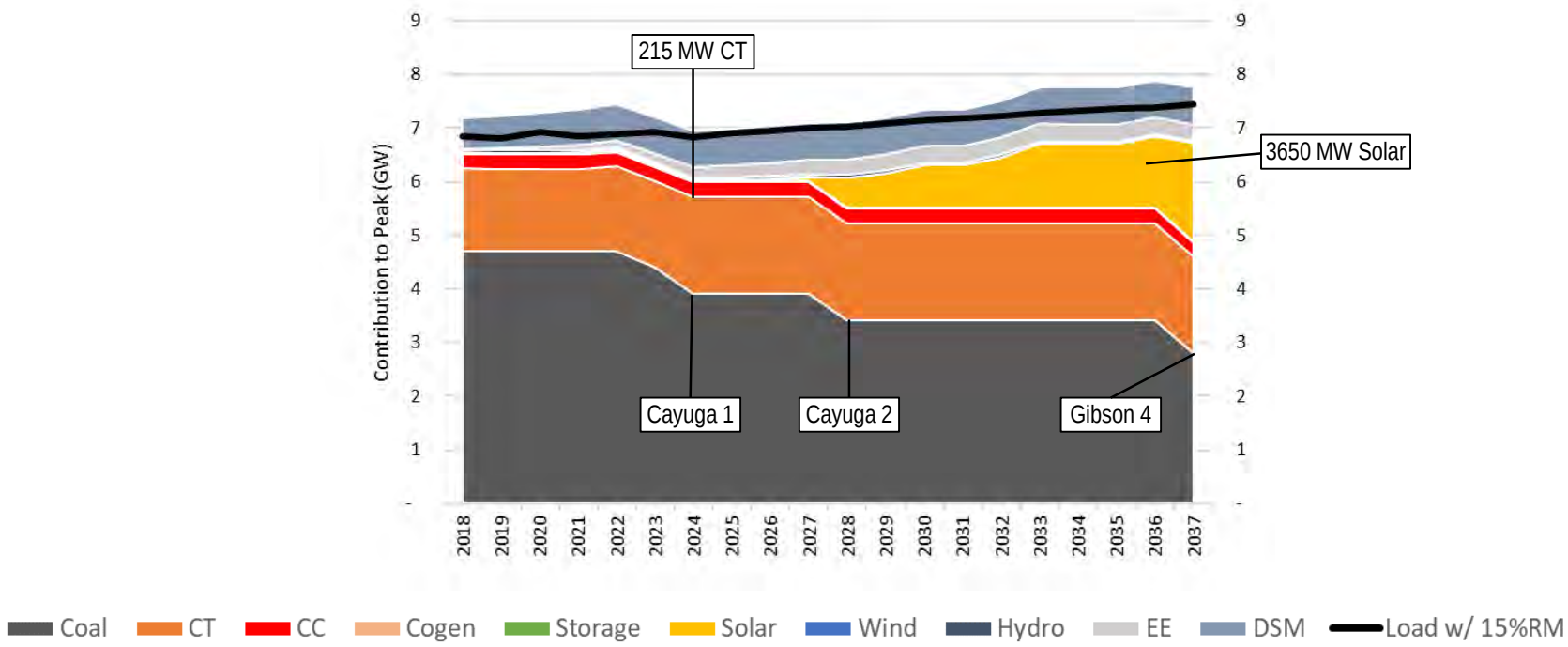
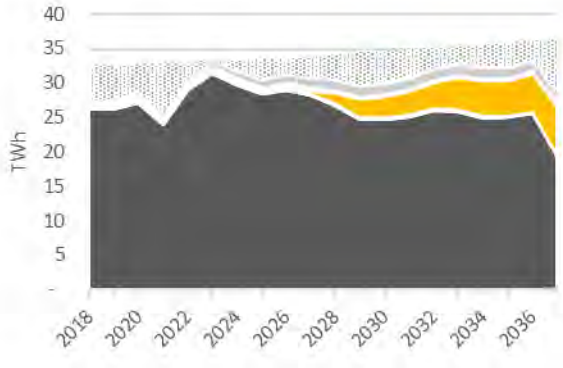
Reference Case Portfolio



Reference Case Energy Mixes

Slower Innovation Scenario



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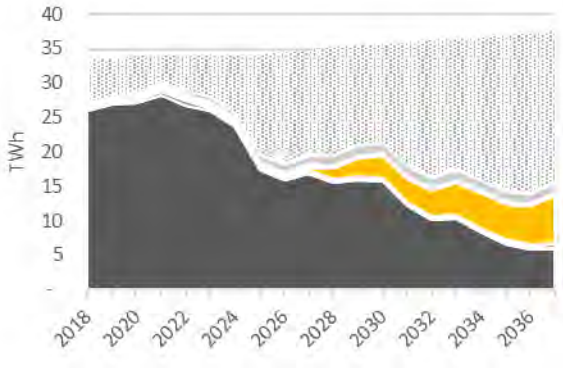

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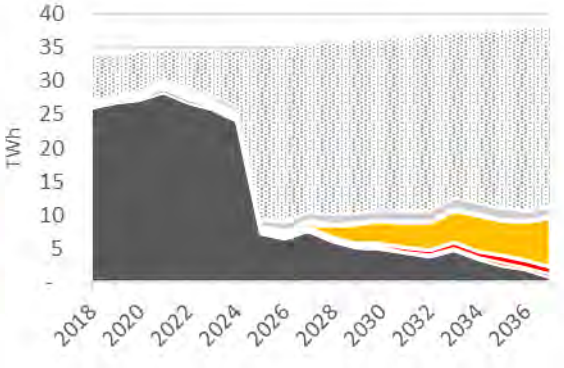

Coal CT CC Cogen Solar Wind Hydro EE DSM Net Mkt Purchase

Observations

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

Observations

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

Observations

- 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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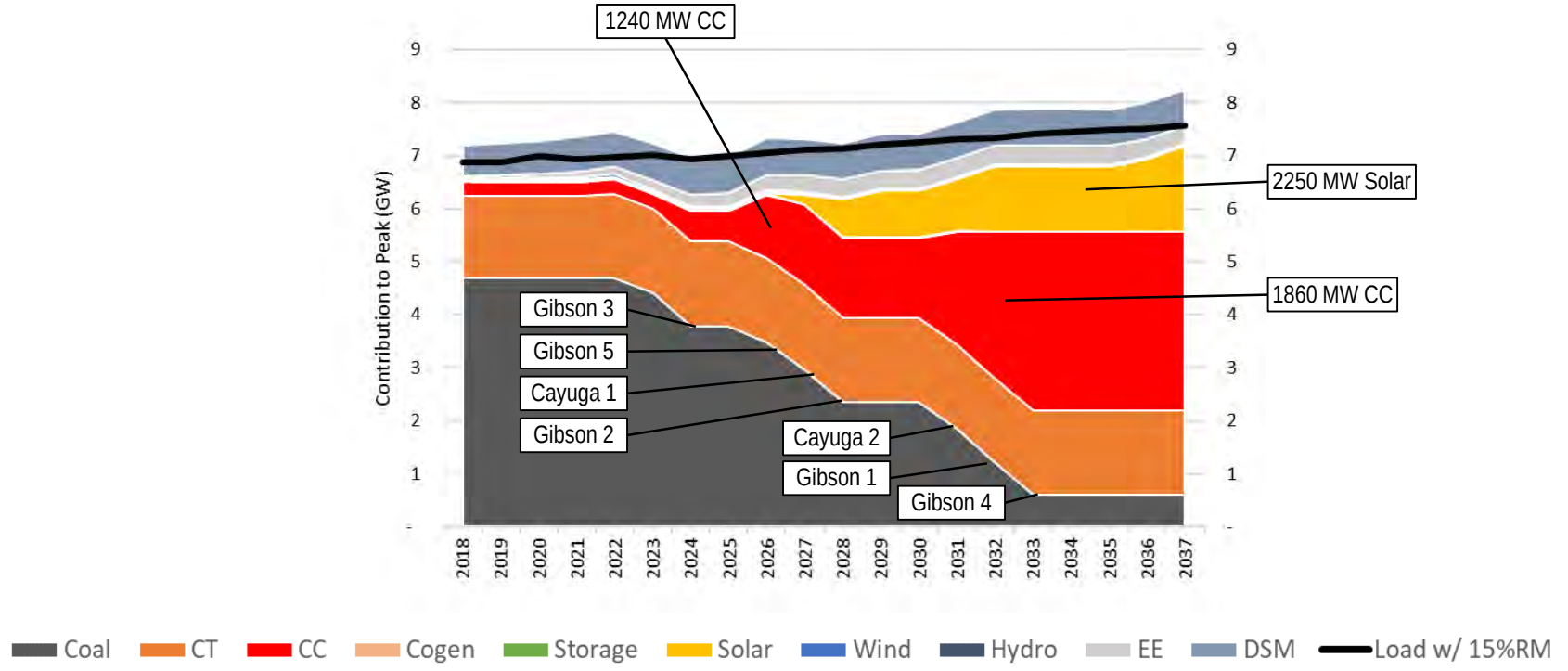
High Tech Future Portfolio



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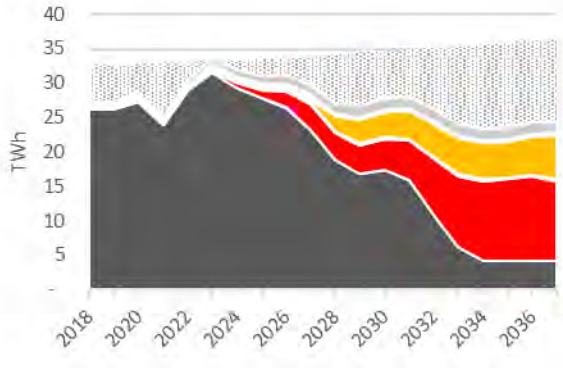
High Tech Future Energy Mixes

Slower Innovation Scenario



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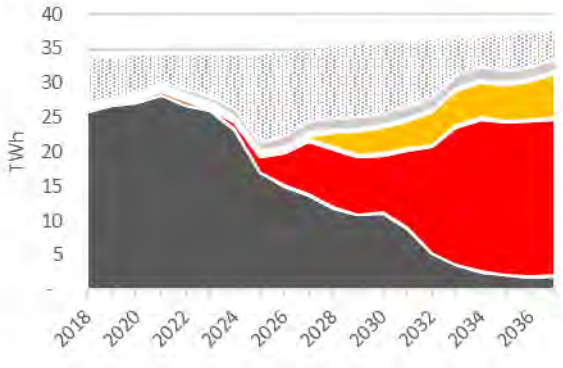

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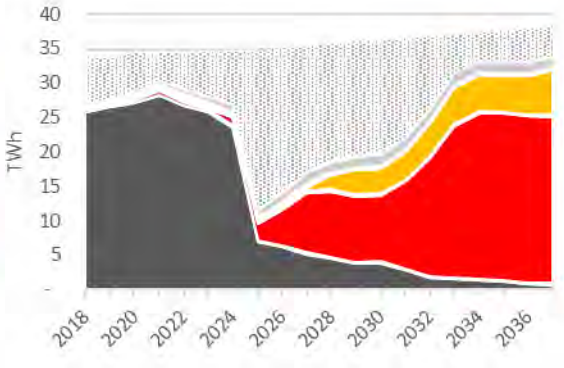


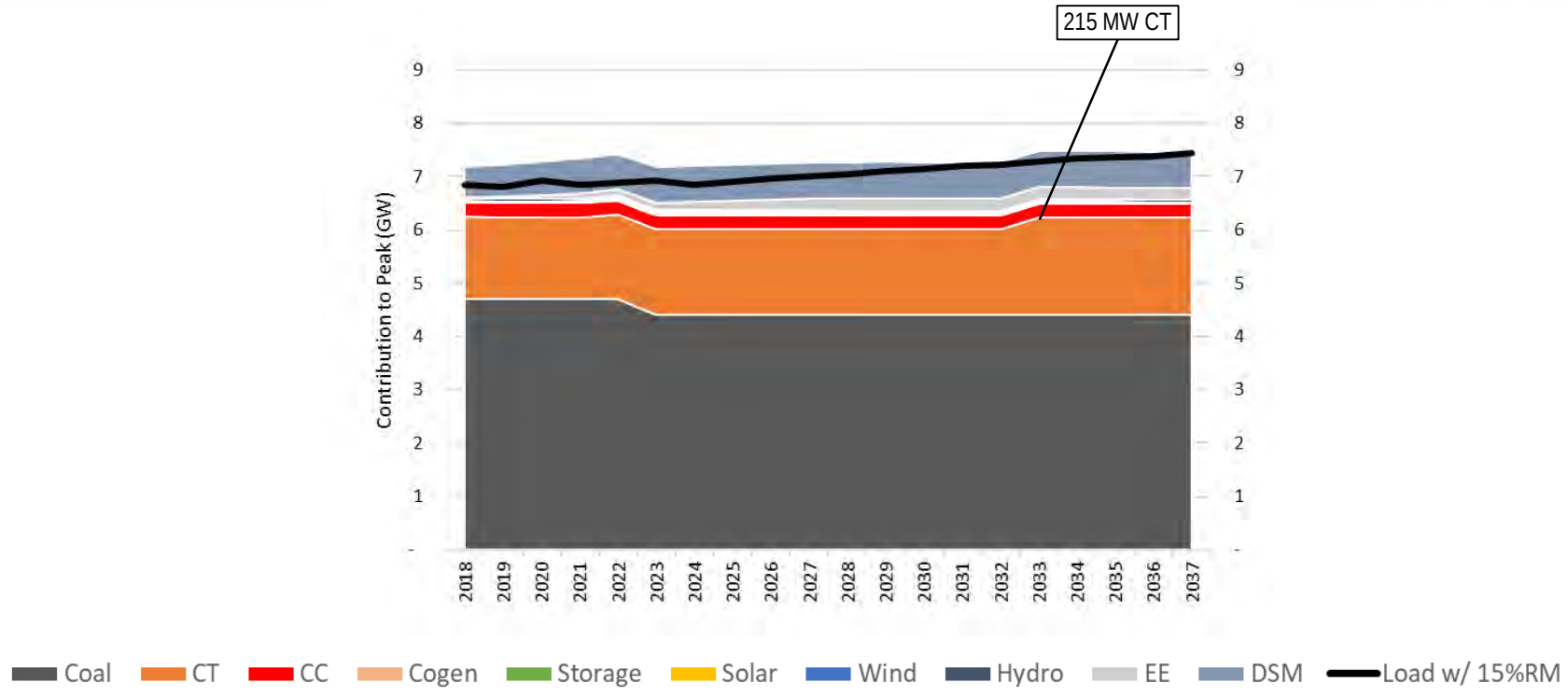
Coal CT CC Cogen Solar Wind Hydro EE DSM Net Mkt Purchase

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

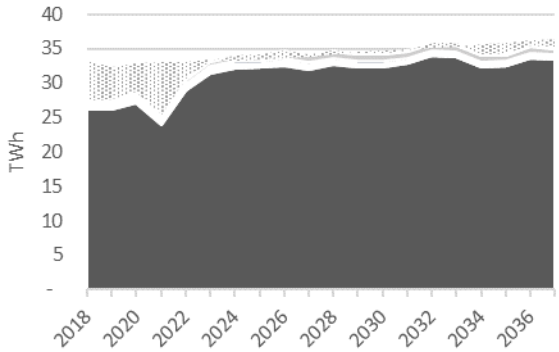
Observations
- CC and solar additions lag carbon price, resulting in substantial market purchases in mid-2020s
- Market reliance diminished as CC capacity ramps up

Current Conditions Portfolio



Current Conditions Energy Mixes

Slower Innovation Scenario



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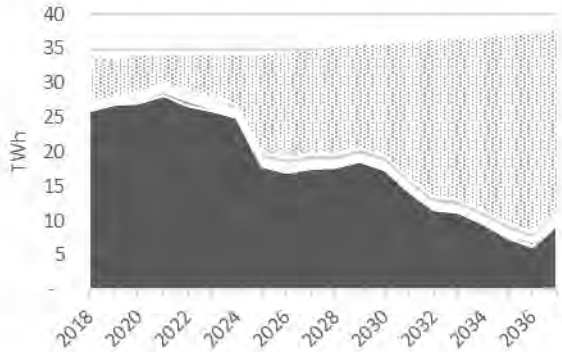

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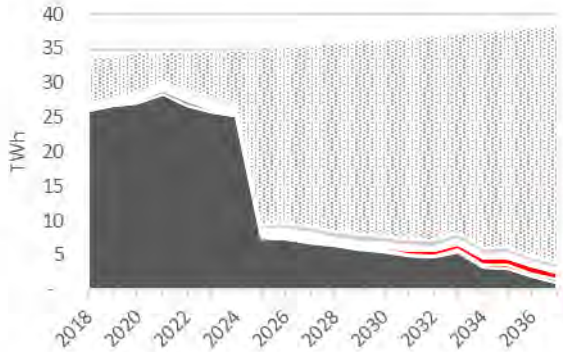

