BEFORE THE NORTH CAROLINA UTILITIES COMMISSION
DOCKET NO. E-100, SUB 190

In the Matter of Biennial Consolidated Carbon Plan and Integrated Resource Plans Duke Energy Carolinas, LLC, and Duke Energy Progress, LLC Pursuant to N.C.G.S § 62-110.9 and § 62-110.1(c)	)))))	**DIRECT TESTIMONY OF JEFFREY BOWER FOR AVANGRID RENEWABLES, LLC**

I. INTRODUCTION

Q. PLEASE STATE YOUR NAME, POSITION, AND BUSINESS ADDRESS.

A. My name is Jeffrey D. Bower and I am a Managing Consultant for Daymark Energy Advisors ("Daymark"). My business address is 370 Main Street, Suite 325, Worcester, MA 01608.

Q. PLEASE SUMMARIZE YOUR PROFESSIONAL EXPERIENCE AND QUALIFICATIONS.

A. I have been a consultant with Daymark since 2010. I have expertise in the areas of integrated resource planning, production cost modeling, energy policy, wholesale energy and capacity market rules and operations, and economic evaluation of energy infrastructure projects. My CV is attached as Direct Exhibit JDB-1 and contains a complete description of my qualifications and experience.

Q. PLEASE SUMMARIZE DAYMARK AND ITS BUSINESS.

A. Daymark provides integrated policy, planning, and strategic decision support services to the North American electricity and natural gas industries. Daymark serves a diverse clientele by providing consulting services to organizations involved with energy markets, including renewable energy producers, private and public utilities, transmission owners, energy producers and traders, energy consumers and consumer advocates, regulatory agencies, and public policy and energy research organizations. Our technical skills include cost allocation, rates and pricing, power market forecasting models and methods, economics, management, planning, energy procurement, contracting and portfolio management, and reliability assessments. Our experience includes detailed

analyses of energy and environmental performance of electric systems, economic planning for transmission and distribution, and market analytics.

Q. HAVE YOU PREVIOUSLY TESTIFIED BEFORE THIS COMMISSION OR OTHERS?

A. I have not previously submitted testimony before the North Carolina Utilities Commission. I have previously testified before the Georgia Public Service Commission, the Arkansas Public Service Commission, and the Maine Public Utilities Commission, as well as the Public Utilities Board of the Province of Manitoba. A full list of my appearances is included in Direct Exhibit JDB-1.

Q. ON WHOSE BEHALF ARE YOU APPEARING IN THESE PROCEEDINGS?

A. I am testifying on behalf of Avangrid Renewables, LLC ("Avangrid").

II. SUMMARY OF TESTIMONY AND KEY CONCLUSIONS

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. Avangrid retained Daymark to review the filing by Duke Energy Progress, LLC ("DEP") and Duke Energy Carolinas ("DEC," collectively "Duke" or "the Company") of its 2023–2024 Carbon Plan and Integrated Resource Plan ("CPIRP"), including the Supplemental Planning Analysis ("SPA") filed in January 2024. My particular focus is on the conclusions of Duke's analysis pertaining to offshore wind development as a component of North Carolina's future resource portfolio.

My review focused on the assumptions used in the modeling, the drivers of the incremental analysis in the SPA, the Company's treatment of particular risks in the

IRP process, the revenue requirement and customer bill impact of various portfolios, and the consistency of Duke's long-term resource plan with emissions policy in North Carolina.

Q. WHAT INFORMATION DID YOU REVIEW IN PREPARING YOUR TESTIMONY?

A. The primary sources used in my review include the Company's initial CPIRP filing on August 17, 2023 (the "Initial Filing"),[1] the Company's November 30, 2023 filing indicating the need for additional analysis due to unexpected load growth conditions,[2] and the Company's Amended Petition and SPA analysis filed on January 31, 2024 (the "Amended Filing").[3] I also reviewed other filings on the docket including Public Staff's motion for a Commission Order related to the issuance of the offshore wind Acquisition Request for Information ("ARFI")[4] and responses to that motion filed by other parties. Finally, I reviewed multiple sets of responses to data requests submitted in this proceeding.

Q. PLEASE SUMMARIZE YOUR CONCLUSIONS AND RECOMMENDATIONS.

A. Duke is currently facing a challenging set of resource planning conditions. The Amended Filing demonstrates that there is a growing need for new resources, and the Company will be approaching a compliance deadline for significant greenhouse

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1 Docket No. E-100, Sub 190, *Verified Petition for Approval of 2023-2024 Carbon Plan and Integrated Resource Plans of Duke Energy Carolinas, LLC and Duke Energy Progress, LLC*, August 17, 2023.

2 Docket No. E-100, Sub 190, *Supplemental Direct Testimony of Glen A. Snider on Behalf of Duke Energy Carolinas, LLC and Duke Energy Progress, LLC,* November 30, 2023.

3 Docket No. E-100, Sub 190, *Verified Amended Petition for Approval of 2023-2024 Carbon Plan and Integrated Resource Plans of Duke Energy Carolinas, LLC and Duke Energy Progress, LLC*, January 31, 2024.

4 Docket No. E-100, Sub 190, *Public Staff's Motion Requesting Issuance of Commission Order*, April 17, 2024.

gas ("GHG") emissions reductions in the coming years. The Amended Filing concludes that offshore wind is a critical element of the Company's future portfolio. The Company's analysis also provides evidence of certain planning risks on the horizon. Based on my review and analysis of the filing, it is clear that accelerating the buildout of offshore wind would provide important benefits to customers and protect them from significant risks:

- Offshore wind represents a large potential source of non-emitting generation that can help meet accelerating load growth while making measurable progress toward the state's emission reduction requirements. Offshore wind provides important reliability benefits and a strong source of winter capacity.
- Pursuing offshore wind earlier in the planning period may give Duke additional margin to meet incremental future load growth, while deferring or avoiding construction of new combined cycle facilities. This would help avoid risks associated with future environmental policy and economic risks of resource underutilization.
- Building offshore wind sooner could help mitigate the impact of potential delays or cost increases associated with nuclear development on resource adequacy and compliance with emissions policy.
- Accelerating the build out of offshore wind capacity will have a minimal impact on customer rates.

Based on these conclusions, I recommend that the Commission direct the Company to accelerate the development of offshore wind resources as part of a low-cost, low-risk portfolio that keeps the state on track to achieve emissions targets.

