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

In the Matter of:	)	**DIRECT TESTIMONY OF**
Biennial Consolidated Carbon Plan and	)	**DR. JOHN O'BRIEN AND**
Integrated Resource Plans of Duke Energy	)	**PHILIP MOOR ON BEHALF**
Carolinas, LLC and Duke Energy	)	**OF THE NORTH CAROLINA**
Progress, LLC, Pursuant to N.C.G.S.	)	**SUSTAINABLE ENERGY**
§ 62-110.9 and § 62-110.1(c)	)	**ASSOCIATION**
	)	

Q DR. O'BRIEN, PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A My name is Dr. John N. O'Brien, and my business address is 1093 A1A Beach Blvd 175, St. Augustine, FL 32080.

Q PLEASE DESCRIBE YOUR BACKGROUND AND EXPERIENCE.

A I spent 10 years as a scientist at the U.S. Department of Energy's Brookhaven National Laboratory in the Department of Nuclear Energy. While at Brookhaven, I studied the safety and security of special nuclear materials, international nuclear proliferation, security at nuclear weapons fabrication facilities, and a number of aspects of nuclear reactor safety. After that, as an entrepreneur, I founded, operated, and divested several companies in the natural gas and electric markets. I later joined several different consulting firms where I advised energy related firms operating in the natural gas and electricity markets, including several utilities and renewable energy developers. In 2006, I was named a Commissioner on the Florida Energy Commission, serving as Chair of the Climate Change Subcommittee. Currently, I am a faculty member in the Public Administration Program at Flagler College where I teach both undergraduate and graduate courses.

For the last 20 years I have served as an expert witness in numerous judicial and regulatory proceedings involving energy-related matters. During that time, I have testified before the United States Congress, the New York State Legislature, and the energy regulatory commissions in Massachusetts, Virginia, and New York.

Q PLEASE DESCRIBE YOUR EDUCATIONAL BACKGROUND.

A I hold a baccalaureate degree in Chemistry from Syracuse University, and an M.A. and Ph.D. in Interdisciplinary Social Sciences from the Maxwell School at Syracuse University.

Q HAVE YOU EVER PUBLISHED ON PUBLIC UTILITY REGULATORY ISSUES?

A I have published numerous nuclear energy related regulatory guidance documents called NUREGs for the U.S. Nuclear Regulatory Commission on various aspects on the management of nuclear reactors. I also published a book on regulatory aspects of controlling international proliferation of nuclear materials and nuclear weapons. I have published two Law Review articles and a number of pieces in general periodicals. My curricular vitae is provided in **Appendix I**.

Q HAVE YOU EVER TESTIFIED BEFORE THIS COMMISSION OR OTHER UTILITY COMMISSIONS?

A No, I have not testified before the North Carolina Utilities Commission ("Commission"). However, as previously noted, I have testified before the Virginia, Massachusetts, and New York utility commissions.

Q MR. MOOR, PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A My name is Philip M. Moor, and my business address is 4451Brookfield Corporate Drive, Suite 107, Chantilly, VA 20151.

Q PLEASE DESCRIBE YOUR BACKGROUND AND EXPERIENCE.

A I have been in responsible positions for the construction of nuclear power plants, and for capital project modifications of boiling water reactor operating nuclear

plants and pressurized water reactor operating nuclear plants. I have also been a project developer of new fossil fuel generation projects. I have provided consulting services to clients in the nuclear industry for over 20 years, particularly in project development and management and project controls. I have been deeply involved in the development of small and advanced reactors for decades, serving as the Chair of the American Nuclear Society (ANS) President's Special Committee on Small Modular Reactor (SMR) licensing for three successive ANS presidents. I have been an expert witness or technical support of experts on several litigations that involve electrical generating and nuclear power plant disputes.

Q PLEASE DESCRIBE YOUR EDUCATIONAL BACKGROUND.

A I have a Bachelor of Science Degree in Mechanical Engineering from Fairleigh Dickinson University and a Master of Science Degree in Engineering Management from the New Jersey Institute of Technology. I am a registered Professional Engineer in New Jersey. My curricular vitae is provided as **Appendix II**.

Q HAVE YOU EVER TESTIFIED BEFORE THIS COMMISSION OR OTHER UTILITY COMMISSIONS?

A No, I have not testified before this Commission or any other state utility commission.

Q ON WHOSE BEHALF ARE YOU BOTH APPEARING IN THIS PROCEEDING?