Coal CT CC Cogen Solar Wind Hydro EE DSM Net Mkt Purchase

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

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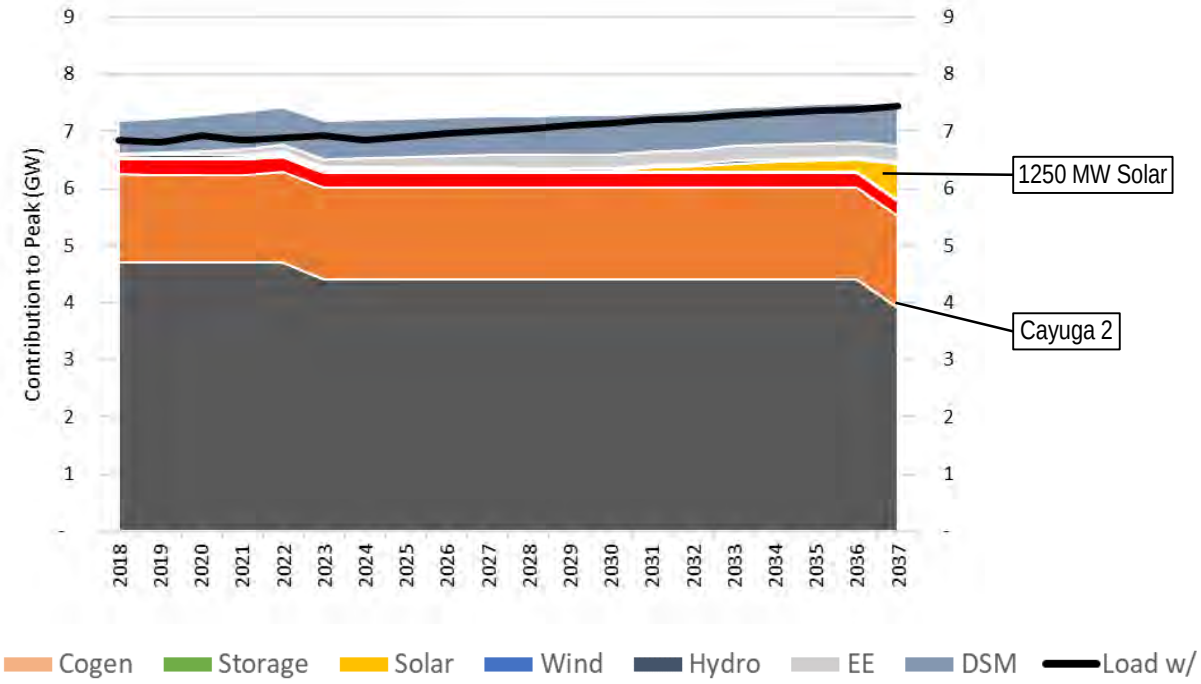
Reference w/o CO2 Reg Portfolio



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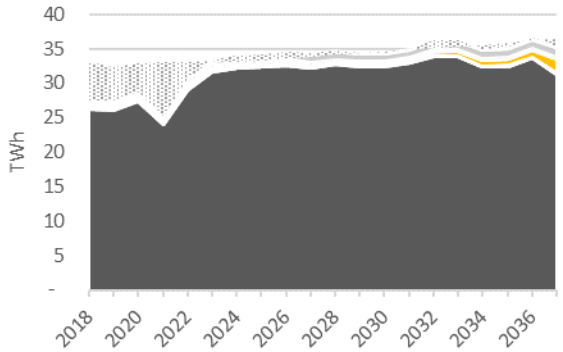
DUKE ENERGY

Reference w/o CO_2 Reg Portfolio Energy Mixes

Slower Innovation Scenario



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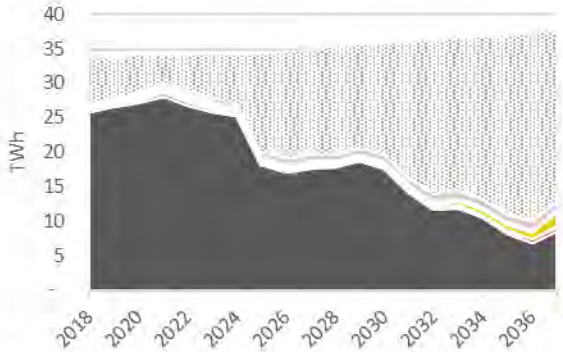

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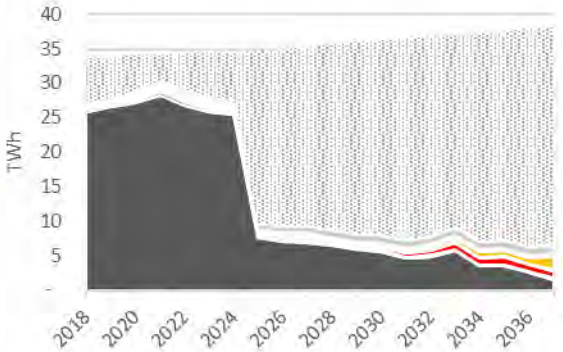


Coal CT CC Cogen Solar Wind Hydro EE DSM Net Mkt Purchase

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

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

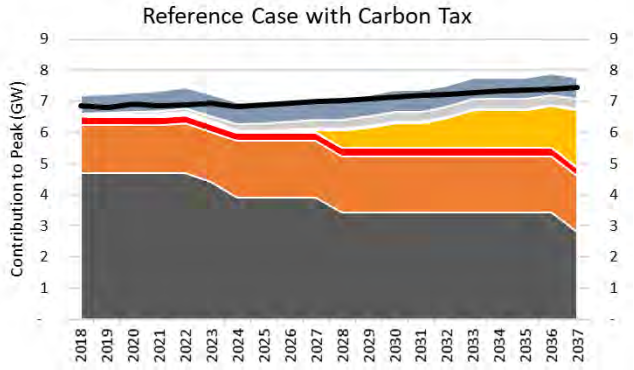
High & Low Load Sensitivity

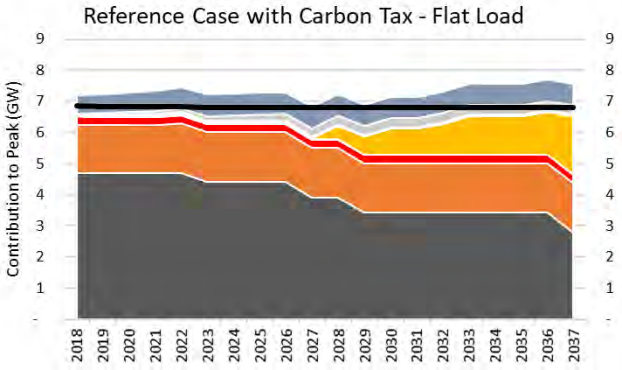
- High and low load sensitivities primarily conducted via scenario analysis:
  - High
    - High Tech Future scenario load forecast CAGR ~15% higher than Reference scenario
    - Slight acceleration of new capacity additions – choices driven by other factors (CO_2 tax, gas prices)
    - Additional energy 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%

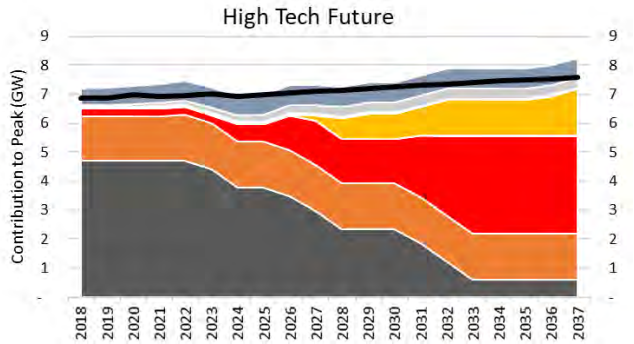
CAGR	Reference	Slow Innovation
MW (Peak)	0.47%	0.39%
MWh (Energy)	0.58%	0.49%

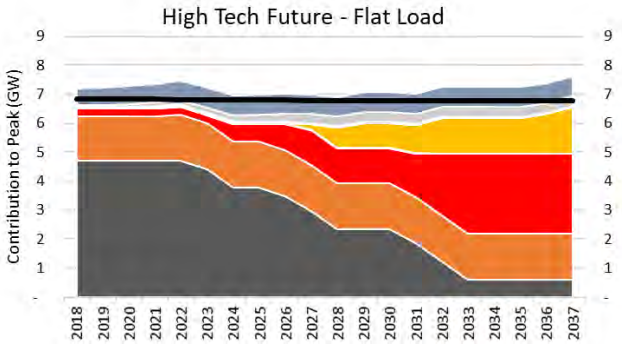
Flat Load Sensitivity





- 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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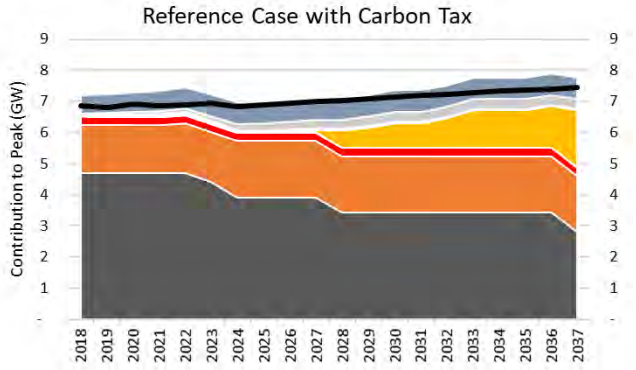
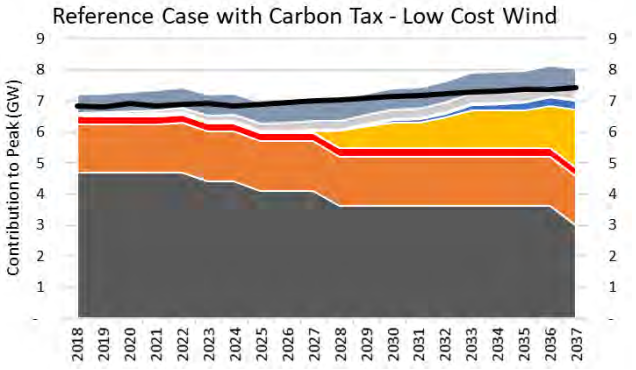
Low Gas Cost Sensitivity

- 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

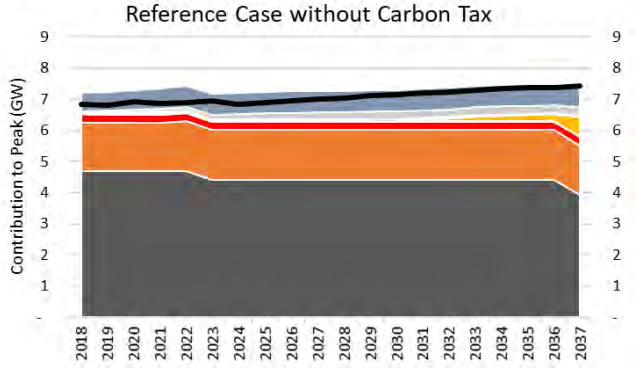
Low Cost of Wind Sensitivity

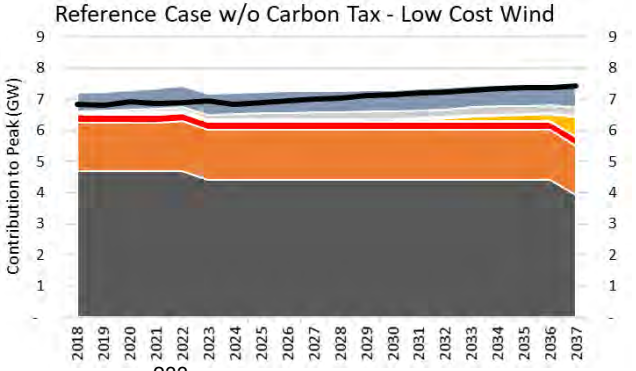




- Adds 2250 MW wind from 2029-2037
- Slight change in coal retirements
- Solar build reduced by 50MW

Wind capital cost reduced by 25% from base assumption





- No change

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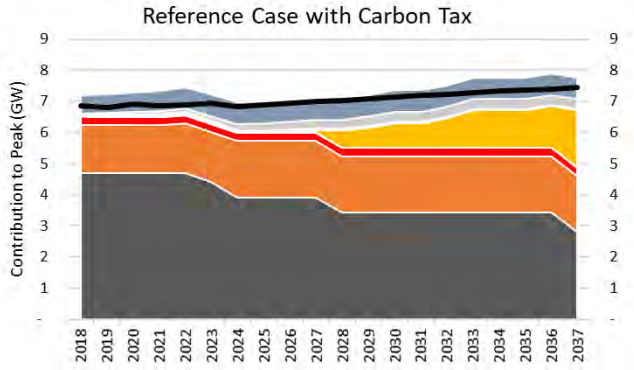
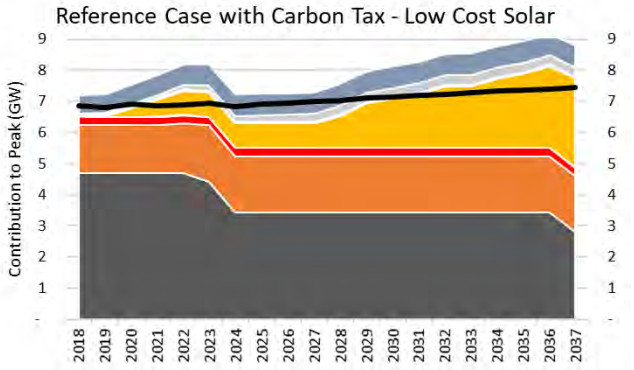
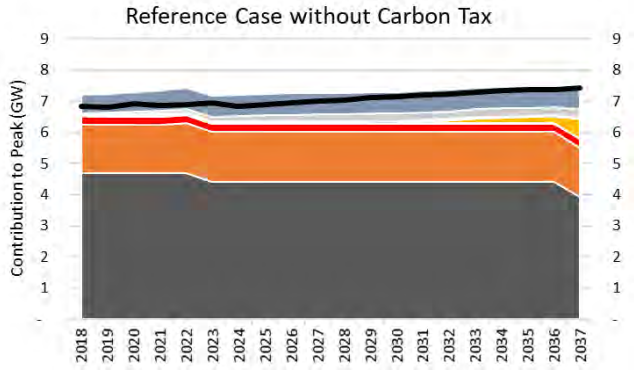
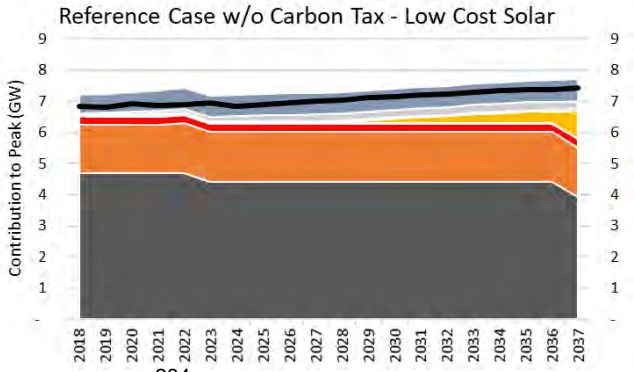
Low Cost of Solar Sensitivity





- 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

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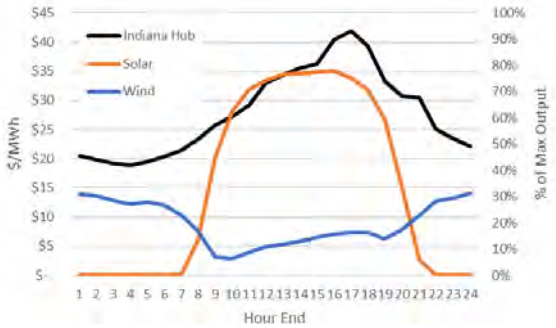
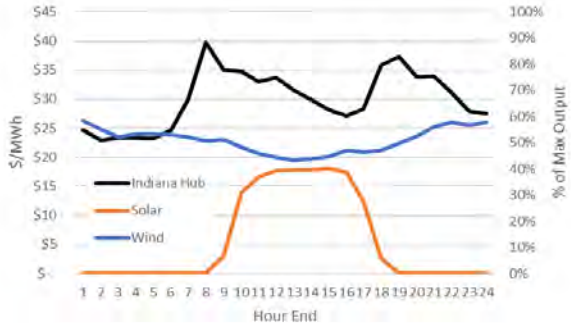
Economics of Wind vs. Solar

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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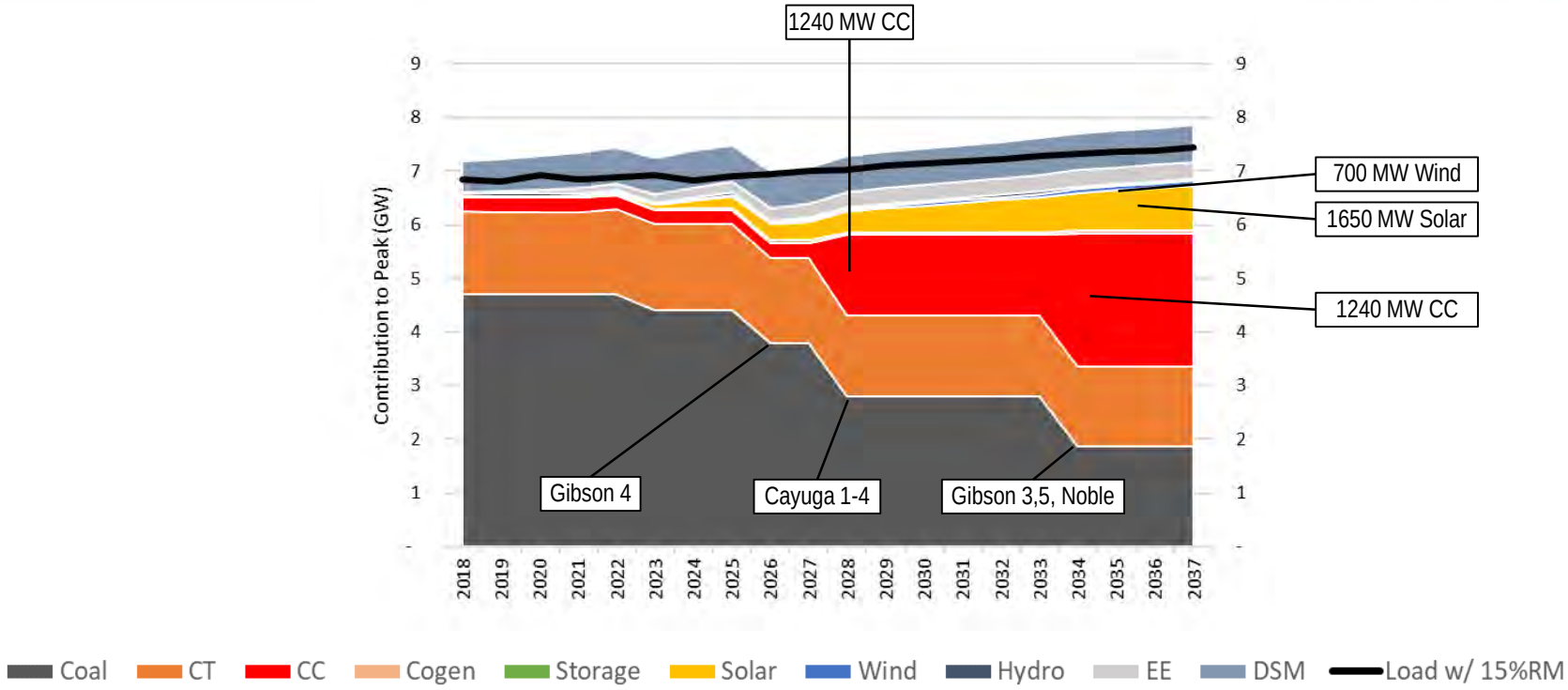
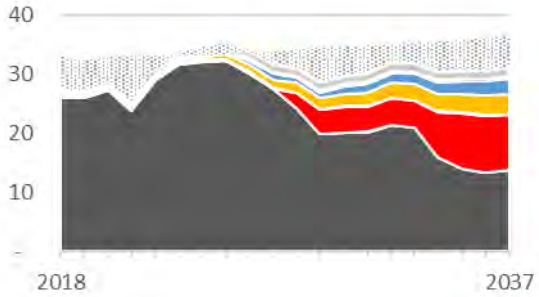
Moderate Transition Portfolio