III. DRIVERS OF NEW LOAD GROWTH PRESENT FUTURE PLANNING RISKS

Q. PLEASE SUMMARIZE THE AMOUNT OF NEW LOAD GROWTH IDENTIFIED BY THE COMPANY IN THE AMENDED FILING?

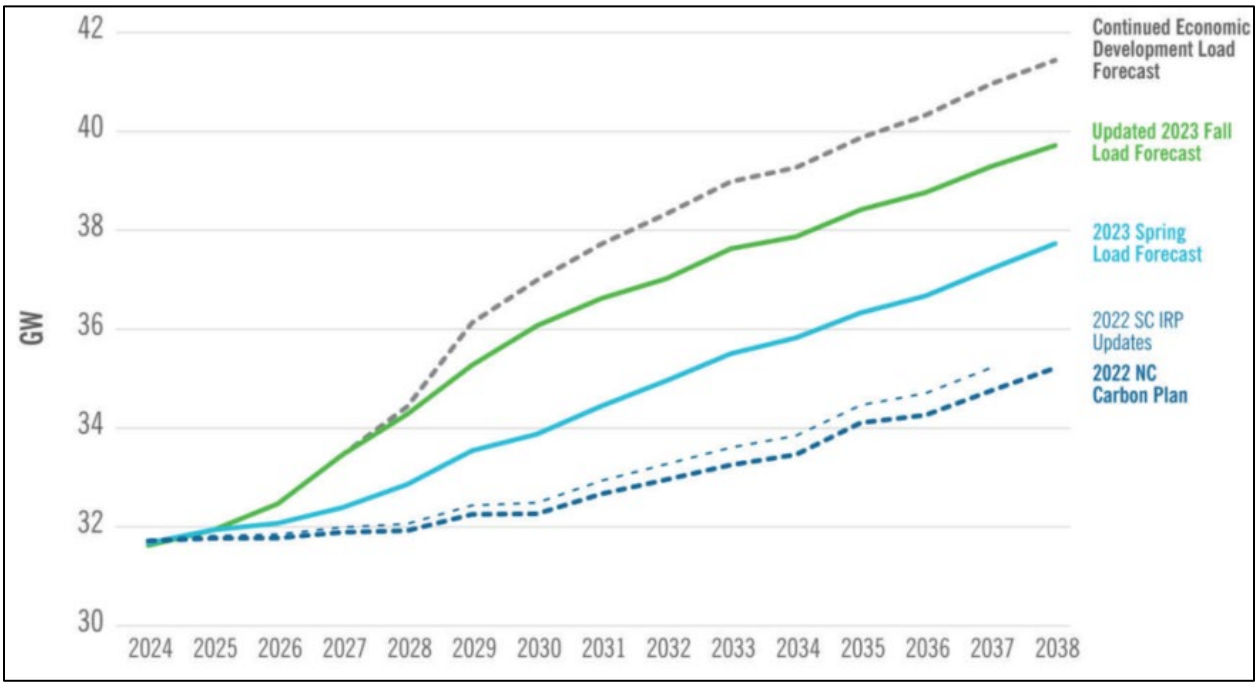
A. The SPA was conducted using an updated load forecast including over 2,100 MW of additional peak load by 2033, as compared to the Spring 2023 load forecast used in the Initial Filing.[5] The SPA notes that the load growth is being driven by new large-load economic development customers that are locating operations in the Carolinas, including "manufacturers, the electric transportation industry, data centers and advanced cloud computing and blockchain operations."[6] Since the Spring 2023 forecast was completed, an additional 27 large site projects have entered the pipeline, each exceeding 20 MW.[7]

The figure below, reproduced from the SPA, compares the winter peak demand between the load forecast used in the Initial Filing (in blue) with the new load forecast used in the SPA (in green). The grey line at the top reflects the Company's "Continued Economic Development Load Forecast," a sensitivity case assuming

[5] Docket No. E-100, Sub 190, Supplemental Planning Analysis, pp. 4-5.
[6] *Id.*
[7] Docket No. E-100, Sub 190, *Supplemental Testimony of Snider, Quinto, Beatty, and Passty*, p. 5, lines 12 & 16.

that several additional proposed large economic development projects come to fruition.[8]

Figure 1. Load Forecast Evolution, 2021 to 2023 Carolinas Combined DEC and DEP Non-Coincident Winter Peak at the Generator (Figure SPA 1-1)[9]



Due to the rapid change in the load forecast, as well as other changes to planning assumptions,[10] the Company conducted the SPA to produce an updated long-term resource plan to address future resource needs.

Q. WHAT WERE THE KEY CONCLUSIONS OF THE SPA, AS IT PERTAINS TO YOUR TESTIMONY?

A. The results of the SPA determined that additional energy and capacity is needed to meet expected load growth. There were some significant changes to the Company's

[8] SPA, p. 22.
[9] SPA, Figure SPA 1-1, p. 5.
[10] Other changes to planning assumptions included updated resource cost assumptions and the inclusion of the Mountain Valley Pipeline project in the base case. *See* SPA, pp. 5-6.

preferred portfolio. Figure 2 below, reproduced from the SPA, compares the preferred (P3) portfolio results between the Initial Filing and the Supplemental Filing. The most notable changes in the portfolio are the addition of 2.7 GW of additional combined cycle ("CC") capacity and 2.4 GW of offshore wind capacity by 2035 in order to meet the needs driven by the increased load forecast.

Figure 2. Supplemental Portfolio Analysis Results - Incremental Resource Additions by 2035 and 2038 (Figure SPA 1-2)[11]

I will discuss the resource expansion in the SPA in more detail in Sections IV - V of this testimony.

Q. ARE YOU AWARE OF OTHER UTILITIES EXPERIENCING SIMILAR ISSUES RELATED TO LOAD GROWTH?

A. Yes. Large load growth has been identified in multiple jurisdictions across the country. I offer two examples below: the Georgia Power Company in Georgia and Dominion Energy in Virginia.

The Georgia Power Company ("GPC") has faced similar circumstances, also driven by large economic development projects in the industrial sector. In its 2022 IRP,

[11] SPA, Figure SPA 1-2, p. 8.

GPC expected less than 400 MW of growth from winter 2023/2024 through winter 2030/2031.[12] In late 2023, GPC filed an updated forecast reflecting expected load growth of 6,600 MW in the same period. This updated forecast was based on a pipeline of potential large load customers totaling approximately 17 GW, representing an expected materialization of approximately 40%.[13] GPC summarized the key drivers for this load growth also rising from large economic development projects, primarily manufacturers, electric transportation, and data center customers.[14]

In May 2024, GPC filed its Q1 Large Load Economic Development Report, showing that the total pipeline grew from 17 GW to 21 GW.[15] Assuming this load were to materialize at the same rate as expected in the 2023 IRP Update filing, this would represent more than 8,000 MW of load by 2031, as compared to the prior 6,600 MW. It is clear that projected economic development growth continues to surpass utility expectations.

Expectations for continued economic development growth are also demonstrated by Dominion Energy's ("Dominion") experience in Virginia. Dominion described its rate of growth as having "no immediate signs of slowing," as mentioned in Duke Witness Snider's November testimony.[16] According to Dominion's IRP, the

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[12] Georgia Public Service Commission, Docket No. 55378, Georgia Power Company, *2023 Integrated Resource Plan Update*, p. 8.