A We are appearing on behalf of the North Carolina Sustainable Energy Association ("NCSEA").

Q WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A The purpose of our testimony is to assist the Commission in the principal goal of this proceeding, to make rational and reasonable determinations for the best overall mix, use, and timing of the deployment of several generation technologies proposed to be deployed by Duke Energy Carolinas, LLC, and Duke Energy Progress, LLC (collectively, "Duke" or the "Companies"). The Companies have put forward their proposal for the optimal mix and timing of deployment generation technologies in their proposed resource portfolios and their Near-Term Action Plan ("NTAP"), which extends through 2026, and the Intermediate Term, extending through 2032. We have prepared an Expert Report, titled "Evaluation of the Temporal Deployment of Offshore Wind Generation and Advanced Nuclear Generation in the Duke Energy Carolinas Resource Plan," attached as **Appendix III**, to provide the Commission informed guidance on the technological and economic feasibility and optimal timing of deployment for two, primary long-lead resources: Offshore Wind ("OSW") electric generation and Advanced Nuclear technology and Small Modular Reactors (collectively referred to as "New Nuclear").

Q WHY IS YOUR TESTIMONY FOCUSED ON THE TECHNICAL AND ECONOMIC FEASIBILITY OF THE DEPLOYMENT OF THESE LONG LEAD GENERATION TECHNOLOGIES?

A Important questions regarding the relative timing and mix of the Companies' plan for deployment of each of these two long lead technologies during the next decade have been raised. Specifically, is it reasonable to move forward with the early development of the New Nuclear option in the near-term while deferring the early development of the OSW option for an indeterminate period of time?

The Companies, in their preferred portfolio (P3 Base) for the Carolinas Resource Plan, initially proposed to rely heavily on the New Nuclear option by taking significant steps towards the early development of New Nuclear facilities, but defer and effectively postpone any early development activities necessary to facilitate the future deployment of OSW. Not until the Companies identified a significant increase in their load forecast and submitted a supplemental portfolio (P3 Fall Base), did the Companies' modeling accelerate the selection of limited OSW generation to 2035. However, despite proposing limited OSW deployment by 2035, the Companies continue to defer the early development of the OSW option by only requesting $1.4 million dollars to develop and administer the proposed Acquisition Request for Information ("ARFI"), while seeking no other authorizations to incur early development costs necessary for the timely deployment of OSW. Appendix III, at 6–7. Comparatively, the Companies are requesting another $365 million dollars for early development activities for New

Nuclear on top of the $75 million they are already authorized to incur. *Id.* We disagree with the Companies' proposal in their original plan, as filed on August 17, 2023, that OSW should be considered at some point in the future while New Nuclear is already being actively deployed. We further believe that early development for both technologies should be funded and undertaken in the near term. Meaning, as discussed throughout the Expert Report, we recommend that the Commission authorize the material progress towards the construction and operation of OSW facilities of the North Carolina coast by allowing the Companies and the wind energy area ("WEA") leaseholders to incur early development costs that are more substantive and proportional in value compared to the Commission's authorization for early development activities for New Nuclear resources.

Crucially, we believe that pursuing deployment diversity provides an additional element of redundancy and reliability in resource planning. Redundancy and diversity are basic, conservative tenets of energy regulation. OSW early development costs will be dwarfed compared to the future economic costs of a generation capacity shortage that may result from a lack of generation diversity. As we explain in the Expert Report, "[i]f one technology is not deployed as planned, which is a distinct possibility with either [OSW or New Nuclear], the other could make up for the absence of generation capacity that will be required to effectively power the quickly growing North Carolina economy." Appendix III, at 8. Deployment diversity is also a cost-effective means to address this

vulnerability of the Companies' plan as balanced against the risk of stranded costs by allowing OSW developers the ability to incur early development costs—which will likely be significantly less. Our examination concludes that OSW is equally as deployable as New Nuclear. That is not to say that either technology can be routinely or easily deployed in the Companies' electric generation mix. Both are somewhat new technologies, never previously deployed in North Carolina and the Companies' service territories and should be carefully implemented over an appropriate period of time. However, given the benefits and challenges that may arise during the implementation of these two technologies, our conclusion is that neither technology is any more advantageous for early deployment than the other. In other words, our analysis does not support the conclusion that the New Nuclear option is deployable significantly in advance of the OSW option as outlined in the Companies' preferred portfolio.