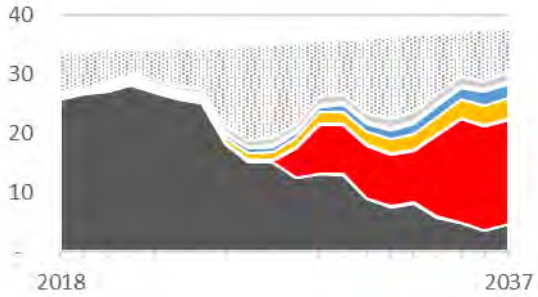


Moderate Transition Energy Mixes

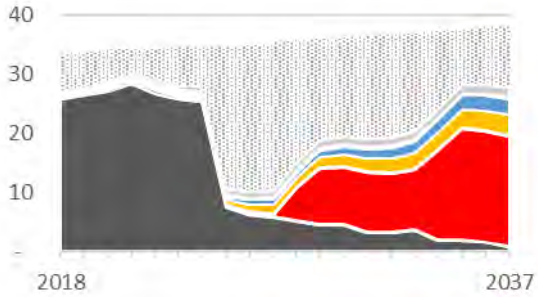
Slower Innovation Scenario



Reference Scenario



High Tech Scenario



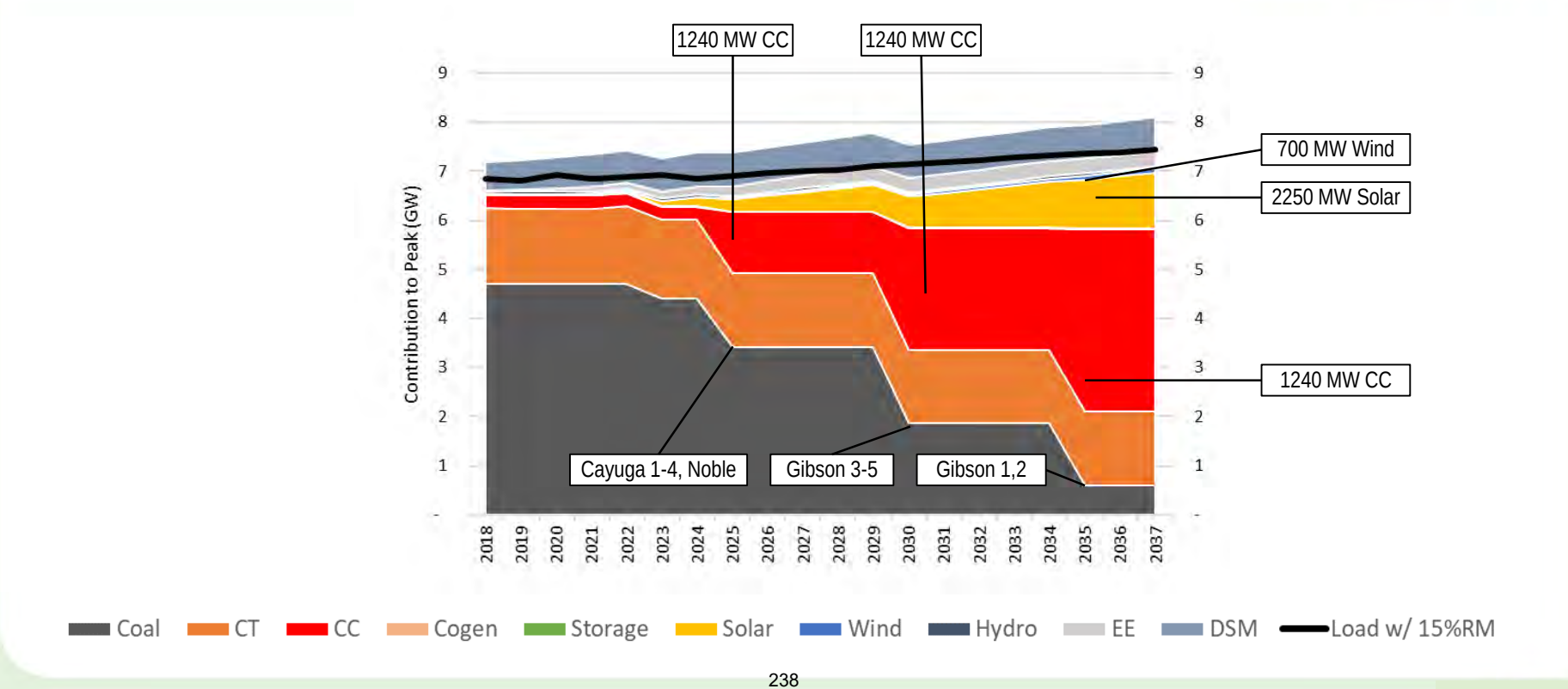
Coal CT CC Cogen Solar Wind Hydro EE DSM Net Mkt Purchase

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

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

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



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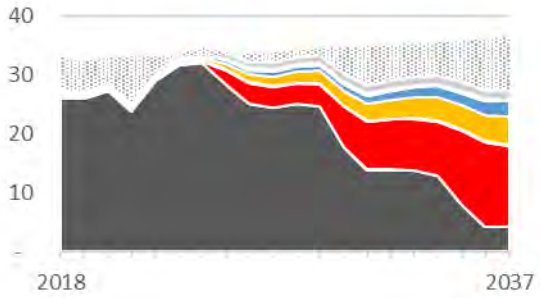
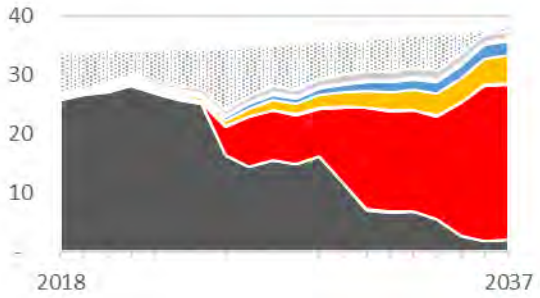
Aggressive Transition Energy Mixes

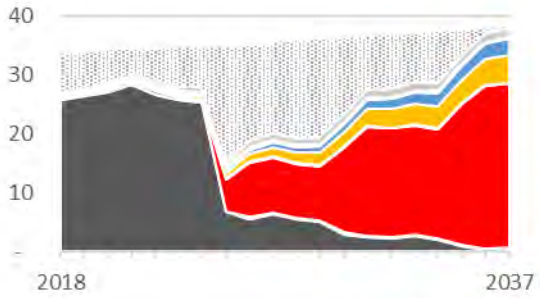
Slower Innovation Scenario



Reference Scenario



High Tech Scenario



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

Observations

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

Observations

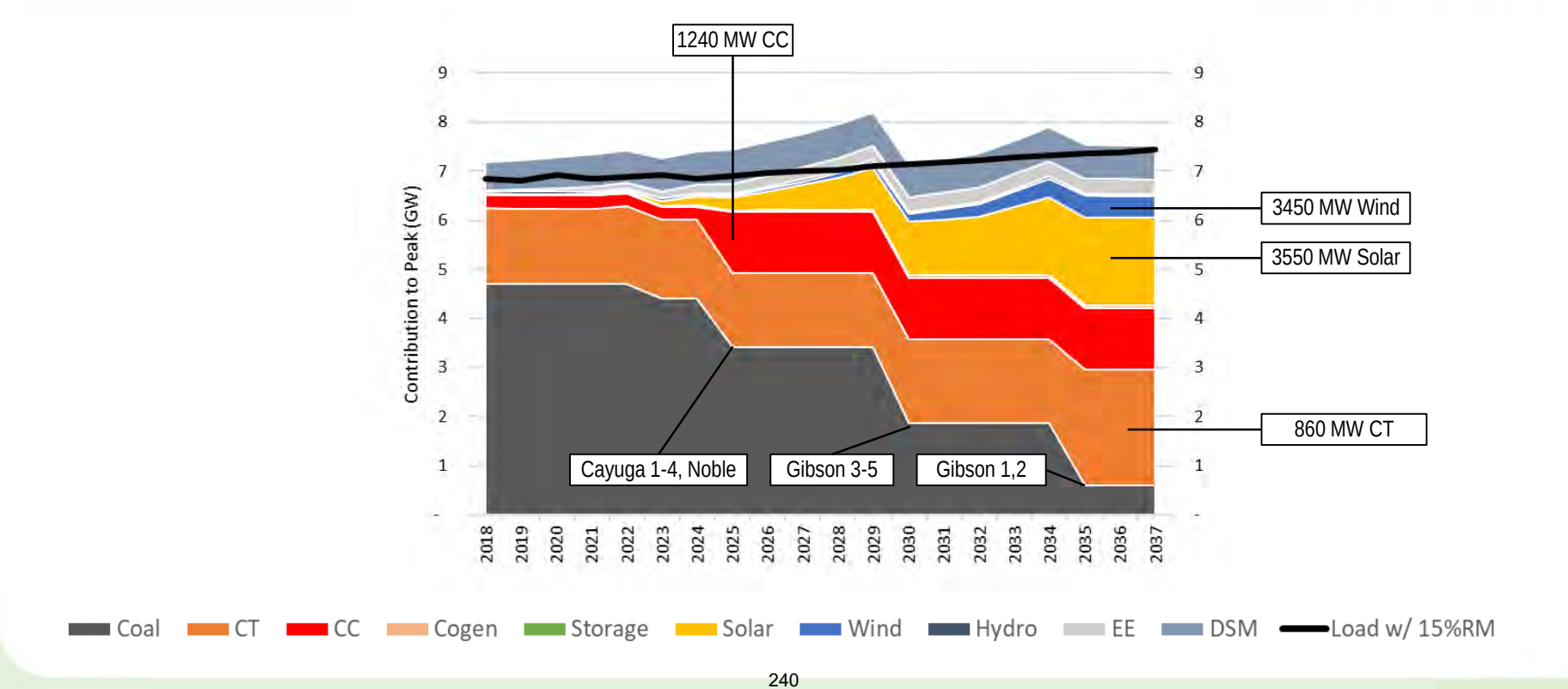
- Market purchase increase due to 2025 CO_2 tax is mitigated by 2025 CC build
- CC and renewables build increasingly displaces market purchases through 2030s

Observations

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

DUKE ENERGY

Rapid Decarbonization: CT Portfolio



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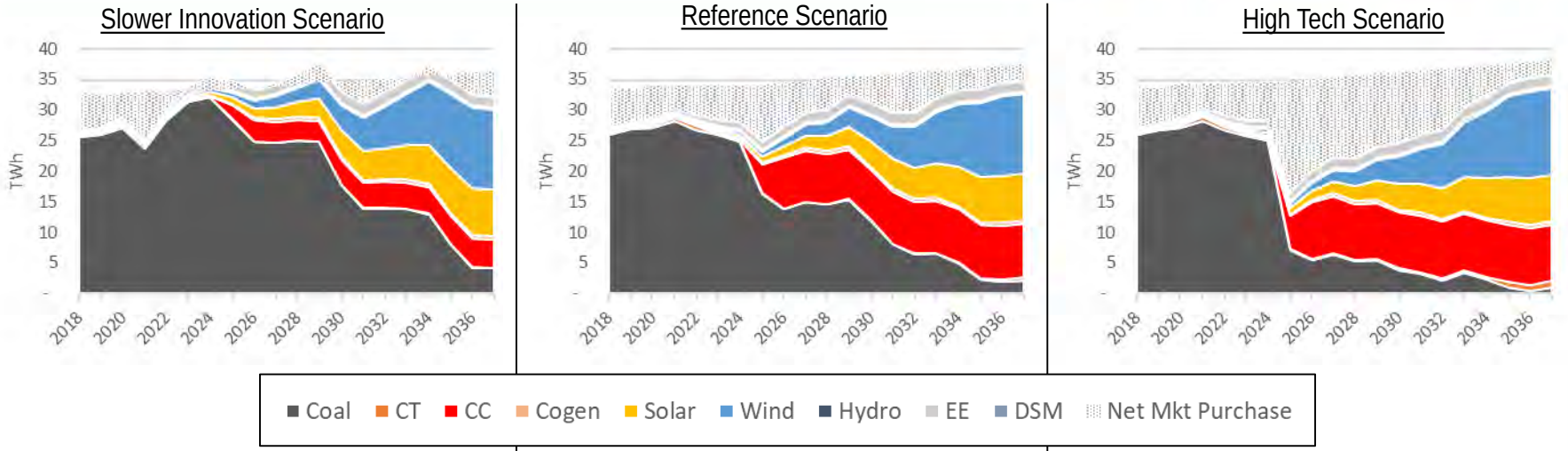
Rapid Decarbonization: CT Energy Mixes



Observations

- 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

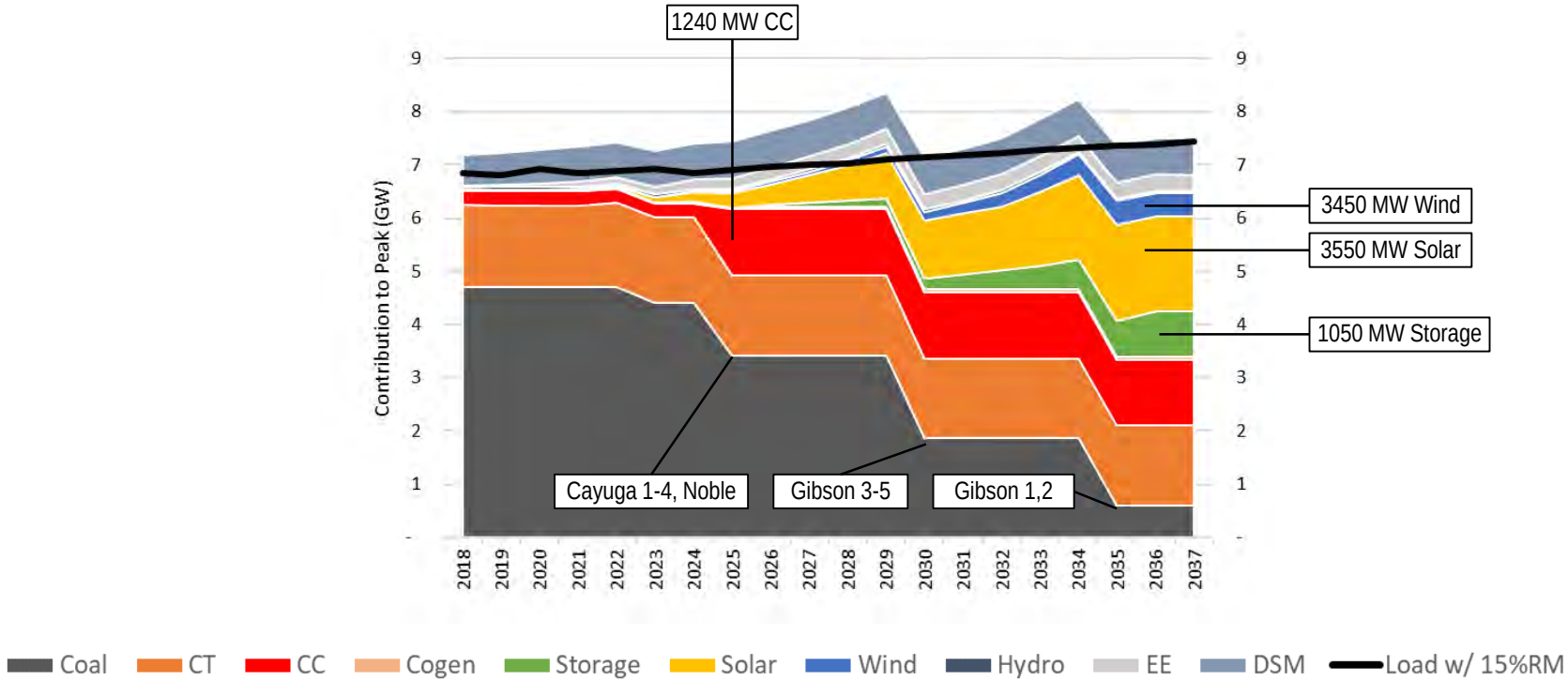
Observations

- 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

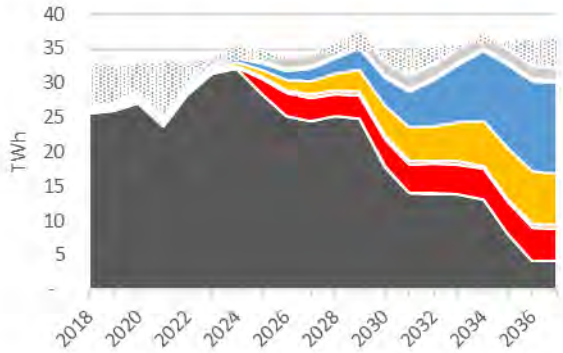
- Coal Generation declines sharply upon enactment of higher CO_2 tax
- Loss of coal generation replaced initially with market purchases and CC. Renewables displace market by mid 2030s