[13] Georgia Public Service Commission, Docket No. 55378, Georgia Power Company, *Large Load Economic Development Report Q1 2024*, p. 1.

[14] Georgia Public Service Commission, Docket No. 55378, *Direct Testimony of Grubb, Valle, Evans, and Bush*, p. 9, lines 10-12.

[15] Georgia Public Service Commission, Docket No. 55378, *Direct Testimony of Grubb, Valle, Evans, and Bush*, p. 9, lines 10-12.

[16] Docket No. E-100, Sub 190, *Supplemental Direct Testimony of Glen A. Snider on Behalf of Duke Energy Carolinas, LLC and Duke Energy Progress, LLC*, p. 4, lines 13-17. November 30, 2023.

significant load growth is "driven primarily by data centers and, to a lesser extent, electrification."[17]

Q. DO YOU HAVE ANY OTHER COMMENTS REGARDING THE ACCELERATED LOAD GROWTH?

A. Economic development load growth is generally the result of policy or economic conditions that foster a welcoming business environment. Much of the recent load growth is driven by tech firms and other large corporations, many of which have renewable energy commitments. Pursuing a low emission resource portfolio will contribute to making North Carolina an appealing location for new or expanded business development.[18]

Q. WHAT DO YOU CONCLUDE REGARDING THE ACCELERATED LOAD GROWTH?

A. The new load growth added to the Fall 2023 load forecast is driven primarily by manufacturing and technology projects with high load factors. As noted by the Company, the additional load included in the forecast is based on actual projects that have taken specific steps to locate load in the state.[19] While there is some uncertainty regarding whether all these projects will ultimately be built, there is also a risk that more large economic development projects will attempt to locate in North Carolina. The Georgia example demonstrates that the pipeline of potential new load has continued to grow rapidly.

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[17] *Dominion Energy Virginia 2023 Integrated Resource Plan*, p. 2, Case No. PUR-2023-00066, (May 1, 2023).
See, https://www.canarymedia.com/articles/utilities/data-centers-want-clean-electricity-can-georgia-power-deliver-it (Last checked 5/25/2024) or https://www.there100.org/re100-members (Last checked 5/25/2024).

[19] Docket No E-100, Sub 190, *Supplemental Direct Testimony of Glen A. Snider on Behalf of Duke Energy Carolinas, LLC and Duke Energy Progress, LLC*, p. 6. November 30, 2023.

Assuming the state continues to attract large load projects, the Company estimates approximately an additional 2 GW impact to the winter peak by 2038, in addition to the new load analyzed in the Amended Filing forecast.[20] If large-load economic development projects continue to emerge at current rates (or faster), as seen in regions such as Georgia and Virginia, the Company may not be able to meet those potential needs given current resources, requiring even more incremental resources in the future. As all the states in the region are facing similar challenges to keep up with large load growth, it may also be challenging to find available capacity for import.

Given the uncertainty surrounding load growth, accelerating the development of offshore wind, which has a long development lead time, will give Duke some optionality to address future system demands and meet state emissions regulations.

IV. OFFSHORE WIND IS CRITICAL TO MEETING EMISSIONS TARGETS

Q. PLEASE DESCRIBE THE NORTH CAROLINA EMISSIONS REGULATIONS PERTINENT TO DUKE'S CPIRP.

A. Section 62-110.9 directs the Commission to "take all reasonable steps to achieve a seventy percent (70%) reduction in emissions of carbon dioxide (CO2) emitted in the State from electric generating facilities owned or operated by electric public utilities from 2005 levels by the year 2030 and carbon neutrality by the year 2050."[21] The required 70 percent reduction by 2030 ("Interim Requirement") may be delayed by the Commission under certain circumstances.

[20] Based on Figure 1 above, "Continued Economic Development Load Forecast."
[21] N.C.G.S § 62-110.9.

Q. DOES DUKE'S PREFERRED PLAN COMPLY WITH THESE TARGETS?

A. No. Duke conducted the resource planning analysis to meet the Interim Requirement by three different dates, with a portfolio achieving the statutory target in 2030, and two additional portfolios meeting the target in 2033 and 2035 (referred to as "P1, P2, and P3," respectively).[22] Duke's preferred plan is the P3 approach, which achieves compliance with the Interim Requirement in 2035.[23]

In the Amended Filing, the Company continued its focus on achieving compliance with the Interim Requirement by 2035, and identified a preferred portfolio referred to as P3 Fall Base.[24] The additional load growth exacerbated the challenge of achieving emissions reductions by 2030.

Q. WHAT DID THE COMPANY'S ANALYSIS CONCLUDE REGARDING OFFSHORE WIND IN THOSE THREE CASES?

A. In the Initial Filing, offshore wind is a component of the optimized resource buildout in the P1 Base portfolio, which reaches the Interim Requirement in 2030, and the P2 Base portfolio, reaching the Interim Requirement in 2033.[25] The P1 Base case calls for 1,600 MW of offshore wind by 2030 and 2,400 MW by 2033, while the P2 Base calls for 1,600 by 2032.[26] The P3 Base did not include any offshore wind in the initial analysis.

In the SPA supporting the Amended Filing, Duke updated the three primary cases to achieve the Interim Requirement in 2030, 2033, or 2035, considering the

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22 Initial Filing, pp. 13-14.

23 *Id.*

24 Docket No E-100, Sub 190, *Verified Amended Petition for Approval of 2023-2024 Carbon Plan and Integrated Resource Plans of Duke Energy Carolinas, LLC and Duke Energy Progress, LLC*, pp. 15-16. January 31, 2024.

25 Docket No E-100, Sub 190, *Carolinas Resource Plan, Executive Summary*, p. 15, Figure 6.

26 *Id.*

additional load growth included in the updated forecast. In that analysis all three cases (P1 Fall Base, P2 Fall Supplemental, and P3 Fall Supplemental) included offshore wind in the optimized portfolio.[27] In P3 Fall Base, Duke's preferred case, Duke adds 800 MW of offshore wind by 2033 and 2,400 MW through 2035.[28]

Q. WHAT ARE THE OTHER KEY NON-EMITTING RESOURCES IN THE COMPANY'S RESOURCE PORTFOLIO?

A. Along with offshore wind, the CPIRP includes solar, onshore wind, battery storage, pumped hydro storage, and new nuclear capacity as non-emitting resource options. The Company utilized specific resource availability assumptions which included annual and cumulative maximum development levels for each resource type. The figure below compares the modeling constraints used in both the Initial Filing and the Amended Filing.

[27] SPA Technical Appendix, pp. 8-10.
[28] SPA, p. 37, Figure SPA 3-2.

