NCUC Technical Workshop – Duke Energy 2020 IRP

September 30 – October 1, 2021

CONSULTING SERVICES

STRATEGEN

About Strategen

Energy System Planning & Modeling	Cost of Service Studies and Advanced Rate Design	Regulatory and Policy Innovation	Stakeholder Engagement	Corporate Strategy
Informed by best-in-class system modeling and analytics, Strategen develops impactful strategies, roadmaps, integrated resource plans to support and accelerate cost-effective, clean and reliable energy systems.	Strategen experts are leaders in designing modern and equitable tariffs and programs that provide advanced price signals and compensation schemes to enable increasingly distributed energy networks	Strategen is a demonstrated thought leader in developing innovative regulatory frameworks and clean energy market design solutions that are equitable, consensus-driven, and impactful.	Transitioning complex systems requires people working together toward a common goal. Strategen helps complex, multi-stakeholder organizations build trust, find alignment, and identify and nurture clean energy champions through the power of strategic programming and convenings.	Strategen helps clients create bankable value propositions, business models, and supportive market structures that allow leading edge clean energy technologies to compete.

Overview

1. Topic 1: Coal Retirements
2. Topic 2: All Source RFP (not addressed)
3. Topic 3: Grid Impacts

Topic 1: Economic Coal Retirements

- Using Endogenous Selection optimizes resource additions *and* retirements within the same comprehensive modeling process.
- Duke's Sequential Peaker approach arbitrarily grouped units and made other assumptions that may be suboptimal.

Topic 1: Economic Coal Retirements

Approaches to evaluating coal retirement decisions

Duke's Approach in 2020 IRP

+ **"Sequential Peaker Method" conducted as a separate analysis, prior to resource selection**
  - Not a standard method.
  - Not integrated into the core IRP optimization model.
  - Includes many unnecessary steps that could introduce bias (e.g., subjective ranking method).

Strategen's Recommended Approach

+ **"Endogenous Selection" optimizes resource additions *and* retirements within the same comprehensive modeling process**
  - Allows for all retirements/additions to be evaluated simultaneously.
  - Does not require comparison to a hypothetical proxy unit (e.g., CT peaker), or presume by default that a natural gas replacement is required.
  - Avoids suboptimal outcomes likely to occur in a sequential approach.

Topic 1: Economic Coal Retirements

What does an endogenous retirement analysis correctly model? What are the possible limitations?

+ An endogenous approach correctly optimizes for the following costs (or avoided costs upon retirement) at existing coal plants:

- 100% of ongoing fuel costs
- 100% of ongoing variable O&M costs
- Nearly 100% of incremental capital investments and ongoing fixed O&M costs (except for a small fraction in the final 2-3 years prior to retirement date)

+ Possible limitations

- May not correctly model a small fraction of incremental capital investments in the final 2-3 years of plant life (this is due to computational limitations in optimization modeling software)
- This small discrepancy can be corrected through one of several solutions Strategen has recommended

+ A note on sunk costs:

- Previously incurred capital costs (i.e., "stranded costs") are not appropriate to include in *any* forward-looking retirement analysis, regardless of whether they are endogenously selected or not.

The vast majority of *ongoing* costs at existing coal plants would be correctly optimized under an endogenous retirement modeling approach. The minor limitations do not outweigh the benefits of modeling the vast majority of coal plant costs through the core optimization.

Topic 1: Economic Coal Retirements

Other utilities are using an endogenous approach similar to Strategen's recommendation

+ PacifiCorp

- "As part of it 2021 IRP, the Plexos model was able to endogenously consider coal retirement timing options along with other specified options such as gas conversion or carbon capture…"[1]
- To simplify computation, PacifiCorp allows the model to select a retirement date for each unit every 3-4 years, generally coinciding with major overhauls (e.g., Unit 2 can retire in 2023, 2026, 2029, etc.)
- Allowing more retirement year options could increase precision.

+ Xcel Energy

- Although not fully endogenous, coal unit retirement options have been modeled in EnCompass as different resources the model can select as part of the resource selection process.
- Each option has different retirement dates and different fixed costs.
- The model includes an additional constraint that only one of the available retirement dates at the same unit can be included in the scenario.