Rapid Decarbonization: Storage Portfolio

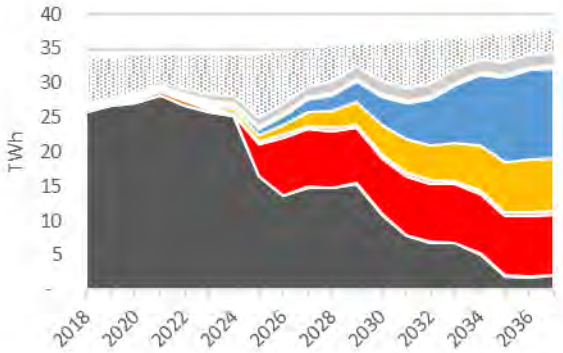


Rapid Decarbonization: Storage Energy Mixes

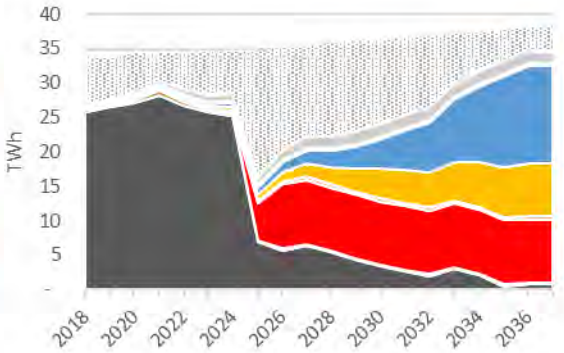
Slower Innovation Scenario



Reference Scenario



High Tech Scenario



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

Observations

- Decline in coal generation generally follows retirements
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Observations

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- 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

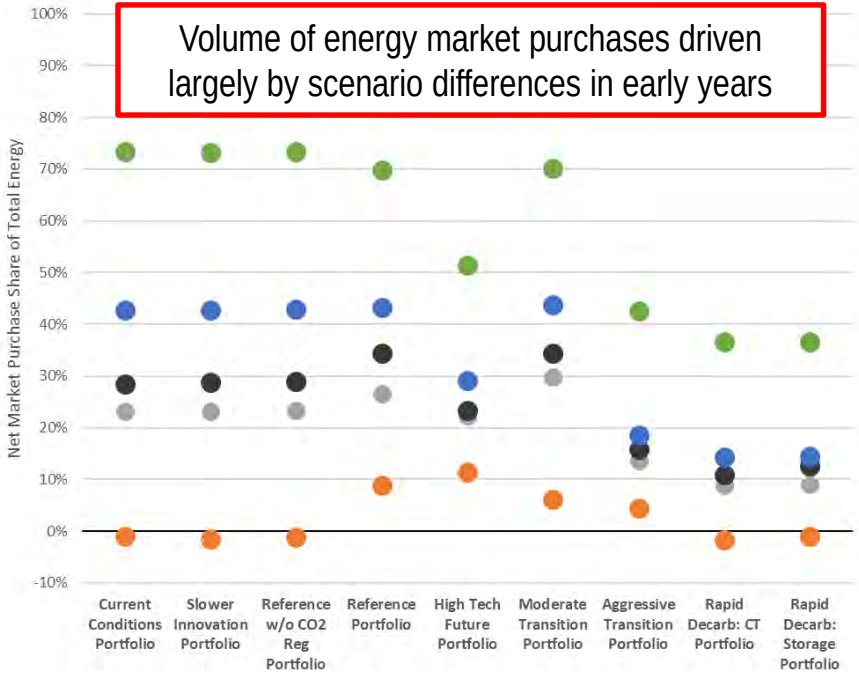
Nate Gagnon– Lead Planning Analyst

Modeling Results – Market Purchases, CO2 Emissions & Cost

Market Purchases by Portfolio

Net Market Purchases in 2027

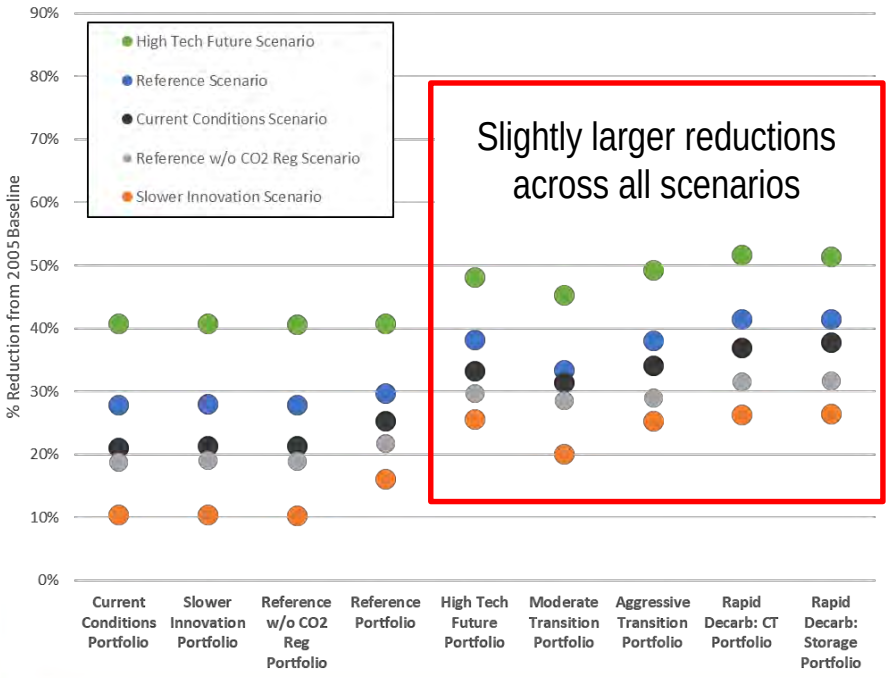
Volume of energy market purchases driven largely by scenario differences in early years



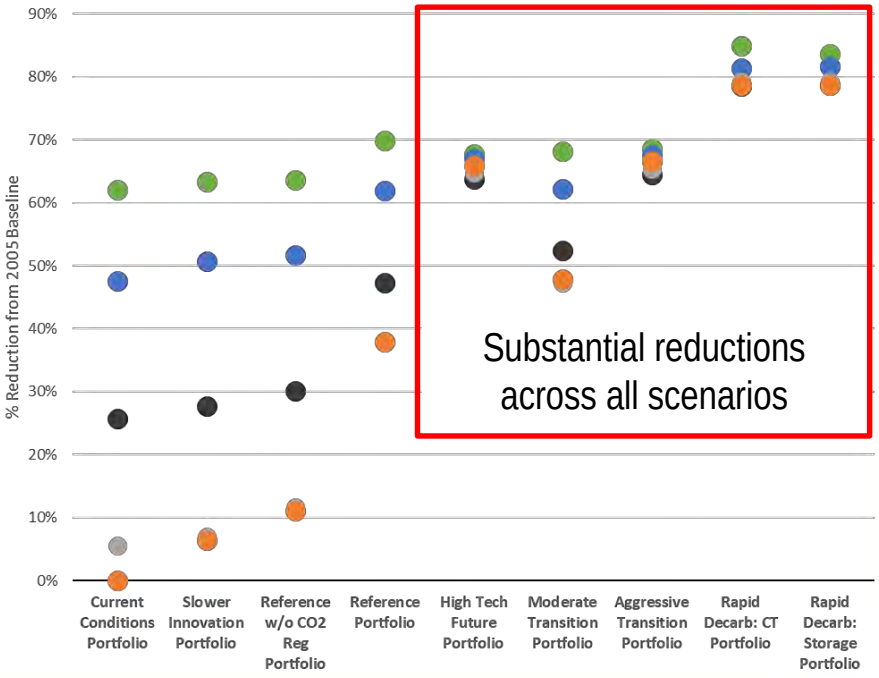
Net Market Purchases in 2037

CO_2 Emissions Reduction by Portfolio

Reduction by 2027 from 2005 Baseline



Reduction by 2037 from 2005 Baseline



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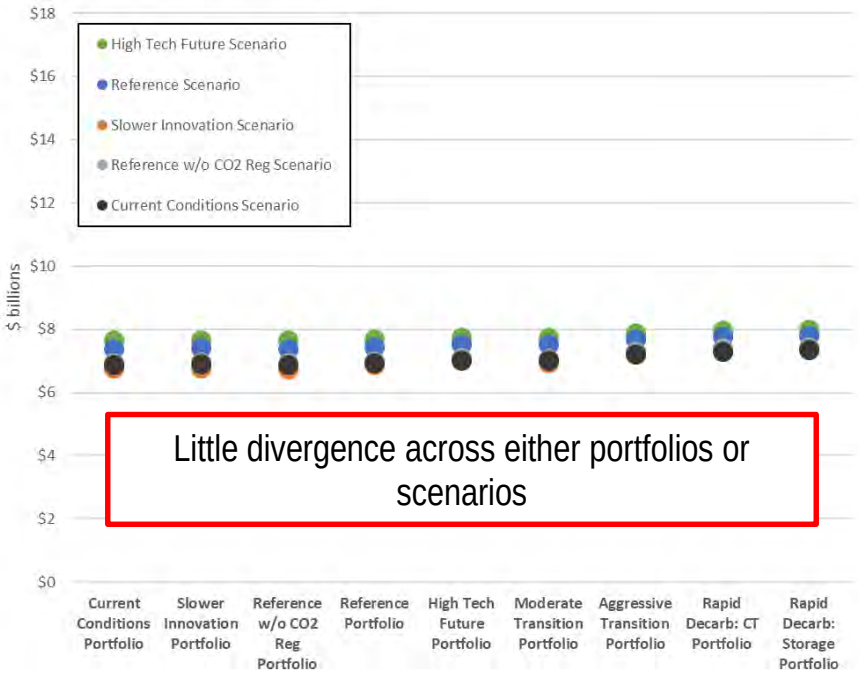
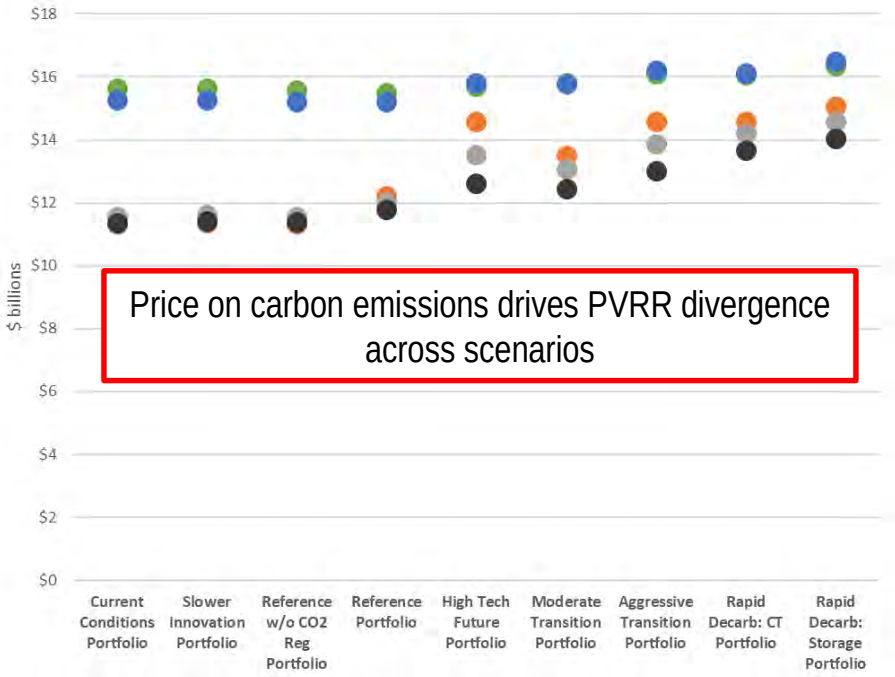
PVRR by Portfolio

Investments Through 2027



Little divergence across either portfolios or scenarios

Investments Through 2037



Price on carbon emissions drives PVRR divergence across scenarios

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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

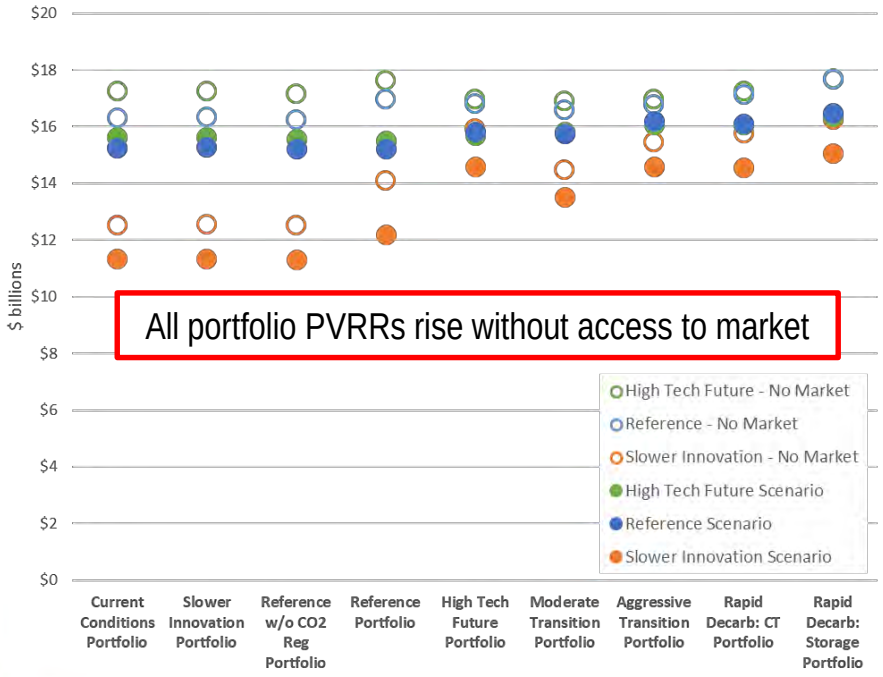
Risk Sensitivity Analysis

Sensitivity Analysis

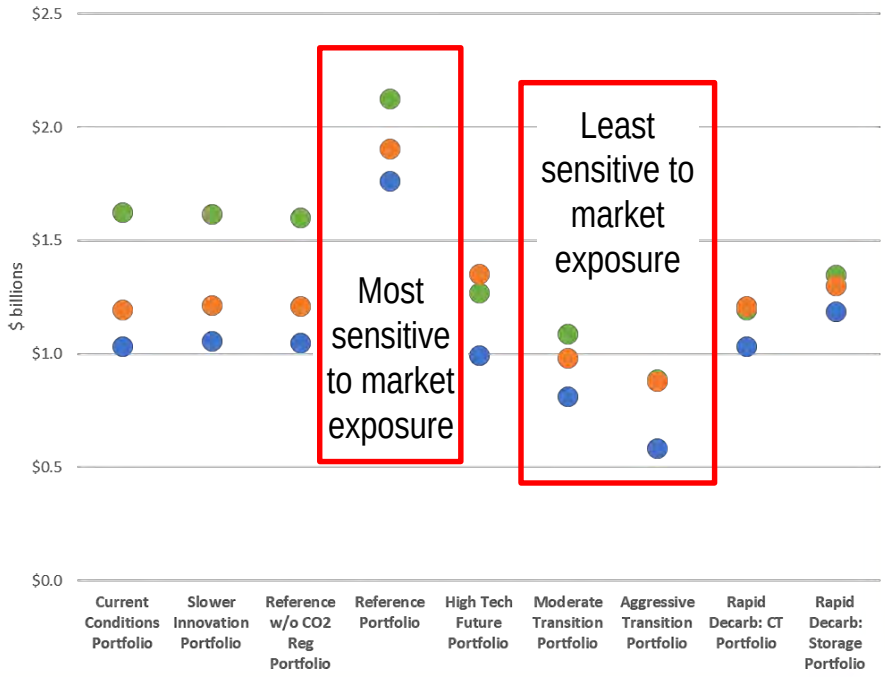
- In addition to the 45 combinations of portfolios and scenarios analyses, sensitivity analysis was performed to test each of the portfolios on:
  - Market purchase exposure
  - Social Cost of Carbon

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.