Table 1. Combined DEC/DEP Annual Resource Availability Assumptions (Duke Table SPA 2-11)[29]

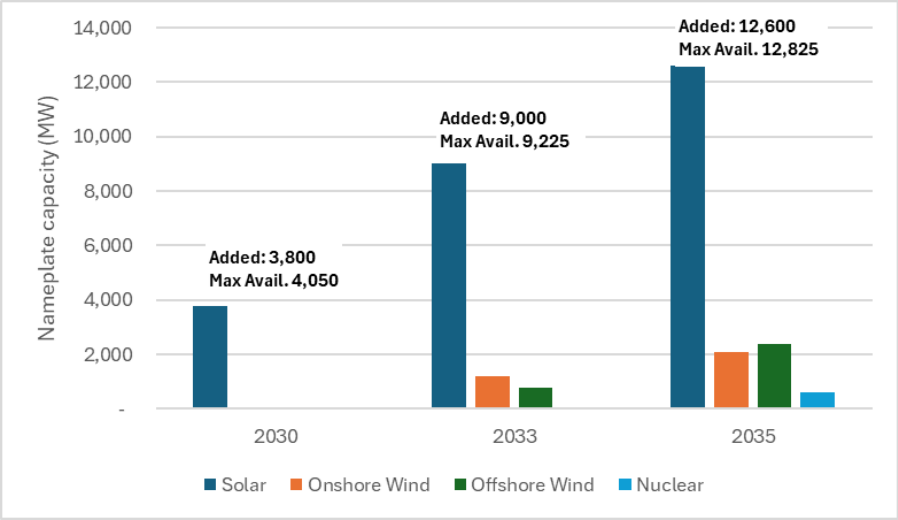
Technology	Initial Plan Assumption		Supplemental Planning Analysis Assumption	
	Annual	Cumulative	Annual	Cumulative
Solar (including SPS)	2028-2030: 1,350 MW 2031+: 1,575 MW	N/a	2028-2030: 1,350 MW 2031: 1,575 MW 2032+: 1,800 MW	N/a
Stand-alone Battery	2027+: 4,400 MW	N/a	2027: 200 MW 2028-2029: 500 MW 2030+: 1,000 MW	N/a
CT	2029+: 4,250 MW	N/a	2029+: 4,250 MW	N/a
CC	2029: 1,360 MW 2030+: 2,720 MW	4,080 MW (3 CC Units)	2029: 1,360 MW 2030+: 2,720 MW	8,160 MW (6 CC Units)
Onshore Wind	2031: 300 MW 2032+: 450 MW	2,250 MW	2031: 300 MW 2032+: 450 MW	2,250 MW
Pumped Storage	2034: 1680 MW	1,680 MW	2034: 1834 MW	1,834 MW
Offshore Wind	2032+: 800 MW	2,400 MW through 2038	2033+: 800 MW	2,400 MW through 2038
Advanced Nuclear	2035: 2 Units	15 Units through 2040	2035: 2 Units	11 Units through 2040

Q. HOW DO THE RESOURCE AVAILABILITY ASSUMPTIONS COMPARE TO THE OPTIMIZED BUILDOUT IN THE PREFERRED PORTFOLIO?

A. The Figure displays the resource additions in the P3 Fall Base portfolio. With the exception of the solar additions noted on the figure, the model added the full amount of non-emitting capacity available, shown in Table 1 above.

[29] SPA, p. 28, Table SPA 2-11.

Figure 3. P3 Fall Base non-emitting capacity additions[30]



This figure demonstrates that the optimization model is building the maximum allowed offshore wind, and nearly as much non-emitting capacity as the constraints allow, including new nuclear. In order to achieve the Interim Requirement in 2035, the preferred portfolio builds the maximum nuclear allowed by the model in 2035 (two 300 MW small modular reactors for a total of 600 MW). This is important given the risks associated with nuclear development.

Q. PLEASE ELABORATE THE RISKS ASSOCIATED WITH ADVANCED NUCLEAR.

A. The nuclear resource available in the portfolio optimization is a 300 MW advanced small modular reactor ("SMR"). This type of unit has never been constructed in the U.S. and is not currently commercially available. There has been significant development interest in these resources in recent years, and there are several federal programs to fund research and development of SMRs. However, given that the technology is still under development, along with the recent experiences of other

[30] Based on data from SPA, p. 28, Table SPA 2-11 and Figure SPA 3-2.

utilities in the U.S. constructing new nuclear generation, it is reasonable to consider the risk that those units will not yet be available in 2035 due to development delays, or may be more costly than assumed in the CPIRP.

This risk has been acknowledged by the Company, noting that:

> While Duke Energy is the largest regulated nuclear operator and owner in the country, integration of the next generation of advanced nuclear generation carries uncertainty in timing for deployment. While the Companies look to be a close follower for the deployment of the first-of-a-kind advanced nuclear technologies, delays in advancement of the projects currently being pursued by other utilities in North America could impact the time frame for first deployment for advanced nuclear for DEC and DEP in the Carolinas.[31]

In the Company's modeling of a "Delayed Nuclear Availability" portfolio variant, they assumed a two year delay in the availability of nuclear. The optimization model selected offshore wind and battery storage in place of the nuclear.[32]

If either cost or schedule risks materialize, it may threaten the ability of the Company to meet the Interim Requirement in 2035.

Q. DO YOU HAVE ANY OTHER OBSERVATIONS REGARDING THE COMPARISON OF P3 BASE AND P3 FALL BASE?

A. Yes, I do. As noted above, when Duke added new load totaling 2,100 MW in the SPA, the two primary resources that increased in the optimized portfolio for 2035

[31] Docket No E-100, Sub 190, *Carolinas Resource Plan, Appendix C*, p. 58.
[32] *Id.* at pp. 58-59.

were new natural gas combined cycle resources and offshore wind, with smaller amounts of incremental solar, battery storage, and pumped hydro (see Figure 2 above.). This indicates that Duke does not anticipate that, other than offshore wind, there will be significant ability to ramp up other sources of clean energy and capacity before 2035.

Q. WHAT DO YOU CONCLUDE REGARDING THE CONTRIBUTION OF OFFSHORE WIND TO MEETING EMISSIONS TARGETS?

A. The results of the SPA demonstrate that offshore wind is a critical component of achieving the Interim Requirement for emissions reductions. With the increased load growth, even in the P3 case (70% by 2035), offshore wind is a key component of the portfolio; achieving the Interim Requirement closer to the statutory deadline of 2030 relies on offshore wind even more heavily. Given that, according to Duke's assumptions, solar and onshore wind are not able ramp up much beyond the base case build out, offshore wind and nuclear generation are the only options for meeting continued load growth without increasing emissions. With the uncertainty related to nuclear development, both in terms of timing and of cost, offshore wind deployment is critical to Duke serving these large load increases while keeping North Carolina on target to meet its emissions reduction requirements. If load growth increases further or if new policy developments require faster decarbonization, earlier deployment of offshore wind will give Duke and North Carolina additional optionality to continue to pursue an optimized, lowest-cost resource portfolio.