[1]: https://www.pacificorp.com/content/dam/pcorp/documents/en/pacificorp/energy/integrated-resource-plan/2021-irp/Volume%20I%20-%209.15.2021%20Final.pdf

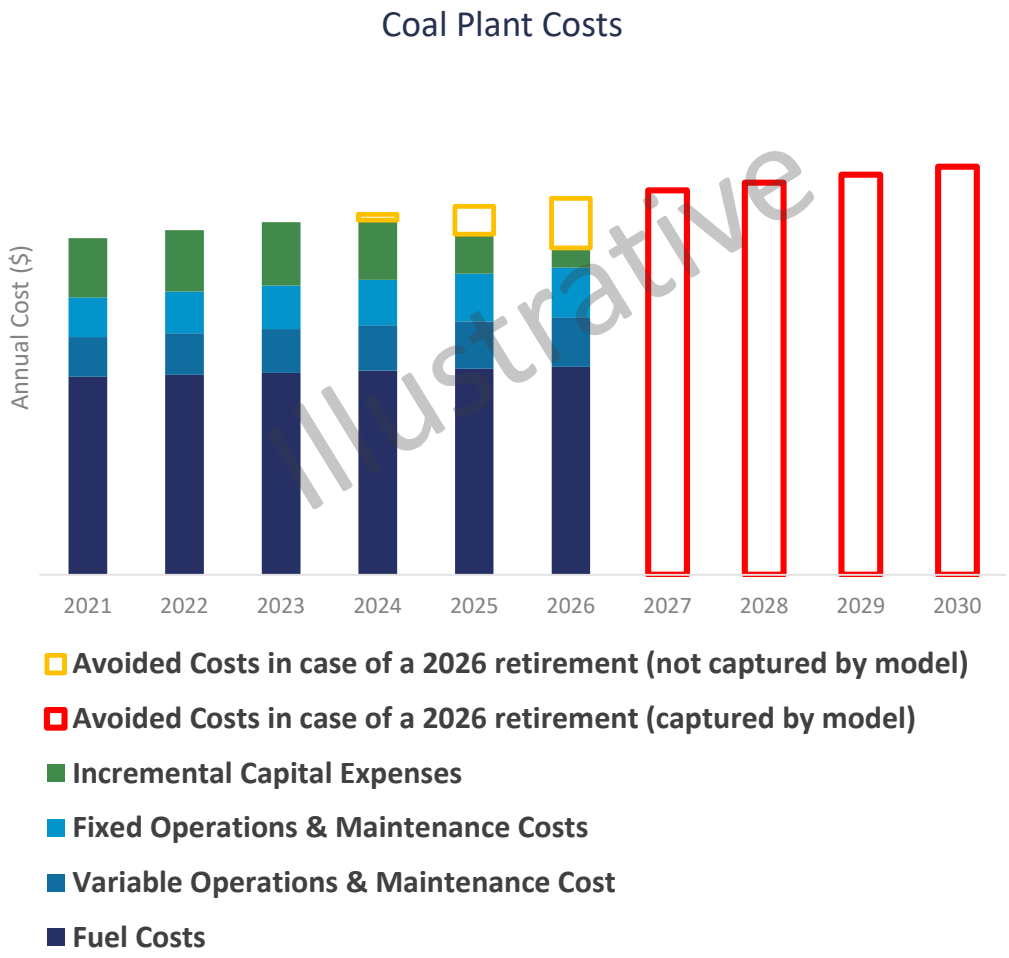
Topic 1: Economic Coal Retirements

Duke's concerns with endogenous selection

- For the 2020 IRP, Duke performed its core resource selection process using System Optimizer (except for the large amount of resources that were pre-selected or "forced in" under certain scenarios).
- While System Optimizer is capable of endogenously modeling optimal retirement dates, Duke chose not to enable this capability.
- Duke's rationale: "The ongoing capital and fixed O&M expense of a retirement candidate varies with the retirement date. The System Optimizer model cannot dynamically change these expenses as it considers each possible retirement date." (AGO DR 1-2)

Topic 1: Economic Coal Retirements

Duke's concern focuses on a minor issue that misses the big picture



Illustrative example:

- Model selects a 2026 retirement versus 2030 under "business as usual."
- The vast majority of cost savings from retirement (red outline) are captured by the model
- A small fraction of savings (orange outline) are not captured by the model due to computational limits.
- This minor discrepancy still leads to an optimal retirement date since it reflects the vast majority of the benefits/costs of the 2026 retirement.
- If the model selects the 2026 date, the actual cost savings would be higher than modeled (i.e., this is a conservative approach).
- The additional savings can be subtracted from the model's final result to obtain a more precise NPV for overall portfolio analysis.