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

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

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

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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	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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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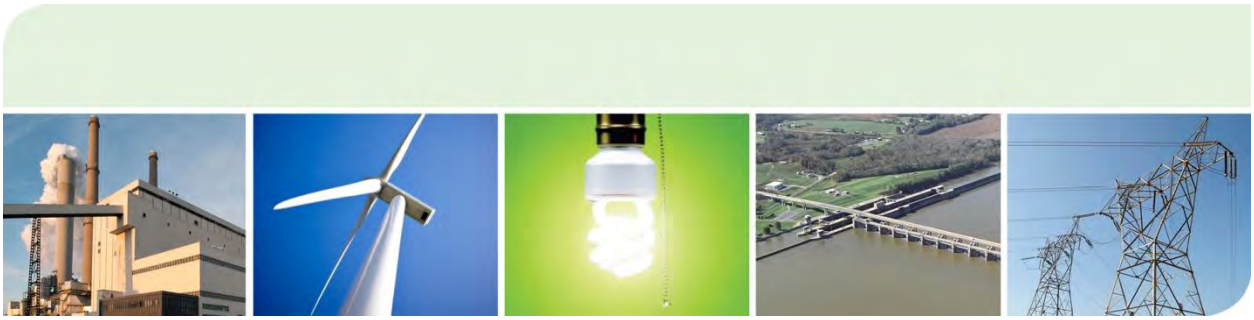
Retirement and Addition Summaries

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	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-



Duke Energy Indiana 2018 Integrated Resource Plan

Stakeholder Workshop #5 Summary
May 30, 2019

Meeting Begins at 9:00am

Welcome and Introductions
Scott Park, Director IRP Analytics – Midwest
Stan Pinegar, State President – Indiana
Heather Quinley, Director of Energy Affairs & Stakeholder Engagement

Scott welcomes everyone to the fifth stakeholder meeting that will be focused primarily on modeling results. He covers safety and the event center location. He mentions the Wi-Fi and instructions on how to get logged in correctly. Scott hands the meeting over to Stan for a welcome.

Stan welcomes everyone and thanks everyone for attending. He acknowledges the importance of this process and welcomes input and healthy dialogue throughout the entire process. Stan notes that we plan to file the IRP on July 1. He looks forward to the discussion today and reminds that we have another opportunity in a couple of weeks to continue the discussion. Lastly, he appreciates the engagement throughout the process and continue and after we file preparing for the next IRP Cycle. He encourages everyone to be engaged and turns it over to Heather Quinley.

Heather welcomes everyone to the fifth of six stakeholder meetings and starts introductions starting with those in the room followed by those on the phone. Once the introductions have been completed, Heather hands the meeting back over to Scott.

Why are we here today? and Agenda
Scott Park, Director IRP Analytics – Midwest

Scott proceeds to slide 3 to cover the reasons we are here today. The topics for day include recapping the fourth meeting (December) and responding to the comments/questions. There will be a review of the main topic from the last meeting, optimized and alternate portfolios. The main topics to be covered during this meeting are modeling results.

Scott then moved on to the agenda on slide 4 and the timeline of the day. He asks if there are any questions at this time on the agenda. There are no questions or comments at this time.

Review of December Meeting & Activities since December meeting
Scott Park, Director IRP Analytics – Midwest

Scott recaps the fourth stakeholder meeting held in December on slide 6, which included an update on EE, scenarios and sensitivities, optimized portfolios, alternate portfolios, and the stakeholder portfolio exercise. Scott goes through the questions from the previous meeting on slides 7 and the responses from Duke Energy.

Stakeholder question: As a follow up to comment in the previous meeting that Duke should model capacity on a UCAP basis, newer technology might need different type of analysis for ICAP vs UCAP, especially as it pertains to Solar or Wind, etc. What are Duke's thoughts on using UCAP especially as it lends itself to new, intermittent resources?
Response: A reliability and capacity contribution to peak planning maybe necessary for newer technologies. We don't yet have a good idea of how to plan for that measurement across time, as more inflexible units are online, a higher reserve margin may be required to meet that. Making that assumption is not prudent at this time. Other analyses including Loss of load expectation can also be used to help us determine if we have enough control of the system with new intermittent resources.

Stakeholder question: IRP meetings with other utilities don't seem to have an issue with an EE Decrement. Why is Duke opposed to modeling EE this way? EE decrement is a tool that can be used to cost out the energy efficiency.
Response: We will continue to engage with other alternatives to modeling EE following this IRP Process, but Duke will not model decrement approach in this IRP process, in part because the costing referenced is based on how the decrement is applied and may not align to real world measures.

Stakeholder comment: There are concern over the aspects of the CAC scenario's modeling results. Apart from that, there are also fundamental issues with Duke MPS. Duke should be looking for better ways to model EE in the future including the decrement analysis. The stakeholder appreciates the commitment to continue to work on modeling options between now and the next cycle, but hopes they can find a way to more effectively implement cheap EE for customers sake, who will foot the bill for higher priced energy.
Response: We will continue to engage with other alternatives to modeling EE following this IRP Process.

Stakeholder comment: The stakeholder is glad there is no limitation on market purchases. The stakeholder would like to see the model with some of the scenarios presented today with the reserve margin in only applied during the peak month. The stakeholder states that there is an excess of winter capacity to be able to purchase energy when needed for the winter peak. Only holding the largely uneconomic capacity (as witness to winter purchase levels) to meet reserve margin requirement for the winter, restricts the model from retiring this uneconomic capacity.
Response: As we retire existing capacity and go with changing seasonally contribution to peak generation, the planning peak can actually switch to the winter. Therefore, it is necessary to plan for serving peak loads in the winter as well.

Stakeholder comment: The stakeholder feels strongly that both conceptional and technical framing of the planning period. 20-years is not appropriate. There is technical transform happening during this 20-year planning period and this process is not reflective of totality of process, especially recognition of the global, deep decarbonization and efficient electrification along with the technological transformation that will enable this. This fundamental issue need to be addressed. Premature retirements are more important than what we will replace with it. Ongoing operating costs of current units will be even more than replacement with new technologies. New modeling will need to be done with financial analysis and generation analysis to capture these impacts

On slide 8, Scott discusses the activities since the December meeting including working with stakeholders on developing their own portfolios, performing hourly dispatch model runs of all portfolios in each of the scenarios, and conducted sensitivity analyses for certain variables. Scott discusses the stakeholder provided scenario inputs and look forward to how we can address capturing complete and internally consistent scenario inputs in the future.

Stakeholder Comment: EMCC appreciates the work Duke has done. They believe Duke is opening the itself up in the right directions, but agrees we did not get all the way there this go around, but are getting closer.
Response: Scott agrees and creating a fully internally consistent scenario will help for the reasonableness of the outputs.

Review of Scenarios & Optimized Portfolios
Nate Gagnon, Lead Planning Analyst

On slide 9, Nate recaps the approach to scenario analysis and how the scenarios are used to analyze the performance of each of the portfolios in hourly dispatch models. He discusses the connective narrative behind the scenarios, and how that impacts the changes in quantitative inputs.

Nate asks for additional questions/comments.

Stakeholder statement: What is the carbon pricing in the mid and high cases?
Response: The mid carbon tax trajectory starts at $5 per ton of CO2 in 2025 growing at $3 per year throughout the study. The high carbon tax trajectory starts at $10 per ton of CO2 starting 2025 growing at $3 per year throughout the study.

Stakeholder question: Why is the low coal price forecast in high tech future scenario?
Response: The narrative of the scenario is that low gas price drives down demand from coal which in turn puts downward pressure on coal prices

Stakeholder comment: The stakeholder disagrees that coal and gas are corelated as previously stated. The stakeholder believes there should be a high gas price and low coal price scenario.
Response: Slower innovation case has steeply rising gas prices, with a relatively static coal price, that is only slightly higher than the reference coal forecast.

Stakeholder question: In current conditions, solar and wind is mid-priced. In Slower Innovation, does that mean the price is higher than in current conditions. The stakeholder doesn't understand why slower innovation would have higher priced solar and wind then today.

Response: The trajectory is higher forecast, but not necessarily higher than today. It is a decreasing price forecast in all scenarios over the next 10 years for solar, but for the high trajectory case, those prices decrease at lesser of a rate.

Nate follows up on the overview of each of the scenarios with the optimized portfolio and each optimized portfolio's energy mixes in the Slower Innovation, Reference, and High-Tech scenario. Nate discusses observations for the performance of each portfolios performance in each scenario in the hourly dispatch model.

Slower innovation

Stakeholder question: How is the model optimized? Cost only or other constraints? Can you provide the constraints?
Response: Yes, Duke will provide the constraints. The model optimizes on PVRR base on any constraints that the model has. For example, Gallagher is schedule to retire in 2022, but economic (optimized) retirement of other coal units is not eligible until 2024.

Stakeholder question: Slower innovation is both a portfolio and scenario?
Response: Correct. Each scenario has a portfolio that the model has optimized for that scenario inputs based on cost.

Stakeholder question: In the slower innovation scenario, why is this portfolio dominated by coal generation.
Response: In a high gas scenario with no carbon tax, the coal becomes the most economic to operate and generate power. Capacity factors and outputs would increase, because they are the most economic option.

Stakeholder question: What is the purpose of testing each of the portfolios the different scenarios.
Response: We run the portfolios in the different scenarios because are looking at which characteristics of a portfolio allow it to perform well across multiple possible futures.

Stakeholder question: Why are there so much market purchases?
Response: Apart from cost effectively serving load with our own generators, we can also buy and sell energy out of or into the MISO Market. In carbon tax scenarios with heavy coal portfolios, its more opportune to buy energy from the market than to generate with our coal assets and incur the costs of generating with carbon intense generators

Stakeholder question: Can you describe the load forecasts in these scenarios.
Response: Each is slightly different between Slower Innovation, Reference, and High Tech Future. Total energy demand in each scenario is fixed. However, in some cases, you will see some bump from the flat trend. Those are indicative of net seller in those years, generating above our annual load.

Stakeholder question: Lead time constraints for technologies consistent between all scenarios?
Response: Yes, all optimized portfolios has the same lead time constraints for each technology.

Stakeholder question: Was the constrain on retirement on coal units consistent?
Response: Yes, in optimized portfolios, coal units became eligible for economic retirement in 2024 across all scenarios.

Stakeholder question: The stakeholder observed no wind is built. This fact is one of the biggest issues from the stakeholder's perspective. The stakeholder sees this as a big issue in the model.
Response: Brian will get into this more later. Alternative portfolio addresses this lack of wind in the optimized portfolios. One item to note universally through models is the lack of feedback loops. Significant penetration of one type of non-dispatchable resource would likely dampen the incentive to build more as power prices during those time fall. Those additions on top of saturation during a certain time of day price strike could begin incentivizing the build of another resource.

Stakeholder question: With respect to the modeling of net market purchases, is there that much energy available in the market to purchase?
Response: We do the modeling to see how a portfolio in that scenario performs. We flag observations like high reliance on the market and address those risks, like there not being enough energy available at the purchased market price, in alternate portfolios and risk analysis. The risk of relying on the market is taken into consideration.

Stakeholder question: In this presentation it seems like we are only given the option of buying and selling energy. What about buying capacity at the market. Is that a lower cost scenario for customers?
Response: The portfolio of capacity is now fixed based on the scenario. When there is a need for capacity we will evaluate whether that capacity should be built or purchased.

Stakeholder question: Why are we buying so much energy from the market in the high tech future scenario?
Response: The slower innovation portfolio is optimized for a no carbon tax, high gas price scenario. If we end up a largely heavy coal capacity fleet in a high carbon tax and low gas scenario, we would buy energy from the market as it is the cheapest way to serve energy for our customers.

Stakeholder question: It appears that coal capacity factors rise quite a bit into the future. Are these capacity factors near historical levels? The stake holder mentions they have heard from other utilities that it's hard to dispatch with gas prices low. Is Duke not experiencing that?
Response: This is not the case for Duke Energy Indiana in MISO-IN Zone. We have not experienced this as much yet. Also, we continue to monitor that issue as it unfolds throughout time. Currently, Duke operates large, efficient, well controlled coal units that are still well positioned against the local price we are open to.

Reference Case Scenario

Stakeholder question: What real life concerns that you mentioned as additional factors that are not modeled? The biggest additional factor that comes to mind for this stakeholder is climate catastrophe, and it doesn't appear to be considered.
Response: Sequencing of retirement is one real world, additional factor that is not modeled. Engineering or operational insight is not captured in the model. The optimized portfolios shouldn't be taken as certainty in decisions, but rather cost informed sign posts for decisions on portfolio transition. These are least cost models, but the risk and sensitives begin to consider market exposure and CO2 emissions in the planning process. Also, engineering, procurement and construction lead times and transmission impacts of build or retirements are another example of real world constraints that may change if and when we transition the fleet.

Stakeholder question: How do solar and wind self-build compare to PPAs for solar and wind in terms of selection and cost. Can we assume that PPA is less cost than self-build? If so would we see solar sooner because of cost?
Response: For this analysis, the cost in the model are the utility owns option. Cost structure of a PPA versus a self-build is very different. PPAs are paid on an energy basis. When we build, it is on a capital investment basis. PPA is expensed over time. This analysis and decision will be considered when replacement capacity and energy is need when we do make retirement. When we do retire we will consider all viable options to replace the capacity.

Stakeholder question: In previous iterations of the optimized Reference Case Portfolio, Gibson 5 was retired. This version has a different set of retirements. The stakeholder knows there were some changes since then. Can Duke speak to why the order changed and the units retired are different.
Response: Both units at Cayuga and Gibson, have similar cost structures. However, with slight changes, one units might fit the model better than another in terms of size or cost. The overall retirement in this case highlights that these units are close in cost structure and resulting change in PVRR might not be that great.

Stakeholder question: Are there constraints driving the retirement dates? Is there any environmental deadline that is causing them to retire or restricting them from retiring?
Response: Nate suggests not to read too much into the specific years or sequencing. It's the general economics of a coal unit that should be the indication. We don't have some of the emissions control constraints that other utilities have. The decision in the optimized portfolios is based on economics, maintenance cycles, etc. Nothing forces the retirements other than economics of ongoing cost and production cost. There are no major environmental constraints causing the retirements of our coal fleet.

Stakeholder question: What is the original planning retirements of the coal units?
Response: The planning retirements of these units we're outside of the planning window in the previous IRP.

Stakeholder question: Are cost of transmission upgrades included in the analysis.
Response: No. Interconnection is included for new builds but bulk transmission upgrades are not included because these have not been sited.

Stakeholder question: Gibson 5 was previous indicated risk for retirement. We also understand that it is a jointly owned unit also, so retirement of that unit cannot be made unilaterally. How does that factor into the retirement decision making process?
Response: Correct, joint owners is another real-world constraint not in the model. Gibson unit 5 is the youngest of the coal units, but it has oldest scrubber, so that might also be one consideration when evaluating whether or to retire that unit compared to another.

Stakeholder question: Could Duke break out CCR and ELG costs? Can Duke clarify what units have those cost associated with them still?
Response: All ELG costs have already have been funded or complete and are not part of the decision-making process going forward. Any sunk costs are not considered in the model including for CCR. If any cost is "sunk" it is not part of the retirement decision. If a cost does include some upcoming infrastructure investment, that would be used in model for retirement.

Stakeholder question: There are looming environmental costs or retirement deadlines in 2023, but retirements in Duke's are not eligible until 2024. Why is that?
Response: Costs that we might need to incur are included. Costs that we will do regardless are not. Our units are well control assets that have likely complied already with all the restrictions you are referencing, but we can follow up afterword on specifics.

Stakeholder question: Previous notes say that Duke would consider showing a 5-year and 20-year PVRR. Which is being used in the modeling?
Response: Optimization is a based on the full study period of the IRP so it is a 20-yr PVRR. We also want to know how fast those impacts are hitting our customers, so we will take a look at shorter term PVRRs.

Stakeholder question: Are we looking at about the same load forecasts as the previous slides?
Response: Yes, all load forecasts are consistent for all portfolio in each scenario of testing.

Stakeholder question: We see how much market purchase we will have in any given year, but we don't know the market carbon intensity. Is that correct?
Response: We forecast an energy mix from the market. The market is heavier coal in the slower innovation scenario, and more gas and renewables in the reference and high-tech scenarios.

Stakeholder question: How is DSM and EE differentiated in the capacity charges and added throughout time in the model.
Response: In the capacity charts, there is separate colored sections between demand response and EE. Demand response is intended to be exclusively capacity. EE capacity is dependent on measure and its coincidence with the peak and is both capacity and energy. EE is selected in bundles of saving profiles and time bucket. DR is a fixed schedule.

Stakeholder question: Why is market purchase still high for the Reference portfolio in the Reference scenario, because that would indicate that either the coal units are that competitive or that the CCs are being built in the market to supply us with energy. Reference portfolio is optimized for this portfolio, but still has a significant amount of market purchases.
Response: Feedback loops of adding lower cost energy are a problem with most models. A 3rd party develops the expansion plans used in the develop of the power prices. Capacity expansion models have the foresight to look at the power price in to make the decisions whether to build and generate or simple purchase from the market to serve energy at the lowest cost.

Stakeholder question: What does the market here indicate? Spot? Real-time? Day-ahead? PPAs?
Response: The market prices does not represent long term PPAs. This is proxy for a real-time power price on an hourly basis, but the model has perfect dispatching to know how to commit and dispatch units based on load and power prices.

High Tech Future

Stakeholder question: On slide 13, the Reference portfolio has more solar than the High Tech Future portfolio. Why is that? The stakeholder doesn't understand why that happens if solar technology costs are cheaper in High Tech Future scenario and a higher carbon tax.
Response: There is lower cost solar available and higher carbon tax, but a greater capacity need is created through the retirement of the current coal assets and lower gas prices in the scenario, the economics of gas improves as renewables does. Overall the model selects more gas, and backs down

renewables some because it has more capacity contribution and more energy for the price. While the economics of renewables are improving, the economics gas capacity is also improving.

Stakeholder question: With respect to the reliability of gas capacity compared to solar in previous response. Is that a constraint in the model?
Response: The reliability of solar is in the model only in the sense that we need to meet reserve margin. Solar does not receive capacity the in the winter months and only 50% of nameplate in the summer. Gas gets considerably higher percentage year around.

Stakeholder question: If solar has no capacity in the winter, then why isn't there wind being select?
Response: Those observations make sense, but as the model looks at it, Gas CC make more economic sense than then wind.