V. DEVELOPMENT OF COMBINED CYCLE UNITS CARRIES ECONOMIC RISK

Q. YOU PREVIOUSLY DISCUSSED THE IMPORTANCE OF CC DEVELOPMENT IN THE DUKE CPIRP PREFERRED PLAN. PLEASE SUMMARIZE THE ROLE THAT CC UNITS PLAY.

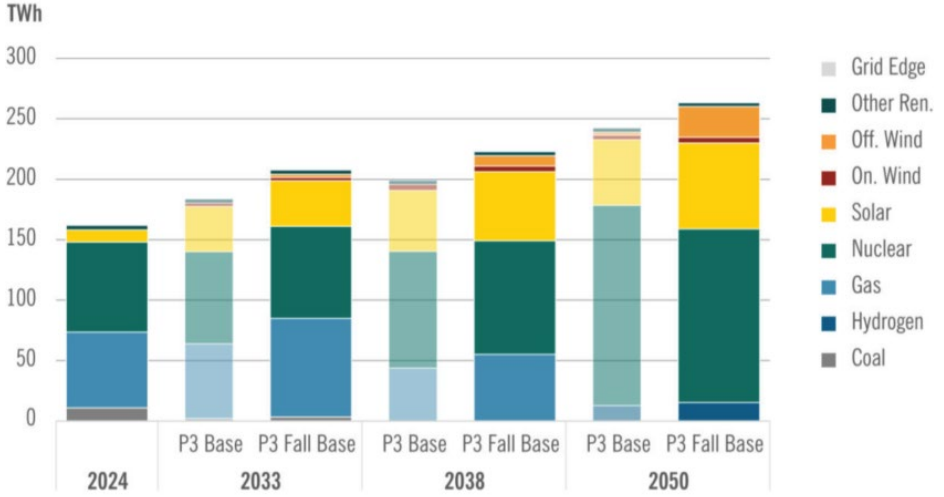
A. The SPA concluded that, in addition to offshore wind, the primary capacity resource added to meet the increased load is new natural gas CC units. As noted above in Figure 1 above, the P3 Fall Base plan added 2.4 GW of additional CC capacity in response to the increased load forecast.

While efficient CC units may play an important role in maintaining reliability during the transition to a net zero resource portfolio, deploying new CCs as a primary component of the 2035 supply portfolio carries significant risks.

Q. PLEASE CHARACTERIZE THE RISKS ASSOCIATED WITH CC DEPLOYMENT.

A. The primary concern associated with adding new combined cycles while simultaneously planning to achieve carbon neutrality is the risk that the resources will be underutilized, and customers will have paid for expensive capacity resources that are only needed for a short time period. If the Company continues to build combined cycle units into the mid-2030s, they will be early into their asset lives when the Company needs to reach net zero GHG emissions in 2050. While Duke assumes that the CC units will be able to operate on hydrogen, the Company's modeled energy mix in 2050 show a small amount of energy coming from these units, as shown in the figure below.

Figure 4. Modeled Energy Mix, Combined Carolinas System (Duke Figure SPA 3-3)[33]



Q. ARE THERE OTHER RISKS RELATED TO CC DEVELOPMENT?

A. In addition to the underutilization risk, there are policy risks to continued reliance on emitting technologies. The U.S. EPA has recently regulated carbon emissions from existing power plants under the Section 111 of the Clean Air Act. These new regulations may not impact the new CCs built as a result of the CPIRP, but there is risk that future regulations would impact the long-term viability of the plants.

Lastly, there are risks related to the planned use of hydrogen fuel in the CCs. Duke's plan for carbon neutrality in 2050 includes the continued use of CCs and CTs, fired by hydrogen instead of natural gas. Despite significant interest and investment in clean hydrogen, there are currently no utility-scale applications of hydrogen as a fuel for electricity generation. That may change over the next 25 years, but there are risks associated with the timing and the cost of hydrogen as a non-emitting resource option.

[33] SPA, p. 38, Figure SPA 3-3.

Q. WHAT DO YOU CONCLUDE REGARDING THE DEVELOPMENT OF CC UNITS AS A COMPONENT OF THE COMPANY'S OPTIMIZED RESOURCE PORTFOLIO?

A. New CC additions are a core component of the Company's resource plan and are the primary resource (along with offshore wind) that was ramped up to meet the new load modeled in the SPA. The development of CC units during a period of portfolio transition and decarbonization carries multiple economic and policy risks. Based on this conclusion, I urge the Commission to exercise caution in approving significant amounts of new CC units when there are alternative sources of non-emitting energy available, namely offshore wind. The Commission should direct Duke to pursue offshore wind development on an expedited basis. This could potentially avoid the need for some of the CC units built earlier in the planning period, which may become underutilized assets later in the study period.

VI. OFFSHORE WIND PROVIDES IMPORTANT RELIABILITY BENEFITS

Q. PLEASE DESCRIBE THE RELIABILITY BENEFITS OF OFFSHORE WIND IN A DECARBONIZING GRID.

A. Offshore wind provides a range of important benefits to the grid to ensure reliability in an increasingly renewable grid. The most important benefit stems from adding fuel diversity to the grid. North Carolina has been very successful in deploying significant new solar capacity over the past decade, and Duke's CPIRP includes high levels of sustained incremental solar capacity additions. However, the output of each solar facility is largely coincident with the pool of resources – the sun rises

and sets at generally the same time across the Carolinas, and cloudy conditions can similarly impact the portfolio across the footprint. Onshore wind will provide some diversity, but there is limited capacity expected (1,200 MW in the CPIRP).[34] Offshore wind has a notably higher expected capacity factor than either solar or onshore wind.[35] In addition, the seasonal and hour production shape is much different from other renewable resources, which provides important diversity, allowing more load to be served by non-emitting resources around the clock. Offshore wind output is highly coincident with winter peak demand conditions. Duke acknowledged this important benefit, stating that offshore wind generation "has its highest seasonal generation on winter mornings. As the peak planning hour has shifted to winter mornings, partially due to high solar integration, having capacity during those times is critically important, which is when offshore wind is consistently producing and peaking."[36] This coincidence with peak load provides important reliability value, and allows for a lower-emission supply portfolio without relying on as much storage to maintain reliability.

Q. HAS THE COMPANY CONDUCTED ANALYSIS TO DEMONSTRATE THESE BENEFITS?

A. Yes. The Company contracted with Astrapé Consulting to conduct studies on the reliability contribution of solar, offshore wind, and onshore wind.[37] These studies

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34 *See* Figure 2 above.