Topic 1: Economic Coal Retirements

There are viable solutions for addressing the relatively minor concern Duke raised over endogenous modeling

+ There are ways to address the potential discrepancy in incremental fixed costs in the final years. Strategen provided three possible solutions in a response to Duke's Data Request 1-3 to the AGO.

1. Scenario-based approach
2. Multiple resource method (Xcel's approach)
3. Post-modeling adjustment (Strategen's recommendation)

+ Any of these approaches could be used to comprehensively model endogenous retirement for all coal units simultaneously.

+ All of these approaches automatically factor in reliability constraints.

+ Additional information on these approaches is provided in an appendix slide.

Topic 1: Economic Coal Retirements

Comments on Synapse's approach and EnCompass's capabilities

- Synapse used Duke's coal retirement dates, rather than endogenous selection.
- Strategen believes this reflects Synapse's intent to do an apples-to-apples comparison that "mimics Duke," with as few changes as possible and may not reflect Synapse's view of what is truly optimal.
- EnCompass is technically capable of endogenous retirements and this capability should be enabled going forward.

Topic 1: Economic Coal Retirements

Duke's 2020 sequential peaker method to coal retirement analysis included arbitrary groupings

Unit	
Allen 1	Allen 1 & 5
Allen 5	
Allen 2	Allen 2-4
Allen 3	
Allen 4	
Cliffside 5	
Cliffside 6	
Marshall 1	Marshall 1-4
Marshall 2	
Marshall 3	
Marshall 4	
Belews Creek 1	Belews Creek 1-2
Belews Creek 2	

Unit	
Mayo	
Roxboro 1	Roxboro 1-2
Roxboro 2	
Roxboro 3	Roxboro 3-4
Roxboro 4	

- Groupings substantially decrease the model's flexibility to choose a least-cost pathway.
- Groupings increase the "lumpiness" of replacement generation.
- Recommendation: Unit retirements should be evaluated individually, rather than in arbitrary groupings.

Topic 1: Economic Coal Retirements

Some of Duke's "earliest practicable" retirement dates were based on presumed natural gas replacements, which may not be optimal

+ For 10 coal units, the earliest practicable retirement date was set based on the presumed need to construct on-site natural gas capacity:
  - Marshall 1-4
  - Belews Creek 1-2
  - Roxboro 1-4
+ The notion that new natural gas capacity is a necessary/optimal replacement for these plants was therefore pre-determined, even before the model could identify an optimal portfolio.
+ The choice of "earliest practicable" dates has increased relevance due to Duke's recently filed 2020 SC Modified IRPs which used these dates for its preferred portfolio.
  - DEC 2020 SC Modified IRP: https://desitecoreprod-cd.azureedge.net/_/media/pdfs/our-company/irp/2020-modified-sc-irp-dec.pdf?la=en&rev=ddfc73cd3d394973a482fe6436705613
  - DEP 2020 SC Modified IRP: https://desitecoreprod-cd.azureedge.net/_/media/pdfs/our-company/irp/2020-modified-sc-irp-dep.pdf?la=en&rev=c2363ffe441f48ac8a3113dd88311335
+ Recommendation: the model should be able to freely select any retirement date based on economics. An earliest practicable date could later be specified after the economic portfolio results are produced.

Topic 1: Economic Coal Retirements

Recommended Directives

+ 1. Require Duke to implement endogenous selection of economic coal retirements in EnCompass (or any other capacity expansion model used in the IRP process). If Duke believes there are limitations in the software regarding ongoing CapEx, Strategen has identified several ways to address that concern.

+ 2. Require Duke to allow each unit to be retired independently in the model, without any arbitrary groupings or rankings.

+ 3. If adjustments to retirement dates are made due to practical limitations, Duke should be required to provide the results both before and after those adjustments. Additionally, it may be beneficial for the portfolio-wide retirement modeling to be accompanied by a unit-by-unit analysis.