Current Conditions
No questions or comments

Reference Case without CO2 Regulation
No questions or comments

Nate concludes this section with overall take-aways from the optimized portfolios. Nate asks for additional questions/comments. There are none at this time.

Initial Sensitivity Analysis & Development of Alternate Portfolios
Brian Bak– Lead Planning Analyst

Brian covers slide 23, Discussion of Modeling Results. Brian reiterates why we create optimized portfolios. He then explains why we create alternate portfolios, and what considerations we consider when moving from optimized portfolios to alternate portfolios.

On to slide 24, Brian discusses the high and low load sensitivities and the implications to the optimized expansion plan. He then expands on the topic to flat load. Brian explains how this sensitivity, in general, compresses or stretches out the expansion planning, but does not change the technology selection overall.

Stakeholder question: The stakeholder states that there have been considerable losses of wholesale load for Duke Energy Indiana, however, the load forecasts are flat or increasing. CAC has flagged this as a concern. That stakeholder would like to know when Duke will know definitively when wholesale contracts will be announced if they are renewed or will not be renewed?
Response: All known wholesale losses are reflected in our load forecasts. Wholesale losses are a downward impact; however, we still have slightly increasing natural load growth in residential which may, in the near-term, net out to flat or slightly positive load growth. Account managers are always on ingoing discussion with our wholesale customers. When each contract nears the end of its term dictates lead time to plan on that load.

Stakeholder question: The Stakeholder notes a discrepancy on the solar additions for high tech future portfolio? The pervious slide showed less than the current slide.
Response: We will check and let you know at break.

Lunch Break from 12:00noon – 12:30pm

Slide 28 covers the low gas sensitivities in the High Tech Future and Current Conditions scenarios and the impacts to the resource plan. Brian then discusses on slides 27 and 28 the impact of low wind cost and low solar cost on the expansion plan. He notes the roles that carbon tax plays on the selection of the resources, regardless of low price sensitivities. With respect to the stakeholder engagement discussions, solar is consistently selected over wind, and Brian discusses why that is on slide 29.

Stakeholder question: In these runs, does the capacity value of wind change throughout the year?
Response: No, it is 13% year around.

Stakeholder question: This is done on ICAP basis, correct? The stakeholder appreciates the consideration of UCAP, but they do want the capacity plans developed on this basis.
Response: Yes, it is done on an ICAP basis.

Stakeholder question: Why isn't wind being selected? Are we limiting the modeling by not being sufficiently imaginative by combining renewables packages for lowest cost options? The stakeholder also adds that the market is diluted with prices that are not true market with self-commit, must-run requirements.
Response: These are more modeling results and optimized for cost. The lack of wind in the optimized portfolios doesn't mean we are not considering wind. We see value in wind and solar together. All of the alternate portfolios that will be present in the upcoming slides do have wind in the portfolio mix. When these are added, they would be considered under self-build or PPA options. We are continuing to look into solar and storage pairing, and a resource mix that could lend itself to this. Additionally, we worked with our dispatch groups to try and get realistic dispatching in current market conditions.

Stakeholder question: Is Duke doing a comprehensive emission valuation of natural gas with respect to CO2 and methane from production though plant emissions?
Response: No, we are only capturing the emissions of the plants. Nothing upstream is considered in these analyses. The stack CO2 emissions are supposed to be a proxy for overall emission potential of a portfolio.

Stakeholder question: How are future impacts of CC emissions factored into the analysis, especially ones that will outlive the study period. How are you handling the CO2 emissions of that going out further?
Response: We are only looking at the emissions and impacts in the study period.

Stakeholder question: With not allowing retirements until 2024, do you feel that there would have been an opportunity to retire more coal units, if the replacement solar would have been able to take advantage of the Tax credit situation? How is that impacted and impacts retirements not allowed until 2024?
Response: The earlier retirements might be affected, but again we are limited on how much solar we can build at one time and replacing a large coal unit require a lot of replacement capacity. The model still could select these tax incentivized units, but it doesn't not.

Stakeholder question: Can you provide us some background information on energy storage's part in the model?
Response: Energy storage is available for selection. Standalone battery costs are still relatively high on storage. The current market rules are not fully capturing the value of storage, which leave us with less justification for them. Price arbitrage is the only recognition it gets at this point. Another hurdle battery storage has to overcome is that the model can essentially treat the market as large battery. We do include battery storage in an alternate profile.

Stakeholder question: Thank you for including the low solar costs sensitivities in the IRP analysis. What would it take for Duke to view this cost solar profile as reality or the base assumption and not sensitivity?
Response: The base assumptions for solar costs are developed working with 3rd party consulting groups including Navigant. We did use the media sourced sensitivity costs. We fully understand what's in the cost from our 3rd party providers, which is essential for consistency in our model. When those market proposal prices are validated and normalized in our vendors data, we will see that reflected in our model inputs.

Stakeholder question: Are the drop offs for the investment and production tax credits factored in?
Response: Yes, the expiration and extension and eventual expiration of tax credits is included in all of our runs.

Stakeholder question: This stakeholders group asked us to make a run without solar as an option to see if wind was selected. In these runs wind was still not selected. The reserve margin requirement is enforced in all months which might change the selection of resources from holding on to uneconomic coal units for capacity to selecting more low-cost energy production machines and buy the remainder from the cheap market.
Response: Looking at trade off capacity requirements with capital and energy, The model picks gas over wind. The alternates address this because we do see value in low cost energy production generators such as wind.

Stakeholder question: How are the generic unit characteristics developed? Do you feel a 20-year useful life for wind is appropriate?
Response: Burns and MacDonnell are our generic unit characteristic providers along with insight on other resources from Navigant. We rely on their expertise on those generic characteristics.

Stakeholder question: These runs are still dispatching on an hourly basis and not a purchase power agreement basis. Because the graph only shows grey for market purchases so we don't know if those market purchases are wind, solar, gas, coal, etc.
Response: Market purchase are hourly. The economics of solar versus wind builds are on a life of the asset basis. We do see the prices that drive that.

Stakeholder question: For sensitivity analysis, the stakeholder would like to see, as a consideration as a Duke customer, a range for carbon pricing. The prices we are using start out way too low.
Response: The start is low, but it does have a higher growth rate than most and reaches some high levels by the end of the period.

We then move into discussing the alternate portfolio, those developed by Duke energy with certain resource selections to address certain concerns that we observe in the optimized portfolios. The

capacity and energy mixes of Moderate Transition, Aggressive Transition, Rapid Decarbonization with CTs and Rapid Decarbonization with Storage are discussed on slides 30 to 37, with observations of performance for each noted. A preferred portfolio should be flexible and robust portfolio that can react to changes in the market as well. Some of our alternatives also consider some real world considerations that we would look at in wholistic planning for these sites and replacements.

Moderate Transition

Stakeholder question: Is there storage in this portfolio?
Response: No, but you will see it in the last portfolio we present.

Stakeholder question: Solar Trade press in PV Magazine noted that Ranger Power signed with Wabash Valley. The article and author reference solar interconnection que in MISO. There are 9,500 MW in the cue. So, Duke should also be looking at potential for PPA. How do you use what's happening now and factor that into the model?
Response: The cue doesn't play into the model, but the modeling does including the pricing for the low cost of solar sensitivity. Once our 3rd parties continue to recognize these declining costs, they will show up in the modeling as they are incorporated into their data set.

Stakeholder question: Natural gas CT portion shows up as a significant contribution to peak slides, but does not show up in energy mix. What's going on there? Why is it not showing up?
Response: In general, that means that even with the lower gas prices in the future, these natural gas CT units' generating prices are not competitive to the market price available.

Stakeholder question: Bundling wind, storage, and solar, with a peaking unit to collectively enable more renewables seems like it should be a good way to leverage renewables with backed up capacity. Having a low gas peaker with short term response, and avoiding high capital expenditure with a large CC could be a good solution
Response: Yes, Duke agrees that there is some value to a portfolio as such and our decarbonization portfolios address that.

Stakeholder question: Did Duke solicit RFI or RFQ to compare to our generic unit assumptions like NIPSCO did?
Response: When we look at adding resources we will certainly perform FRIs and RFQs, but until then we will rely on our generic unit information from our 3rd party provider.

Stakeholder question: Looking more at retirement analysis rather than addition analysis, should be looking at RFI or RFQ into account in these analyses. Not to meet near term load, but retirement of uneconomic stations.
Response: We are looking to prepare to transition the fleet. A more aggressive retirement schedule gets us in position to change and replace capacity and generation soon. There could be value it, but that process can give misleading results. As we get closer to fleet transition, we will do that and could incorporate RFIs and RFPs into the future IRPs as we get nearer fleet transition.

Stakeholder comment: The stakeholder thinks NIPSCO did a good job with their RFP and wants Duke to know we could be missing out in transition fleet earlier and rate payers could be footing the bill to delay transition.

Aggressive Transition

Stakeholder question: Is there storage in this portfolio?
Response: No, the slim line you are seeing 700 MW of wind, but because of the small contribution to peak, it does show up as a small sliver. Storage shows up in the last portfolio.

Rapid Decarbonization: CT
No comment or questions

Rapid Decarbonization: Storage

Stakeholder question: Is it safe to assume this locks in retirements?
Response: Yes. This portfolio locks in the retirements in certain years.

Stakeholder question: Are these rapid decarbonization portfolios proxies, for the EMCC and CAC portfolios? Will this be part of the IRP filing? There were numerous issues and concerns that were not able to be resolved to put their scenarios or portfolios into the model.
Response: Yes, these portfolios can be viewed as proxies for the work we went through with stakeholder group, and with the spirit of decarbonization, we wanted to show this representation as stakeholders voiced interests.

Brian concludes by asking the group if there are any other additional questions. There are no additional questions at this time.

Modeling Results – Market Purchases, CO2 Emissions & Cost
Nate Gagnon, Lead Planning Analyst

Nate begins discussing how each of the portfolios performed in the 5 different scenarios with respect to areas of interest and goals of the characteristics of a preferred portfolio. Nate begins explaining the charts and how it represents results.

Market Purchases

The first metric is net market purchases on slide 40. A snap shot of purchases in 2027 and 2037 are shown to illustrate how the different portfolios drive market activity into the future. Nate notes that earlier in the period, net market purchases are driven largely by the scenario, and as the resource plans diverge, the plans with more transition become less reliant on the market.

Stakeholder question: What are the assumptions of the carbon intensity of the market?
Response: The market carbon intensity is scenario specific and it is an average of the market energy mix of that scenario.

Stakeholder question: Do high decarbonization plans reflect higher prices and larger demand?
Response: No, the Rapid decarbonization plans are not optimized on higher prices or larger demand. The portfolios are static across all scenarios and generally are about the same time. The performance of each portfolios is based on the characteristics of the scenario.

CO2 Emissions Reductions

On slide 41, Nate similarly discusses the emissions reduction of CO2 as characteristic of a preferred portfolio. Nate notes that the portfolios with more transition result in higher CO2 reductions across all scenarios. He also mentions that market purchases are included in these at the market CO2 intensity of the eastern interconnect. Explains that rationale that globally market purchases are not carbon free and most stakeholders agreed in previous meetings that some CO2 should be ascribed to the purchased power.

No questions or comments.

PVRR

Nate moves on to slide 42 where PVRR for the first ten-year PVRR and the full 20-year PVRR is discussed. Through 2027 there is very little divergence across either portfolio or scenario, largely due to all plans doing nothing in this time period. As the portfolios continue into the future, the cost of the plans diverges based on the price on carbon emissions.

Stakeholder questions: The last take away on this slide states that the portfolios with more renewables are least cost effective in no carbon tax scenarios. This doesn't make sense to the stakeholder
Response: You get the most bang for your buck for renewables when you have a carbon tax, and these zero carbon emitting resources can offset that carbon cost the most. Vice versa without the carbon tax, they can offset less. The cost of carbon in those scenarios are externalities rather than internalities.

Nate sums up his key takeaways on slide 43 and hands the presentation back over to Brian.

Risk Sensitivity Analysis
Brian Bak, Lead Planning Analyst
On slide 45, Brian discusses sensitivity analyses around market purchase exposure and social cost of carbon. Slide 46 highlights the risk each portfolio possesses if we are over exposed to the market and unable to cost effectively serve load. Brian notes that each portfolio's PVRR increases in each scenario when not able to access the market. He comments that not being able to access the market is also a proxy of market price coming in higher than we expected and us having to serve our load with our own generating units.

Stakeholder question: All of Duke's runs show a lot of reliance with the market. This is just another reason why it seems like somethings wrong with the model.
Response: This was done as an additional data point and measures the dollar risk of the market purchase levels.

As Brian moves on to slide 47 which is a PVRR which includes the social cost of carbon. He shows the PVRR of each portfolio in the reference case scenario. He outlines where the social cost of carbon information came from and how to access it. The total 20-year PVRR is the production and capital costs, plus the social cost of carbon, without the carbon tax price to avoid double counting.

Stakeholder question: As the stakeholder recalls from previous meeting and previous IRP cycles, duke has used a 2-step process to come up with PVRRs, capital from the capacity selection model plus

production cost from the hourly dispatch model. Are you planning to do the same in this one? And the cost associated with market purchases are from the production cost model as well, correct?
Response: We do use the production cost from the production cost model (PAR) and capital separately. Here we also added SCC as a 3rd step and did not reoptimize the dispatch of our units. Yes, the market purchases are from PAR.

On slide 48, Brian highlights the takeaways from the sensitivity analyses of market purchase exposure and social cost of carbon. He then turns the meeting back over to Scott and Heather.

Next Steps
Scott Park, Director IRP Analytics – Midwest

Scott summarizes the process of optimized portfolios, alternate profiles, sensitivity and risk analyses, and the balance of reading into these insights and planning for the future. Resource addition is another level of detail and justifying each project on its own merits.

Scott outlines the next steps on slide 49. The next stakeholder meeting will be on June 20th and we will present the preferred portfolio. The final IRP Document will be submitted on July 1. Starting fall of next year will likely start the next cycle for IRP planning.

Stakeholder comments: CAC has invested a lot of in this process. The group is disappointed in the constraints on transitioning Dukes fleet. The group feel that Duke wants to defer the decision making to the next IRP. The makes them feel like "what's the point" of this IRP. The group appreciates the increased dialog in the IRP cycle, but still feel that there are issues with the inputs, modeling, and ultimate choices. Poor resource planning will only negatively impact the customers that have to pay for this plan. The group values transparency and the ability for the model to output reasonable results based on constraints and inputs. The group adjusted the inputs that should have selected some wind. In the group's opinion, from what they've seen, has not shown reasonable and logical outputs. The group does not like the constraints like retirements of coal assets to operate the grid. Overall the group does not have trust and faith in the model.
Response: Duke presented nine total portfolios and how they performed in the different scenarios. Did Duke not provide any resource portfolio that the group would be supportive of? The optimized portfolio is only optimal for the specific set of inputs. The fixed nature of the inputs creates a bit of inconsistency. Normalized data will never exactly coincide with the schedules we have for other hourly schedules. Other outside conditions might need real world lead time for transitions for generation build and transmission system.

Stakeholder comments: EMCC does appreciates the extend the conceptional input that they have offered and the extent the team has outside the box moving forward, but from their perspective working against another clock. Not the rate case or the IRP submission dates. They are working against the climate change clock and a resource transformation that needs to be consistent with that clock. Moving more rapidly with thinking and doing is of greatest urgency. Decision made now are going to determine the world the future generation live in. In terms of the modeling to reflect the innovation, were not yet seeing that. Customers have internal carbon goals. 41% of the Duke shareholders in the last annual shareholders meeting said you must do more on climate as well. They are starting to see some movement, but not nearly enough to meet the urgency for corporations dealing with real world or political world in the united states. The stakeholder thanks Duke for the engagement. The stakeholder

mentions that despite the improvement in the process, it is not enough with the astrophysical constraints. The company needs to move further and more rapidly. Improving the tools to remove the anomalies is going to be crucial going forward. Duke is the biggest and has the potential to be the best, by leading the industry in decarbonization.

Stakeholder comments: Defining and specifying scenarios is certainly needed. However, the modeling capabilities and tools must be able to work on integrated resources including storage (CAES, PS, Battery). The integration of storage is crucial for the viability of renewable non-dispatchable resources. Microgrids technology need to be able adapted and how that impacts the macro grid capabilities. Also, DSM modeling seems messy and can be improved for future IRP.
Response: Scott agrees that dynamic operation technologies, DERs, and other technologies are coming and the tools in the industry need to step up to that.

Stakeholder question: There are several stakeholder groups that go to all IRP meetings for all of the utilities. The OUCC and Staff from IURC are present. Duke needs to stop pretending to lack the capabilities to do what the stakeholder knows can be done. This is not acceptable. The stakeholder understands Duke is the biggest, but the stakeholders in this process are not ignorant to what is happening in the industry and other utilities.
Response: We as always will review how we can improve the process.

Closing Comments
Heather Quinley, Director of Energy Affairs & Stakeholder Engagement

Heather thanks everyone for active participation. June 20 is the date of the next stakeholder meeting. Please send comments/feedback to Scott and we will have meeting notes out by June 7.