35 Docket No E-100, Sub 190, *Carolinas Resource Plan, Appendix C*, pp. 30 (Table C-22), 35 (Table C-28), and 37 (Table C-30).

36 Docket No E-100, Sub 190, *Carolinas Resource Plan. Appendix I: Renewables and Energy Storage*, pp. 29.

37 Docket No E-100, Sub 190, *Carolinas Resource Plan. Attachment II: Duke Energy Carolinas and Duke Energy Progress Effective Load Carrying Capability (ELCC) Study*, Astrapé Consulting, April 25, 2022.

used the effective load carrying capability ("ELCC") methodology, an industry-standard approach to determining the capacity value of renewable resources. The studies concluded that offshore wind provides a much higher winter capacity value, as a percent of nameplate, than either solar or offshore wind.

Due to the high penetration of existing solar PV resources and the low production during winter peak hours, the study concluded that solar (without storage) has a marginal capacity value of approximately 7% or less, depending on the scenario.[38] Onshore wind has an initial marginal capacity value of 43.8%, and offshore wind has an initial marginal capacity value of 74.9%.[39]

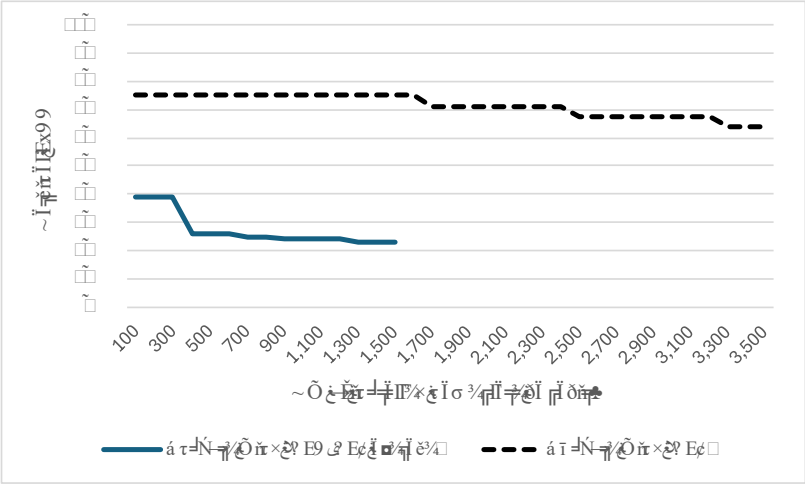
In addition to having a high initial capacity value for the first projects developed, offshore wind also maintains a higher capacity value even after multiple gigawatts of projects have been developed. The figure below charts the marginal ELCC value of onshore and offshore wind, provided in the Astrapé study. The results show that the incremental capacity value of onshore wind declines as more capacity is added. The marginal ELCC value of offshore wind similarly declines, but at a significantly slower rate.

Attachment III: 2023 Wind Effective Load Carrying Capability (ELCC) Study for Duke Energy Carolinas & Duke Energy Progress, Astrapé Consulting, August 15, 2023.

[38] Docket No E-100, Sub 190, *Carolinas Resource Plan. Attachment II: Duke Energy Carolinas and Duke Energy Progress Effective Load Carrying Capability (ELCC) Study*, Astrapé Consulting, April 25, 2022, pp. 10-11.

[39] Initial Filing, *Attachment III: 2023 Wind Effective Load Carrying Capability (ELCC) Study for Duke Energy Carolinas & Duke Energy Progress*, Astrapé Consulting, August 15, 2023, p. 4.

Figure 5. Marginal ELCC, Onshore and Offshore Wind[40]



Q. WHAT DO YOU CONCLUDE REGARDING THE RELIABILITY BENEFITS OF OFFSHORE WIND?

A. The results of Duke's analysis confirm that offshore wind provides important reliability benefits to North Carolina customers. As the grid decarbonizes to reach the Interim Requirement and eventually the net zero emissions goal, fuel diversity and generation coincident with peak load periods will be critical to maintaining reliability and controlling supply costs. Offshore wind will be an important component of North Carolina's future clean, reliable grid.

VII. ACCELERATED OFFSHORE WIND DEVELOPMENT HAS LOW IMPACT TO CUSTOMERS

Q. WHAT CUSTOMER IMPACTS DID THE COMPANY ANALYZE AS PART OF THE CPIRP ANALYSIS?

A. Duke's CPIRP includes an evaluation of the present value revenue requirement (PVRR) of each of the portfolios, and a calculation of the retail bill impact. The

[40] Data source: Duke Initial Filing, Attachment III: *2023 Wind Effective Load Carrying Capability (ELCC) Study for Duke Energy Carolinas & Duke Energy Progress*, Astrapé Consulting, August 15, 2023, p. 4.

PVRR analysis determines the annual revenue requirement of the resource portfolio, considering the impact of capital costs, operational costs, fuel costs, contractual energy purchases, and other factors. The revenue requirement also considers the offsetting value of production tax credits from renewable resources. The analysis considers revenue requirement impacts through 2050 and discounts the stream of annual values to create the PVRR metric.[41]

An analysis of portfolio revenue requirements is also the foundation of the calculation of the bill impacts.[42] For each portfolio, Duke divides the net incremental annual revenue requirement of the portfolio by total energy sales to calculate a net impact per kilowatt-hour (kWh). Lastly, using the estimated 2024 average monthly bill for a customer consuming 1,000 kWh, the Company calculates the change in the bill resulting from the net revenue requirement impact of the portfolio.[43]

Q. PLEASE SUMMARIZE THE KEY RESULTS OF THE CUSTOMER IMPACT ANALYSIS.

A. The table below summarizes the monthly bill impact estimated by the Company for the P1, P2, and P3 portfolios in both the Initial Filing and the Amended Filing for 2038.

41 Docket No E-100, Sub 190, Carolinas Resource Plan, Appendix C, pp. 85-86.
42 Docket No E-100, Sub 190, Carolinas Resource Plan, Appendix C, p. 92.
43 *Id.*

Table 2. Residential bill impact summary (Combined System, 2038), $/month[44]

	P1 2030 Interim Req.	P2 2033 Interim Req.	P3 2035 Interim Req.
Initial Analysis	$70	$56	$55
Amended Analysis	**BEGIN CONFIDENTIAL** [redacted]	[redacted] **END CONFIDENTIAL**	$80

The bill impact varies year-by-year, depending on the annual portfolio changes and the impact on revenue requirement. The figure below details the annual bill impact for the six portfolios from 2024 – 2038.

[44] Data sources: Initial Filing, P1, P2, P3: Duke's Confidential Response to Public Staff Data Request 1-7, attachment "PSDR 1-7 CONFIDENTIAL Tables C-65 through C-68_Carolinas Resource Plan Bill Impacts - Combined DEC and DEP.xlsx" and Amended Filing, P1, P2: Duke's Confidential Response to Public Staff Data Request 42-1, attachment "CONFIDENTIAL PS DR 42-1 - 1 Combined.xlsx" Amended Filing, P3: SPA, Table SPA 3-4, p. 42.