+ 4. Provide intervenors with the opportunity to conduct their own model runs through one of the following approaches:
  - 1. Provide all input/assumptions data used by Duke in the Encompass model runs, so others may conduct their own model runs using the same starting point. (This presumes intervenors have the necessary resources, expertise, and access to model licenses)
  - 2. Require Duke to provide a model license and training to other intervenors so that they can produce their own model runs.
  - 3. Allow each intervenor to request Duke to conduct a model run with modified input assumptions.

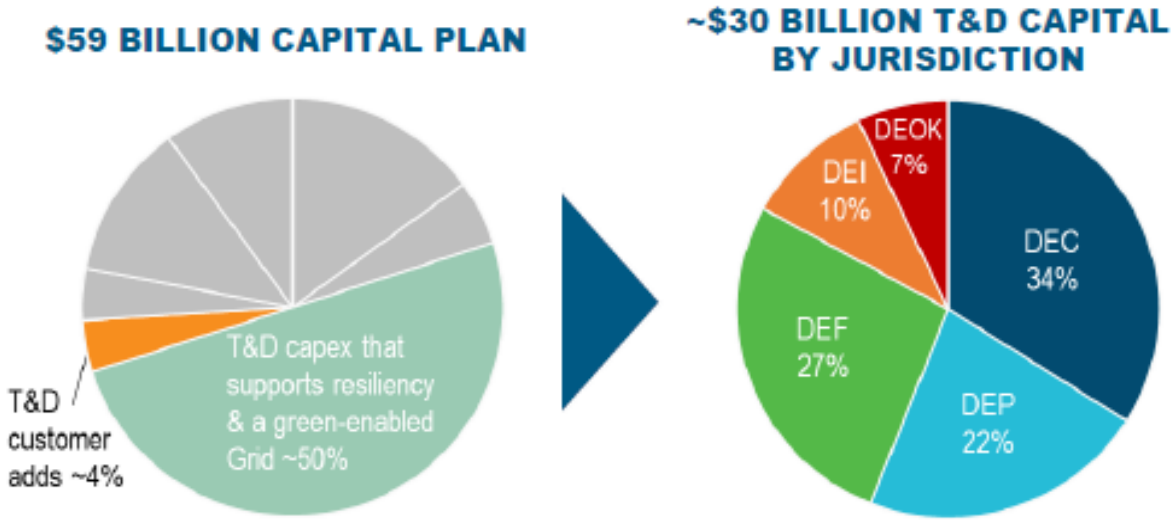
Topic 3: Grid Impacts

- Duke projects significant transmission and distribution needs in the near future (including for coal retirements) but these require more analysis and transparency.
- Understanding Duke's grid interactions with neighboring systems is a fundamental part of resource planning.

Topic 3: Grid Impacts

Duke's projected transmission and distribution investments require more study

+ Duke's planned T&D investments over the next 5 years amount to ~$17 billion for DEP and DEC.
+ This exceeds planned investments in new generation over the same period.
+ The degree of transparency provided by Duke is not commensurate with the scale of this investment.
+ Example of one area needing more info:
  - Transmission to enable coal retirements



Source -- Duke's Q2 2021 Earnings Call: https://desitecoreprod-cd.azureedge.net/_/media/pdfs/our-company/investors/news-and-events/2021/2qresults/q2-2021-earnings-presentation-reg-g.pdf?la=en&rev=283af67423b54292b6e9787dfb1eb0d7

Topic 3: Grid Impacts

Questions remain regarding the need for transmission investments upon coal retirements