Meeting Ends at 2:33pm

2018 Integrated Resource Plan

Stakeholder Workshop #6





June 20, 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 May stakeholder meeting and respond to comments/questions
- Present Preferred Portfolio
- Discuss lessons learned from this IRP cycle

Agenda

Time	Topic
1:30	Registration
2:00	Welcome, Introductions, Agenda
2:20	Review of May Meeting; Responses to Questions/Feedback
2:40	Present Preferred Portfolio
3:15	Lesson Learned Discussion
3:45	Next Steps and Closing Comments

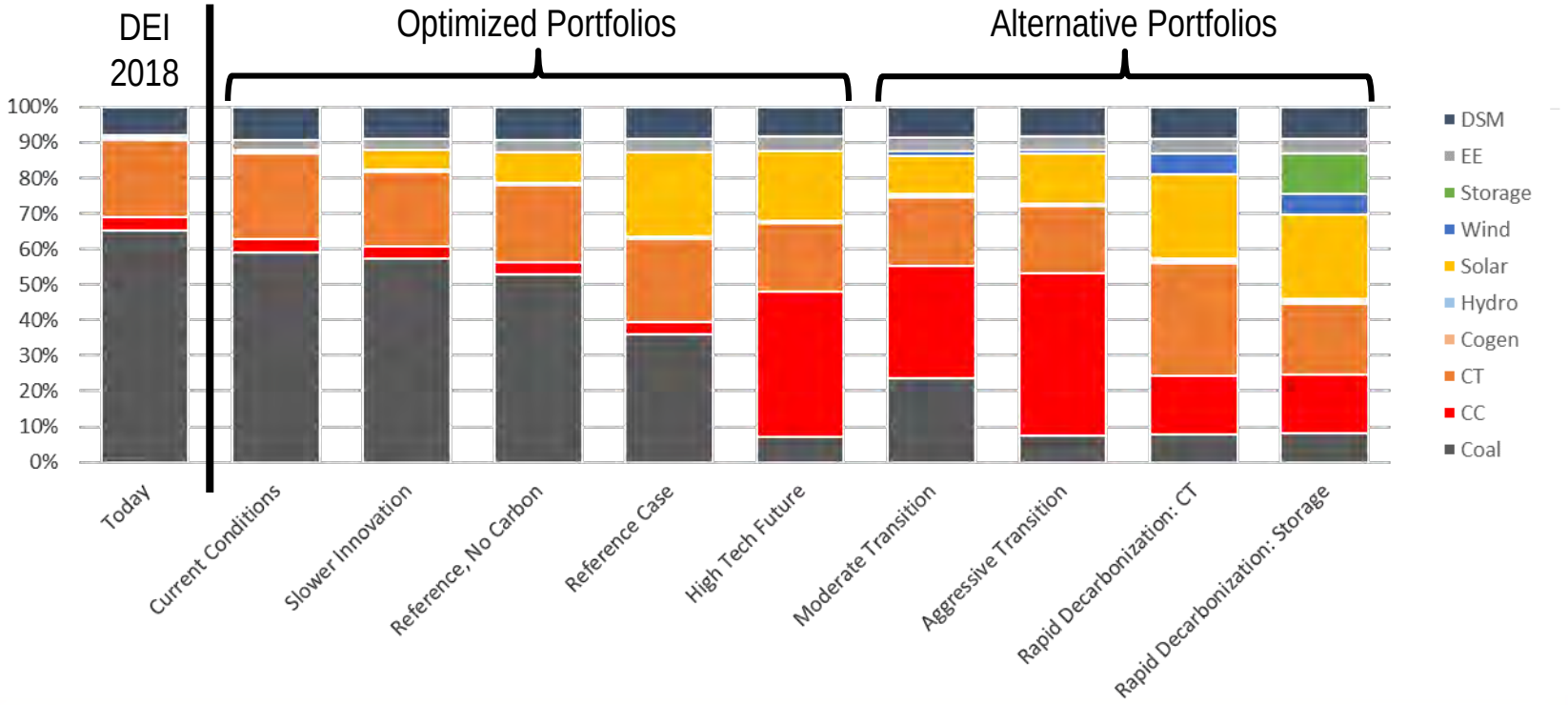
Nate Gagnon – Lead Planning Analyst

Review of May Meeting, Comments and Overall Update

Recap of May Meeting

- Review of previous meeting
- Update on additional work with stakeholders
- Review scenarios & optimized portfolios
- Sensitivities & alternate portfolios
- Modeling results
- Risk Analysis Sensitivities

Portfolio Capacity Mixes by 2037



Comments/Questions from May Meeting

STAKEHOLDER QUESTIONS/COMMENTS	RESPONSES
Duke should model capacity on a UCAP basis	Duke Energy has questions about this approach as it requires the estimate of additional parameters, but is willing to discuss before the start of the next IRP cycle.
EE should be modeled using the decrement approach	Duke Energy has never said that this approach could not be done, but has questions about why the decrement approach is better than modeling EE as a supply side resources. Additionally, the size and the shape of the decrement matters as it relates to the shapes of the various EE measures. We are willing to discuss different methods for modeling EE before the start of the next IRP cycle.
The 20 year time frame for modeling the IRP is inappropriate	Interesting thought and can discuss before start of next IRP cycle.

Comments/Questions from May Meeting

STAKEHOLDER QUESTIONS/COMMENTS	RESPONSES
What is the basis for limiting retirements to beyond 2024?	Retiring one of the larger coal units, in general, will require long lead time transmission upgrades that will depend upon the specific unit retiring as well as other retirement and additions across MISO.
How are CCR and ELG costs modeled in the IRP?	There are essentially two types of costs to consider here: unavoidable costs, such as legacy ash pond closure costs; and potentially avoidable costs, such as capital and O&M investments for continued operation of generating units in compliance with the regulations. First, unavoidable costs do not influence unit retirement decisions, therefore we do not include them in unit go-forward costs for retirement analysis. For CCR and ELG rule compliance, the dry ash and water re-direct projects are already complete at Gibson and Cayuga, and Gallagher's already planned retirement avoids such costs. There are no additional capital costs in the forecast period for CCR or ELG compliance. Specifically, there is ~$32M capital at Cayuga and ~$7.5M capital at Gibson in 2033 for placeholder VSEP technology. This also includes approximately $6M/yr O&M at Cayuga (no incremental O&M at Gibson). In the 2030's) we do have placeholder projects at Cayuga and Gibson for a future ELG revision assumption (including capital and O&M costs for "enhanced ash fixation"), but that is beyond anything envisioned for the current rule.

Scott Park– Director IRP Analytics - Midwest

Preferred Portfolio

Moderate Transition is the Preferred Portfolio

Features of Moderate Transition Portfolio

- Adds over 2300 MW of renewable generation
  - 1650 MW of solar
  - 700 MW of wind
- Retires over 2800 MW of coal generation
- Adds over 300 MW of incremental utility sponsored EE
- Includes CHP
- Adds 2 combined cycle to further diversify fleet

Benefits of Moderate Transition Portfolio

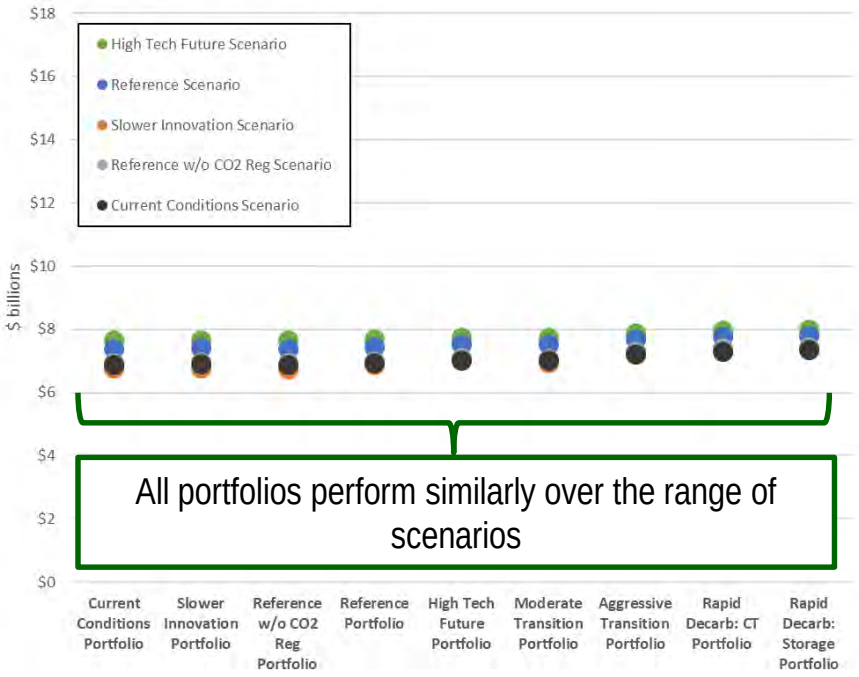
- Cost competitive with other portfolios
- Reduces risk by reducing market purchases and increasing diversity of supply
- Greater CO2 reductions than most optimized portfolios
- Measured additions and retirements smooth rate impacts to customers
- Greater diversity and measured changes increase that ability of the portfolio to respond to changing market conditions

Preferred Portfolio Details

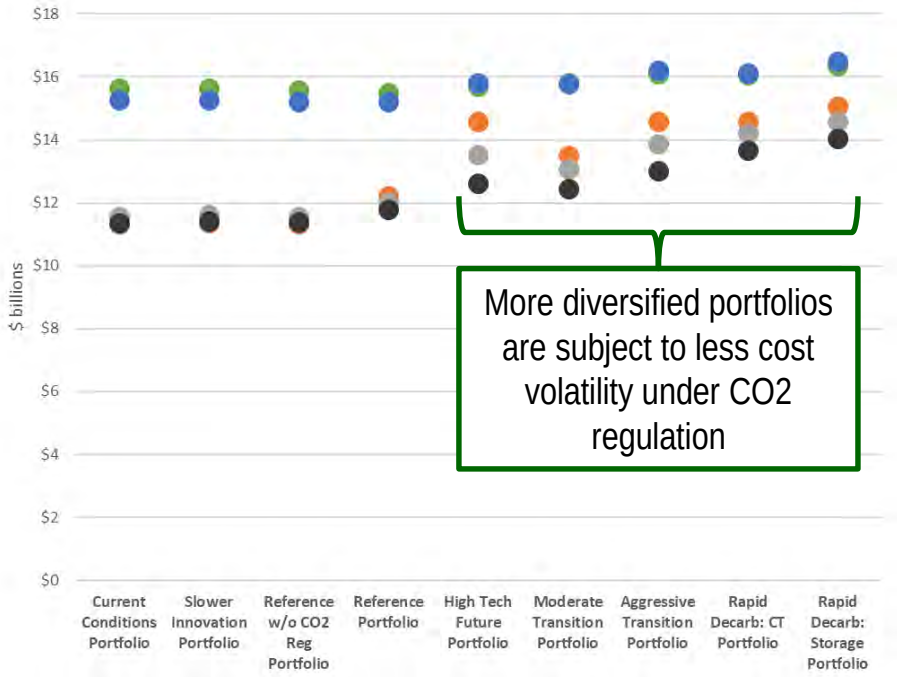
MODERATE TRANSITION	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
RETIREMENTS																				
Unit						Gallagher 2,4			Gib 4		Cay 1-4					Gib 3,5, Noble				
Nameplate MW						280			622		1085					1204				
EE - Contribution to Peak																				
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	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

PVRR by Portfolio

Investments Through 2027

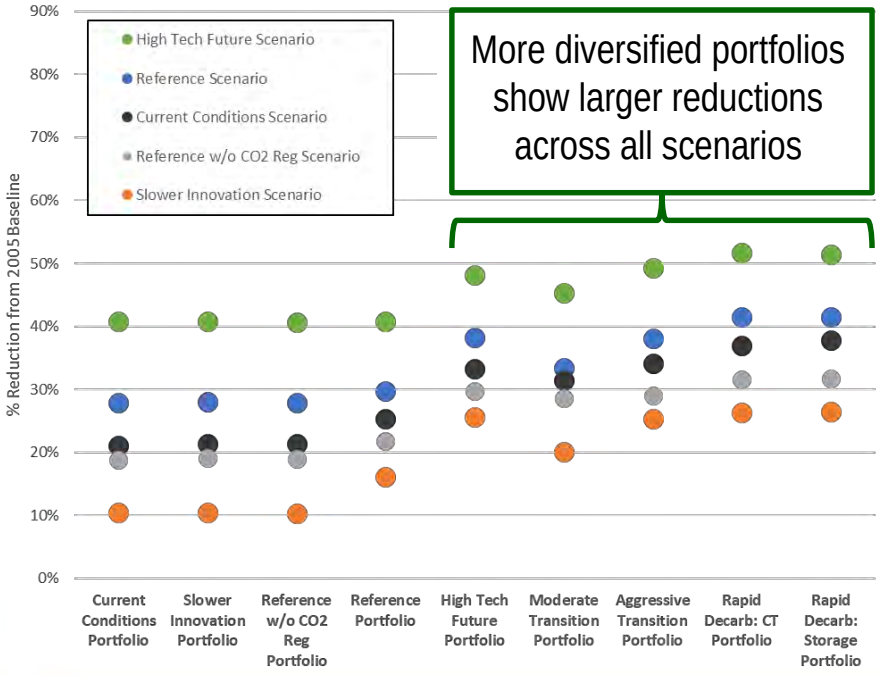


Investments Through 2037

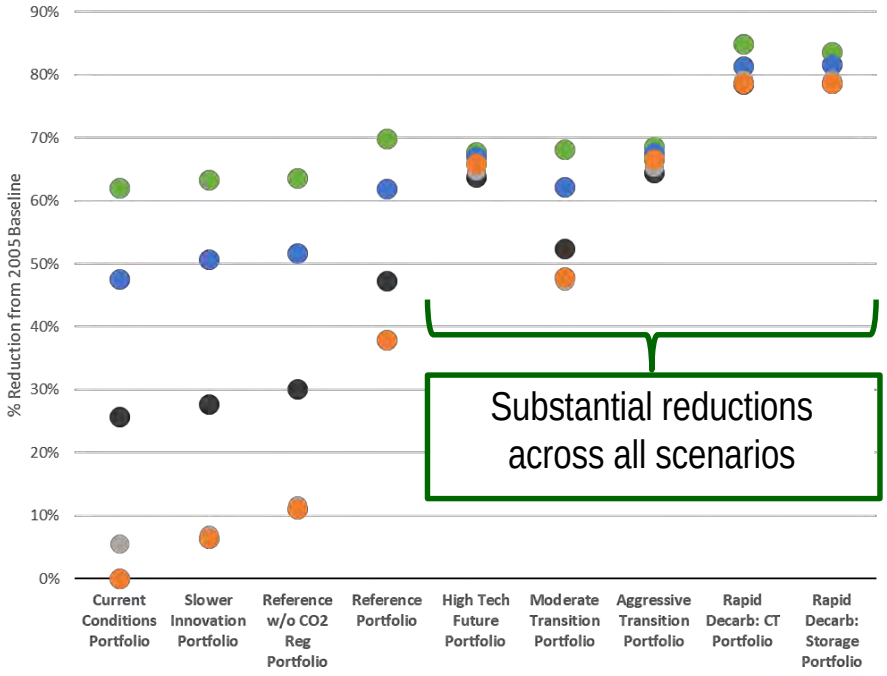


CO_2 Emissions Reduction by Portfolio

Reduction by 2027 from 2005 Baseline

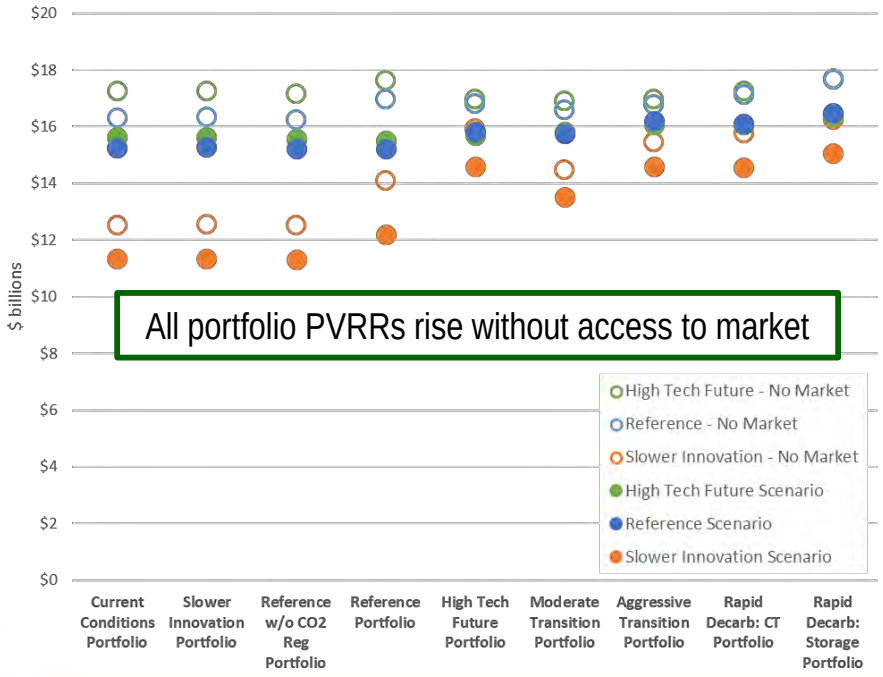


Reduction by 2037 from 2005 Baseline

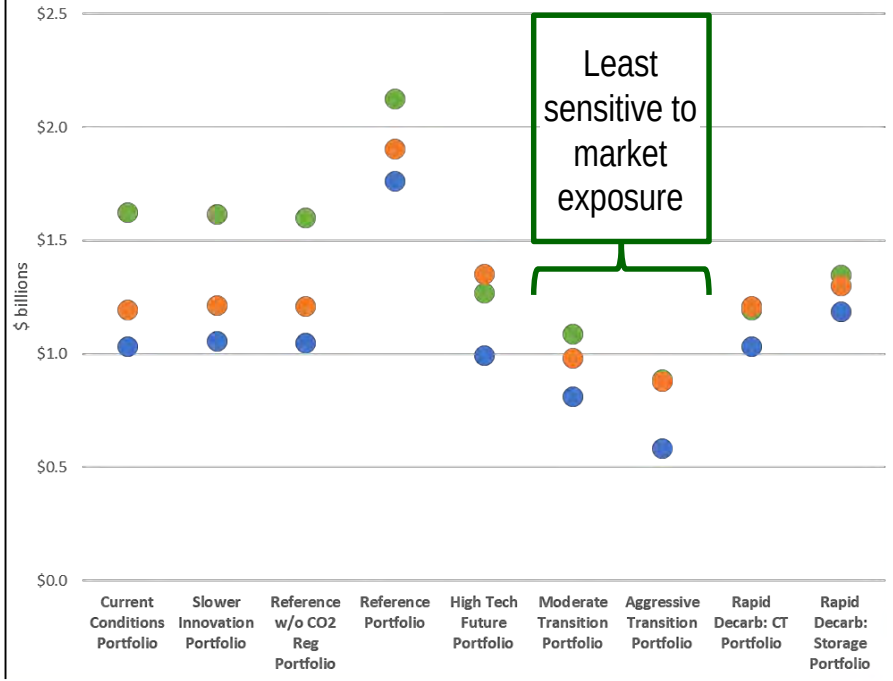


Market Risk (20 years)