BEGIN CONFIDENTIAL

[redacted]

END CONFIDENTIAL

It is important to note that the bill impact results presented by the Company are in nominal dollars.

Q. WHAT IS THE SIGNIFICANCE OF THE BILL IMPACT BEING PRESENTED IN NOMINAL DOLLARS?

A. Since the bill impact is presented in nominal dollars, it automatically includes both the impact of the change in needed supply, as well as the impact of inflation. Duke presents the P3 Fall Base portfolio as an $80/month retail bill impact. However, that is compared to the average 2024 bill for a representative customer using 1,000 kWh per month, in nominal dollars. It is reasonable to expect that, even if there

[45] [redacted]

were no changes to the portfolio, retail bills would increase due to fuel price increases[46] and increases in operational costs due to inflation and other factors. By comparing the bill impact to a 2024 bill, the analysis groups those other economic factors in with the cost of the portfolio.

BEGIN CONFIDENTIAL [redacted]

END CONFIDENTIAL

[46] *See, e.g.,* Initial Filing, Appendix C, Figure C-4, p. 44, depicting Duke's long-term natural gas price forecasts.

Q. DOES THE COMPANY'S ANALYSIS PROVIDE INFORMATION TO DEMONSTRATE THE POTENTIAL BILL IMPACT OF ACCELERATING THE OFFSHORE WIND INVESTMENT?

A. Yes, it does. While the Company did not explicitly conduct a sensitivity analysis isolating the impact of adding or removing offshore wind from a portfolio, we can approximate the magnitude of the customer impact of accelerating offshore wind by comparing the results of the P3 Fall Base case with the P2 Fall Supplemental case.

BEGIN CONFIDENTIAL [redacted] **END CONFIDENTIAL**

[47] [redacted]

Q. WHAT DO YOU CONCLUDE REGARDING THE CUSTOMER IMPACT OF ACCELERATING OFFSHORE WIND DEVELOPMENT?

A. First, it is important to reiterate that the Company's latest analysis demonstrates that offshore wind is an important component of a least-cost, optimized resource portfolio. In the Amended Filing, all the primary portfolios contain significant levels of offshore wind capacity, and as such, offshore wind is delivering customer benefits as compared to alternative supply options considered in the CPIRP.

As the Company's preferred portfolio already includes significant offshore wind, there is a low risk of regret associated with advancing offshore wind deployment. In addition, the customer impact of accelerating renewable development (including advancing the offshore wind buildout) to meet the Interim Requirement by 2033 is a small percentage of the total estimated bill.

Given the other risk mitigation benefits of offshore wind (discussed previously in this testimony, it is clear that accelerating offshore wind development will be beneficial to customers and critical to achieving the Interim Requirement.

VIII. CONCLUSIONS AND RECOMMENDATIONS

Q. BASED ON THE FOREGOING TESTIMONY, PLEASE SUMMARIZE YOUR CONCLUSIONS?

A. Based on my review of the Company's filings and supporting documentation, it is clear that accelerating the planned buildout of offshore wind capacity would provide important benefits and protect customers from significant risks:

- Offshore wind represents a large potential source of non-emitting generation that can help meet the accelerating load growth while making

measurable progress toward the state's emission reduction requirements. Offshore wind provides important reliability benefits and a strong source of winter capacity.

- Pursuing offshore wind earlier in the planning period may give Duke additional margin to meet incremental future load growth, while deferring or avoiding construction of new combined cycle facilities. This would help avoid risks associated with future environmental policy and economic risks of resource underutilization.
- Building offshore wind sooner could help mitigate the impact of potential delays or cost increases for nuclear development on resource adequacy and compliance with emissions policy.
- Accelerating the build out of offshore wind capacity will have a minimal impact on customer rates.

Q. BASED ON THOSE CONCLUSIONS, WHAT DO YOU RECOMMEND?

A. I recommend that the Commission direct the Company to accelerate the development of offshore wind resources as part of a low-cost, low-risk portfolio that keeps the state on track to achieve emissions requirements. Installing offshore wind capacity sooner will provide an important hedge against future load growth and resource risks, providing significant benefits to Duke's customers.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes, it does.

BEFORE THE NORTH CAROLINA UTILITIES COMMISSION
DOCKET NO. E-100, SUB 190

In the Matter of Biennial Consolidated Carbon Plan and Integrated Resource Plans Duke Energy Carolinas, LLC, and Duke Energy Progress, LLC Pursuant to N.C.G.S § 62-110.9 and § 62-110.1(c)	)))))	**DIRECT TESTIMONY OF JEFFREY BOWER FOR AVANGRID RENEWABLES, LLC**

Exhibit JDB-1

DAYMARK ENERGY ADVISORS

Jeffrey D. Bower

Managing Consultant

Jeff advises infrastructure developers, utilities, and regulators pursuing commercial opportunities and policies to develop and deploy renewable energy resources and enabling transmission projects. He has broad experience in integrated resource planning, power market modeling, and the integration of offshore wind, land-based renewable energy, and transmission into RTO/ISO markets. His work includes economic and operational cost-benefit analysis and assessments of strategies to meet utility and state decarbonization goals. Jeff has testified before FERC and before state regulatory agencies in Arkansas, Georgia, and Maine, as well as the province of Manitoba.

SELECTED PROFESSIONAL EXPERIENCE

Integrated Resource Planning

- Evaluated a multi-state IRP in the western U.S. on behalf of a state's public service commission staff, assessing models, methods, assumptions, and conclusions.
- Reviewed the IRP of a vertically-integrated utility in the southeastern U.S., with specific focus on evaluation of renewable resource options and reserve margin. Provided expert witness testimony in regulatory approval proceeding.

Economic Benefits Analysis

- Conducted market and environmental benefits studies for multiple transmission, offshore wind and land-based renewable project proposals. Summarized results for submission by project developers into competitive procurements.
- Analyzed multiple midwestern utility proposals for build-own-transfer transactions for a large solar facilities. Provided expert witness testimony evaluating project need, consistency with IRP, and the utility's forecast of benefits to customers.
- Evaluated a large wind project proposed in the SPP RTO. Provided expert witness testimony regarding project benefits analysis, production cost modeling methodology, congestion risk, and associated transmission proposal benefits.
- Conducted detailed review of a western utility proposal to repower 1 GW of existing wind projects, examining PTC qualification, economic benefits to ratepayers, and project risks.