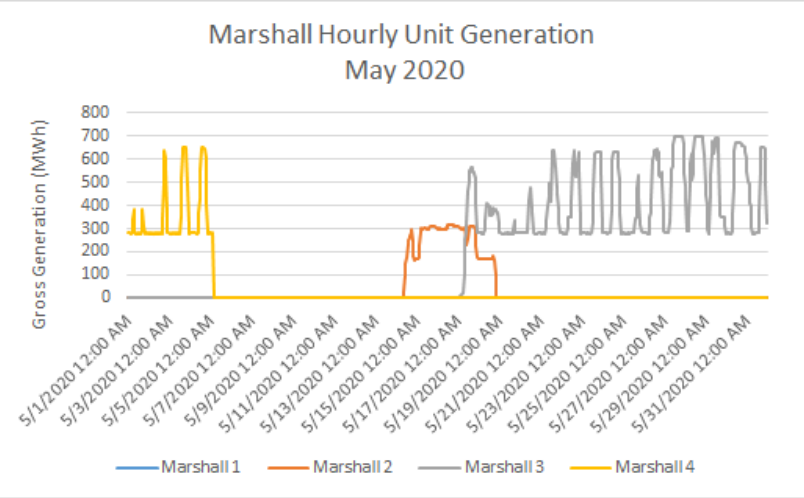
+ [Begin confidential}

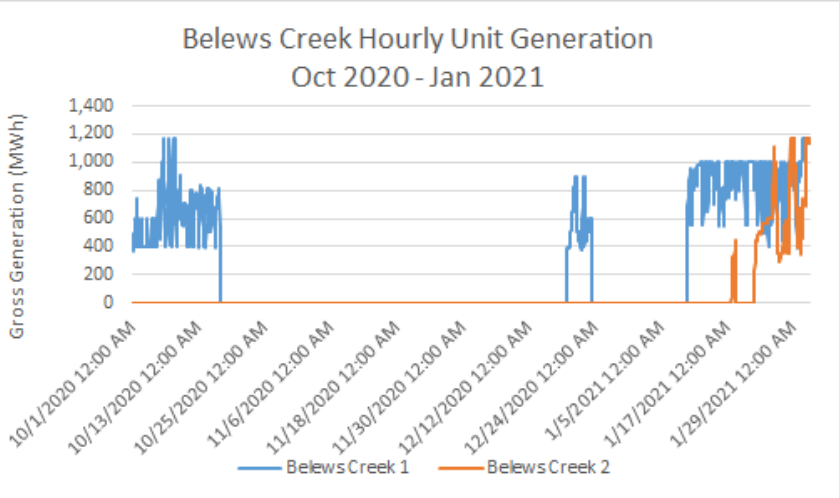
[End confidential]

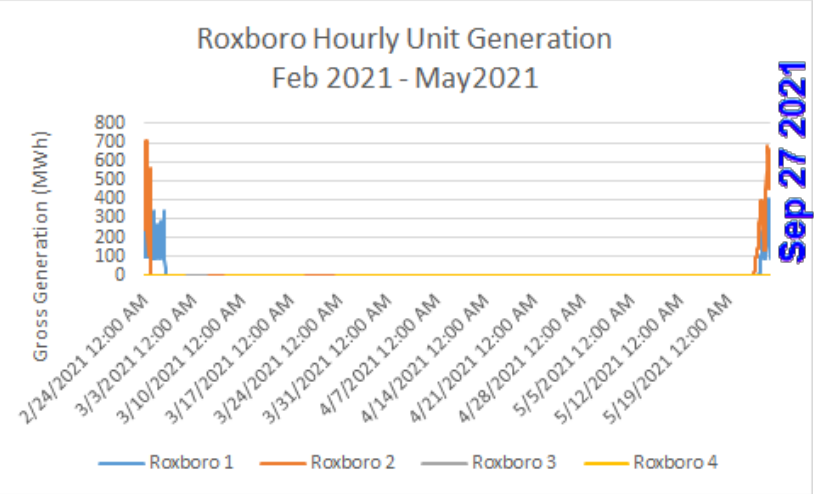
[1]: Similar information was not obtained for Duke Progress plants, including Roxboro.

Topic 3: Grid Impacts

Extended offline periods at Marshall, Belews Creek, and Roxboro







Note: Marshall 1 did not operate during May 2020

+ Generation data at the Marshall, Belews Creek, and Roxboro plants show that there have been extended recent periods where all units were off-line.

+ Presumably Duke operated its system reliably during these off-line periods without any transmission upgrades.

Data Source: S&P Global Market Intelligence

Topic 3: Grid Impacts

Duke's transmission studies for the [begin confidential] [redacted] [end confidential] retirements raise further questions (slide 1 of 3)

+ [Begin confidential] [redacted]

[redacted]

[redacted] [End confidential] An independent review may be warranted.