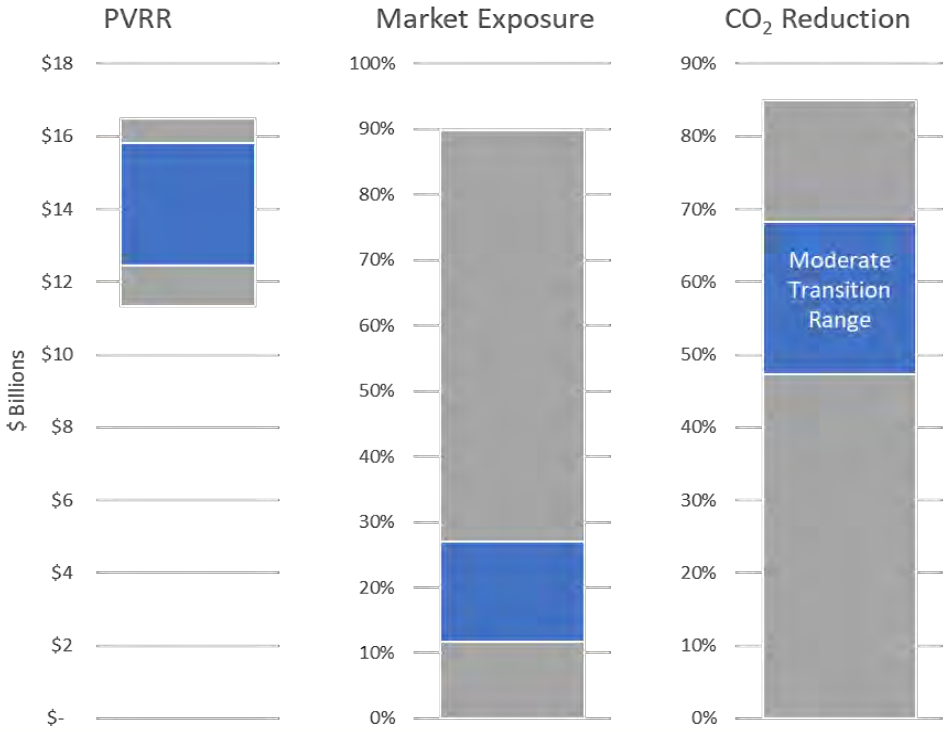
PVRR With and Without the MISO Energy Market



PVRR Change When Market is Unavailable



Moderate Transition Performance



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Brian Bak – Lead Planning Analyst

Lessons Learned

Lessons Learned Discussion

- Scenario Development
- Portfolio Development
- Modeling

Next Steps

- Slides posted to website in late June
- Final IRP document to be submitted on July 1
- IRP process and methodology discussion to take place in Fall 2019 timeframe

Scott Park– Director IRP Analytics - Midwest

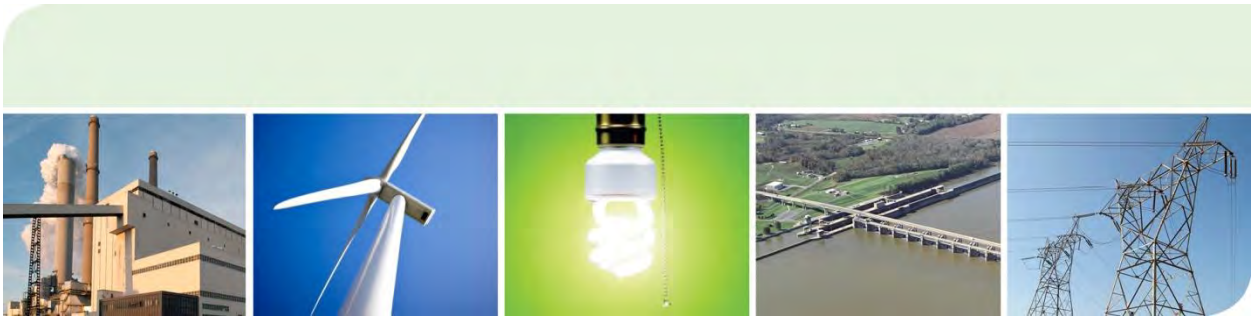
Closing Comments, Stakeholder Comments

Closing Comments

- Please complete comment cards or send by June 26th to Scott at:

  scott.park@duke-energy.com

- Meeting summary and other materials will be posted on website by June 30th
  - (http://www.duke-energy.com/indiana/in-irp-2018.asp)



Duke Energy Indiana 2018 Integrated Resource Plan

Stakeholder Workshop #6 Summary
June 20, 2019

Meeting Begins at 2:00pm

Welcome and Introductions
Scott Park, Director IRP Analytics – Midwest
Stan Pinegar, State President – Indiana

Scott welcomes everyone to the sixth and final stakeholder meeting where the IRP team will be presenting the preferred portfolio. He covers room safety and the evacuation plan. Scott hands the meeting over to Stan for a welcome.

Stan welcomes everyone and thanks everyone for attending. He thanks everyone for the input throughout this long process and their patience, particularly with the communications for this final stakeholder meeting. He notes that the stakeholders will see there are several plants affected by this preferred portfolio plan. For those employees and communities impacted by the potential plant retirements, we wanted to make sure we communicated that to those directly impacted by this plan before sending out the information for this meeting. We understand the frustration on not receiving the presentation until now, but thank you for your patience as we were able to discuss the meaning of this information with our employees beforehand. Lastly, he appreciates the engagement throughout the process and continue and after we file preparing for the next IRP Cycle. He encourages everyone to be engaged and turns the meeting back over to Scott.

Scott starts introductions starting with those in the room followed by those on the phone, asking each person to identify themselves and state the organization they are representing.

Why are we here today? and Agenda
Scott Park, Director IRP Analytics – Midwest

Scott proceeds to slide 3 to cover the reasons we are here today. The topics for day include recapping the fifth meeting (May) and responding to the comments/questions. The main topic for this meeting

with be presenting the preferred portfolio and the analysis that lead us to this decision. We will also cover lessons learned from this IRP cycle and how to improve the process going forward.

Scott then moves on to the agenda on slide 4 and the timeline for afternoon. He asks if there are any questions now on the agenda. There are none.

Review of May Meeting, Comments and Overall Update
Nate Gagnon, Lead Planning Analyst

Nate recaps the fifth stakeholder meeting held in May on slide 6, which included an update on additional work with stakeholders, a review of scenarios and optimized portfolios, and the presentation of modeling results including sensitivities, alternate portfolios results, and Risk Analysis. Nate recaps the characteristics of the five scenarios used for this IRP and the capacity mixes of the nine portfolios as presented in previous meeting. He discusses some of the driving inputs that results in the optimized portfolios for each scenario. He notes that lessons we learned from the optimized portfolios were used to build out alternative portfolios with certain aspects of customer interests considered.

Stakeholder question: Nate referenced some multipliers we can use to convert contribution to peak planning capacity to nameplate capacity. What are the multipliers for capacity planning purposes for renewables.
Response: Stakeholders can use 2x for solar (50% contribution to peak) and 8x for wind (13% contribution to peak) to get from contribution to peak capacity to nameplate capacity

Stakeholder question: EE and DSM don't seem to change much between portfolios. Why is that?
Response: EE capacity does not fluctuate much, but energy might between portfolios. DR is a forecast and static across portfolios.

Nate discusses the changes of operations of portfolios in different scenarios including effects of PVRR, CO2 emissions, and reliance on market purchases.

Stakeholder comment: When Duke references "world changing" between different scenarios, you're talking about legal and political world. Most stakeholders are concerned about astrophysical and geophysical world impacted by CO2 emissions. The legal and political may not change or change quickly, but the astrophysical and geophysical will continue to worsen regardless, with continued CO2 emissions. Duke should be taking steps to internalize and adjust to this fact and be on the forefront of combating climate change versus waiting for externalization to implement changes to reduce CO2 emissions
Response: Duke will continue to look at the tradeoffs with regulators push back on approvals and cost differences.

Nate notes the questions from the previous meeting on slides 8 and 9 and the responses from Duke Energy. In the interest of time, Nate suggests stakeholders can review on their own time if there are no questions.

Stakeholder question: On slide 9, the first question references limiting retirements to 2024 and after. This is a self-imposed criterion and outside of MISO's capacity retirement process?
Response: That is correct. Removing plants from grid support can have impacts that required transmission stabilization projects that can take 4-5 years to implement, so these and other concerns,

including replacement build lead times, that we used to restrict the model selection of retirements earlier.

Preferred Portfolio
Scott Park, Director IRP Analytics – Midwest

On slide 11, Scott presents the selection of Moderate Transition as the IRPs preferred portfolio. He discusses the features of the moderate transition portfolio along with the benefits of this resource plan, including fleet diversity, integration of solar and wind, retirements of 2500 MWs of coal, potential additions of combined heat and power units, replacement generation of dispatchable, efficient combined cycle gas generation, and EE.

Scott notes that a preferred portfolio should perform well across a range of scenarios and the Moderate Transition portfolio does that in terms of cost, market reliance risk, and CO2 reductions. When considering costs, we want to look at not only overall cost impact, but also rate shock represented in year-over-year customer bill impacts. Scott explains that optimized portfolios often implement sudden and significant portfolio changes, which can lead to a step impact to customers, making irreversible decisions. Moderate Transition has the benefit of being measured and deliberate in retirements and additions. CO2 regulation, as discussed at length in previous meetings, is maybe the most impactful uncertainty we face, but how it is enacted can make a big difference on how and when portfolio changes are made, so having a plan that is flexible to change is important. The moderate transition allows for flexibility and cost control over time. Scott show the expansions and retirements on slide 10 of the Moderate Transition Portfolio.

Stakeholder question: With respect to the coal retirements as a selection in the optimized portfolios – What was the basis of this modeling restriction? Who picked 2024 as the first time these units are eligible for retirement?
Response: Transmission upgrades and new generation build times effects retirement windows. Duke will send supporting documents to CAC next week. Different unit retirements could require significant transmission upgrades, so internal transmission planning documents are the basis of these retirement restrictions along with new unit construction lead times. These dates not MISO retirement planning related.

On slides 12 through 16, Scott discusses why Moderate Transition was selected based on PVRR, CO2 emissions reductions, and market exposure risk.

Stakeholder comment: With respect to the solar additions in the moderate transition plan, that might not be the best generation source for Indiana considering that state has not seen sun the last six months.

Stakeholder question: Are the EE additions are cumulative? What do the decreasing selection at the end of the period mean?
Response: You are correct, that EE represented on slide 12 is cumulative peak EE. The decrease in peak EE contribution represents the concept of “roll-off” of EE. EE programs accelerate otherwise naturally occurring energy efficiency captured in the load forecast. The lifespan of EE measures is based on how far forward energy efficiency is pulled forward to offset the load today. When that EE rolls-off, the world is not experiencing less EE, it is just now captured in the load forecast.

Stakeholder question: When you look at load forecast, heating/cooling/other EE is included in residential, but not in industrial. From that, does that mean there are only three end uses captured the load forecast as naturally occurring EE? The stakeholder questions if the model is correctly looking at the savings of EE. Are the EE savings in the load forecast based on historical trends or the MPS? The stakeholder disagreements that the model if effectively selected EE and that EE is being disadvantaged in our model.
Response: Accelerating the EE is the correct way to think about it. Load forecasting creates a before utilities-sponsored EE (UEE) forecast and then the incremental EE accelerates the impact. The before UEE forecast is developed, the EE group bundles measures based on shape, time bucket, and cost, which matters in the model selection because of the use of hourly power prices, and the model can select which bundles are worth selecting to reduce the PVRR of the plan. If the EE are costs effective relative to the assumptions then it is selected.

Stakeholder question: Again, to reiterate, the real world of astrophysical and geophysical is being differentiated from the legal and political plan, such as the clean power plan and clean energy incentive program, which had early adoption and solar, EE, and DSM in low and moderate-income communities. There is no real action between 2018 and 2023. Every minute and every pound of carbon counts the science says. Duke really needs to look at that especially with solar and wind additions that can start soon and ramp in faster. The current plan is giving up the tax credits that are currently available to those resources. Ramping up is a process is not an event. A smaller scale earlier precludes what level you can get to later. This gap imprudence is one that no one should stand for. Community solar and other moderate income directed plans need to be in the plan and earlier.
Response: Renewable additions are implemented in advance of CO2. This portfolio is progressive with respect to reducing carbon emissions a head of a carbon tax penalty to do so. We can try to argue earlier, but need to get clarification between legal world and if doing so is prudent to our customers. We can always add some sooner if it can be judged as prudent or necessary if the legal and political world changes. Community solar can have hurdles too, but we will continue to look at it with stakeholders.

Stakeholder question: The chart on slide 12 only includes EE, correct? There is no DSM on this page
Response: That is correct, just EE on this slide. No DSM on slide 12.

Stakeholder question: Are the overall MWs of EE Capacity up or down from current trend? Previous filings showed "200" and declining from 2016 forward.
Response: When looking at how much EE is implemented, the EE group general looks at the kWh (energy) side, rather than the MW (peak capacity) side used in generation resource planning. The number shown on slide 12 is a contributed to peak capacity value of EE. The "200" referenced in previous EE filings that the stakeholder is reference is on MWh side and not on the peak planning capacity. Energy of EE will be in the IRP document or can be communicated after the meeting.

Stakeholder question: The stakeholder notes that there are no energy charts in this presentation. The amount of market purchase in the preferred portfolio is this stakeholders concern. How much the preferred portfolio relies on the market?
Response: The PVRR market risk is a good proxy for how impactfully the market exposure is. Energy charts are available in the Stakeholder meeting #5 presentation and will be available in the IRP document or can be communicated after the meeting, as well

Lessons Learned
Brian Bak– Lead Planning Analyst

Brian starts on slide 17, where our goal in this section of the IRP process we want to reflect on the process and listen to the feedback of our stakeholders on ways to improve the process going forward and recording lessons learned. Brian moves to slide 18 to discuss the different areas of the process to help guide the conversation. Scenario Development, Portfolio Development, and Modeling, are discussed one by one to address improvements the process in each of these areas.

Stakeholder question: The stakeholder appreciated the increased engage with Duke and increased dialog to come to solutions, but not satisfied with the process or result. The stakeholder thinks the construct of the modeling, MPS, etc. needs to be improved for accurate selection of EE and other renewables are sources.
Response: Through optimized portfolios and alternative portfolios, Duke tried to represent the interests of all the stakeholders as described in previous meetings. Duke is always willing to discuss the tradeoffs and benefits of one modeling method to another to come up with the best results for the customers.

Stakeholder question: There has been considerable variation of Gibson retirements between the optimized portfolios and alternative portfolios. In this plan the two oldest units are still around, while Gibson 5 with the oldest scrubber and jointly owned units which requires approval from joint owner to retire is retired in the middle of the other 4. Have these discussions ben made with the other joint owners. Is Gibson station a candidate for Carbon Capture and Sequestration retrofit or is all of this done without that as a plan or option for these units.
Response: Engineering considerations is largely the reason for the sequencing of retirements in the preferred portfolio. Duke has not discussed the retirement of unit 5 in this plan joint owners yet, as the retirement is not yet imminent. There is no CCS options being considered right now at Gibson. The sequencing of the retirements in the optimized portfolio has much more to do with PVRR minimalization modeling fit rather than the engineering and transmission network planning practicalities.

Stakeholder question: There are many retirements in the first 10-15 years of the plans. Are plant employees aware. Are there plans on how to retain employees in the meantime before retirement of the units and then thereafter? Will the company find it difficult to retain employees to run these stations if they are expected to shut down in the next ten years or will Duke develop specific transition plans for employees?
Response: We don't have specific HR details. Duke has been very focused on the impact to employees. Duke will of course try to find other opportunities for impacted employee to mitigate transition distractions and uncertainty and impacts to the community as well. The company makes that a priority for all our employees. It was important for us that this information was communicated to those employees before that information went out before the meeting today.

If there are additional suggestions, feedback or lessons learned, or if stakeholders do think of something else stakeholders can always reach out to us.

Next Steps
Brian Bak– Lead Planning Analyst

Brian notes on slide 19, that the slides will be posted to the website in late June. He notifies the group that the final IRP document is expected to be submitted on July 1. The IRP process and methodology discussion will likely start again in the fall of 2019.

Closing Comments, Stakeholder Comments
Scott Park, Director IRP Analytics – Midwest

Scott thanks everyone for active participation in this meeting and the IRP Process. Scott asks for comment cards to be completed or sent to him by June 26. The meeting summary and other materials will be posted on the website by June 30. The IRP is expected to be filed on July 1. Scott appreciates the discussion and insight from stakeholders. Scott opens the floor for final stakeholder comments. No additional questions or comments now.

Meeting Ends at 3:26pm