Wholesale Market Advisory Services

- Served as independent expert to Canadian energy regulator, advising on U.S. wholesale market trends and revenue opportunities for export sales
- Analyzed wholesale market pricing risks for generation developers, incorporating long-term price forecasting and market rule changes over time.
- Evaluated a midwestern utility proposal to join a regional transmission organization (RTO). Analyzed the impacts of the transition on transmission and generation resource adequacy and planning, as well as retail rates

- Authored a market survey of PJM for an independent power producer considering plant acquisitions. Evaluated market opportunities and risks, as well as projections of plant revenues and impacts of policy changes.

Clean Energy Strategy and Policy

- Evaluated a methodology for determining costs and benefits of renewable energy for a southeastern U.S. vertically-integrated utility. Advised state agency on avoided cost methodology, modeling techniques, and application of results to quantify system value of renewables.
- Analyzed Massachusetts' Alternative Energy Portfolio Standard, evaluating barriers to adoption of renewable thermal technologies and developing policy recommendations for the state agency to improve program participation and efficacy.
- Authored a market intelligence report for an offshore wind developer considering participation in a BOEM offshore wind lease auction. Summarized key market opportunities and barriers across multiple states and wholesale energy markets, including evaluation of renewable energy policies, market structures, and drivers of future demand for offshore wind and RECs.
- Supported the development of a transmission planning engagement strategy for a national environmental NGO. Advised on opportunities for high-impact engagement to promote rapid integration of renewables. Authored detailed surveys of regional differences in transmission planning needs and processes, and provided recommendations for high-leverage strategy elements.

INDUSTRY EXPERIENCE

Daymark Energy Advisors, Inc. — Worcester, MA
Managing Consultant — 2022 – Present
Senior Consultant — 2017 – 2022
Consultant — 2013 – 2017
Analyst — 2010 – 2013

Consulting practice includes:

- Power market modeling and price forecasting
- Power project financial pro-forma modeling and risk analysis
- Economic benefits analyses for generation and transmission infrastructure projects
- Energy policy analysis
- Integrated resource plan evaluation
- Competitive market design advisory services
- Potential assessment of renewable energy and energy efficiency resources
- Expert witness testimony

Climate Change Policy Partnership at Duke University — **Durham, NC**
Transportation Research Assistant — 2009 – 2010

North Carolina Sustainable Energy Association — **Durham, NC**
Wind Power Research Analyst Intern — 2009

EDUCATION

Master of Environmental Management | Nicholas School of the Environment at Duke University, Durham, NC | 2010

Certificate in Geospatial Analysis | Duke University, Durham, NC | 2010

B.A. Sociology | Tufts University, Medford, MA | 2004

TESTIMONY & PUBLICATIONS

Expert Testimony

FORUM	ON BEHALF OF	MATTER
Arkansas Public Service Commission	Arkansas PSC General Staff	Petition of Entergy Arkansas, LLC for Approval of Power Purchase Agreements. Docket No. 22-082-U.
Arkansas Public Service Commission	Arkansas PSC General Staff	Application of Southwestern Electric Power Company for Approval to Acquire New Renewable Generation Facilities and to Recover the cost of Power Purchase Agreements. Docket No. 22-019-U.
Arkansas Public Service Commission	Arkansas PSC General Staff	Petition of Entergy Arkansas, LLC for Approval of a Build-Own-Transfer Arrangement for a Solar Facility. Docket No. 20-067-U.
Arkansas Public Service Commission	Arkansas PSC General Staff	Petition of Entergy Arkansas, LLC for Approval of a Build-Own-Transfer Arrangement for a Solar Facility. Docket No. 20-052-U.
Arkansas Public Service Commission	Arkansas PSC General Staff	Application of Southwestern Electric Power Company for Approval to Acquire Wind Generating Facilities. Docket No. 19-035-U.
Arkansas Public Service Commission	Arkansas PSC General Staff	Petition of Entergy Arkansas, LLC for Approval of a Build-Own-Transfer Arrangement for a Solar Facility. Docket No. 19-019-U.
Georgia Public Service Commission	Georgia PSC Public Interest Advocacy Staff	Georgia Power Company's 2022 Integrated Resource Plan. Docket No. 44160.
Georgia Public Service Commission	Georgia PSC Public Interest Advocacy Staff	Capacity and Energy Payments to Cogenerators Under PURPA. Docket Nos. 4822, 16573, 19279.
Maine Public Utilities Commission	Central Maine Power Company	Application for Certificate of Convenience and Public Necessity (CPCN) for the New England Clean Energy Connect. Provided analysis of economic benefits of HVDC transmission project. Docket No. 2017-00232.
Manitoba Public Utilities Board	Independent Expert Consultant to the Board	Manitoba Hydro 2023/24 and 2024/25 General Rate Application.
FERC	New York Utility Intervention Unit	FERC Notice of Proposed Rulemaking (NOPR): Offer Caps in Markets Operated by Regional Transmission Organizations and Independent System Operators. Submitted comments addressing the adverse efficiency impact of setting the offer cap too high and of maintaining different caps in adjacent regions. No. RM16-5-000. April 2016.

Publications

- *Memorandum of Wyoming Public Utilities Commission Staff*, report summarizing evaluation and findings related to PacifiCorp (d/b/a Rocky Mountain Power) 2019 Integrated Resource Plan and associated Coal Retirement Study (Docket No. 90000-144-XI-19 and Docket No. 90000-147-XI-19), July 6, 2020. Contributing Author.
- *MCPC Project Benefits; Quantitative and Qualitative Benefits,* confidential report prepared for Central Maine Power regarding the benefits of the Maine Clean Power Connection, a 345-kV transmission expansion accompanied by 1,100 MW of wind energy project development offered in the Massachusetts RFP for Clean Energy Resources, July 27, 2017. Contributing Author.
- *NECEC Project Benefits; Quantitative and Qualitative Benefits,* confidential report prepared for Central Maine Power and H.Q. Energy Services regarding the benefits of the New England Clean Energy Connection, 1,200 MW HVDC transmission expansion accompanied by 1,090 MW of hydropower and wind energy project development offered in the Massachusetts RFP for Clean Energy Resources, July 27, 2017. Contributing Author.
- *Evolving Practices in Electric Company Resource Planning: Key Insights from a Review of 15 Recent Electric Company Resource Plans,* report prepared for the Electric Power Research Institute. May 2017. Contributing Author.
- *MREI Project Benefits; Direct, Indirect, Qualitative and Other Benefits,* prepared for Central Maine Power Company and Emera Maine regarding the benefits of the Maine Renewable Energy Initiative, a 345-kV transmission expansion accompanied by 1,200 MW of wind energy project development, January 28, 2016. Contributing Author.
- *MCPC Project Benefits; Direct, Indirect, Qualitative and Other Benefits",* prepared for Central Maine Power Company regarding the benefits of the Maine Clean Power Connection, a 345-kV transmission expansion accompanied by nearly 600 MW of wind energy project development, January 28, 2016. Contributing Author.