(questions continue)

Topic 3: Grid Impacts

Comparison of Retirement-Related Transmission Upgrades Identified by Duke (slide 2 of 3)

Begin Confidential

[redacted]

End Confidential

Topic 3: Grid Impacts

Duke's transmission studies for the [Begin confidential] [redacted] [End confidential] retirements raise further questions (slide 3 of 3)

+ [Begin confidential] [redacted] [End confidential]

+ **Recommended Directives:**

1. An independent analysis of transmission needs associated with coal retirements should be conducted prior to the 2022 IRP.
2. This analysis should have oversight by a Technical Review Committee that includes interested stakeholders including the AGO and Public Staff.

Topic 3: Grid Impacts

Better understanding Duke's grid interaction with neighboring systems is vital to several key planning issues

+ Winter Reliability

- Greater import/export capability can be thought of as an "insurance policy" under extreme grid stress.
- Greater import/export capability could unlock firm contracts that could provide more dependable neighbor support.

+ Total Peak MW Needs (and resulting system costs)

- Duke's RA Study included an "island scenario" which increased the reserve margins by over 6%.
- The reverse should also be true – greater imports/export capability would lower the reserve margins.
- Recommendation: future RA Studies should include scenarios with relaxed import/export constraints (especially for PJM) even if only for informational purposes.

+ Capacity Value of Solar

- Summer peaking systems (e.g., PJM, Southern) may have excess capacity in winter that could help alleviate Duke's winter peaking needs.
- Greater interaction with these neighbors could shift Duke's capacity needs from winter back towards summer months, when solar is more plentiful.

Topic 3: Grid Impacts

Concrete steps could be taken in advance of future IRPs to develop the understanding of neighbor grid interactions

1. Identify the precise MW import/export constraints with each neighboring system
2. Identify the historical flows across each interface
    1. Consider creating a “dashboard” to illustrate this
3. Identify the source of each constraint as precisely as possible
    1. Is it a specific transmission element’s rating?
    2. Is it a rule of thumb used by system operators?
    3. Is it a legacy contract?
4. Identify specific steps that could be taken to alleviate these constraints, including both T&D upgrades and non-wires solutions (e.g., dynamic line ratings)
5. Identify the resulting MW increase in the import/export constraint if the upgrades above were taken
6. Include a high import/export scenario as one of the cases to be studied in the IRP. Use the results from step 5 to inform this scenario.

Topic 3: Grid Impacts

Co-optimizing between generation and transmission planning

+ **Recent studies have been done to co-optimize generation & transmission across large regions of the grid:**
  - WECC TEPPC
  - NREL SEAMS Study
+ **These are very complex studies but provide a wealth of important insights and information.**
+ **Recommendations:**
  - The Commission could explore initiating partnership opportunities with a national lab to conduct a similar study for the Carolinas region.
  - The goal of this would be to provide guidance on optimal transmission investments for Duke under different resource scenarios.
  - The Commission should require Duke to provide all data and information necessary to complete this study.

Questions?

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Appendix

Detail from slide 10

Solutions for modeling limitations identified by Duke

1. *Scenario-based approach*: The model could be run with the resource, (e.g., "inc_cap_2030"), and an economic retirement option for any year up to 2030. A second run could include the resource (e.g., "inc_cap_2025"), and an economic retirement option for any year up to 2025. The run that would result in the least cost portfolio would indicate the more economic retirement date.

2. *Multiple resource method*: Instead of two scenarios, the model could include two identical resources with different (maximum) retirement dates and different incremental capital costs (i.e., "inc_cap_2030" and "inc_cap_2025"). An additional constraint could be introduced that would allow only one of the two to be active, which would lead to the selection of the resource with the most economic retirement date.

3. *Post-modeling analysis*: Another option would be to incorporate the capital expenses in a post-modeling analysis. In this case, a run with a 2030 maximum retirement date and "inc_cap_2030" costs could still result in an earlier retirement date even if the fixed costs are not dynamically changed. This approach would correctly capture the plant's O&M costs, while providing a close (but not exact) approximation of capital expenses. This is a conservative approach because if an earlier retirement date is selected by the model, then the capital costs in the final years before retirement would be even lower (i.e., better than the model's optimum) under the early retirement scenario. In such a case, the post analysis would reduce the portfolio cost to reflect this difference in incremental capital expenses due to earlier retirement.

+ Strategen has confirmed that each of these approaches could be readily performed using the EnCompass model.