Q HOW IS YOUR EXPERT REPORT STRUCTURED?

A We have framed our analysis of the objective stated criteria to reflect on a realistic and pragmatic basis, a direct comparison of the attributes and obstacles of deploying the OSW and New Nuclear technologies. This report first comprehensively examines a parallel taxonomy of relevant characteristics of the OSW technology (Chapter 2.0) and the New Nuclear technology (Chapter 3.0) that are relevant to the decision-making process that we believe the Commission must undertake. In each chapter, the information is framed and organized into four broad, principal topical areas and significant subtopics of concern to examine each technology in a side-by-side manner. The principal topical areas are:

(1) the execution risks associated with each technology to promote an orderly transition from the current generation mix to the new mix of generation assets,

(2) the capability of the business models for each technology to effectively achieve the least-cost carbon reduction results and ratepayer equity,

(3) how each technology contributes to the most effective means of maintaining and/or improving system reliability, and

(4) the capability of each technology to promote the general welfare and wellbeing of the citizens and residents of North Carolina.

Chapter 4.0 is a comparative analysis, presented as a summary, discussing our analyses and conclusions of the four relevant areas of concern for the timely deployment of OSW and New Nuclear technologies. This chapter represents an "apples-to-apples," side-by-side comparison of a detailed taxonomy of critical considerations in the timing of the development and deployment of these two technologies. There, we attempt to form an objective basis for the Commission's determination of the optimal timing and development of the deployment of these two carbon free generation technologies. As a result, these direct comparisons carefully illustrate the relative risks and benefits for the deployment of the OSW and New Nuclear technologies.

Q DOES YOUR EXPERT REPORT MAKE ANY ADDITIONAL SPECIFIC RECOMMENDATIONS?

A Yes, we make the following specific recommendations:

(1) Adopt a procedural schedule that requires interim updates from Duke and the WEA leaseholders of the ARFI and its preliminary results, including meaningful direct negotiations, written filings and/or convening a technical conference for the purposes of receiving presentations from the Companies and the WEA leaseholders on ARFI and its preliminary results in the Fall of 2024 to inform the Commission's decision-making related to next steps for the development and procurement of offshore wind in this proceeding;

(2) Direct the Companies and the WEA leaseholders to jointly develop, through direct negotiations, procurement schedules for each WEA, with achievable milestones through 2032, to guide the development of all, or a portion of, each WEA to achieve, at a minimum, the proposed 2.4 GW of offshore wind generation in the Companies' supplemental portfolio and analysis.

(3) Authorize, for purposes of executing the CPIRP, early development activities for the deployment of OSW with the ability to incur an equivalent level of funding—approximately $75 million—committed to New Nuclear near-term development actions through 2026. These funds should be earmarked towards the necessary site assessment activities—like geophysical surveys using high resolution instruments to map the seafloor and geotechnical site investigation equipment needed to map out the areas 200 feet under the subsea bottom surfaces—to prepare and collect the site characterization data required for approval of the Kitty Hawk and Carolina Long Bay lease areas' Construction and Operating Permits (COP), as well as supporting early transmission planning for the OSW facilities in development; and

(4) Following the conclusion of the ARFI, convene a separate docket specifically for the purpose of receiving annual and/or regular updates to track the OSW procurement and development activities.

Appendix III, at 13–14. These recommendations should aid the timely deployment of OSW by providing the Commission all the information it requires, as well as ensuring the federal approval processes administered by the Bureau of Ocean Management ("BOEM") and the Bureau of Safety and Environmental Enforcement ("BESS") continue without delay.

Q CAN YOU ELABORATE ON THE RECOMMENDATIONS 1 AND 2 THAT PROPOSE MODIFYING DUKE'S PROPOSED ARFI?

A Yes. Our rationales for Recommendations 1 and 2 are first explained in Chapter 1.0 of the Expert Report and adopts much of the reasoning put forth by NCSEA et al. in their comments in support of the Public Staff's Motion for Issuance of Commission Order, as filed with the Commission on April 25, 2024.

It is our belief that the purpose of any ARFI the Commission approves should be expressly intended to enable the Companies and WEA leaseholders to enter meaningful negotiations with the explicit goal of finalizing draft operative procurement procedures and realistic development schedules for each WEA. As explained in the Expert Report, the WEA leaseholders are already in possession of most of the information currently sought in the proposed ARFI as they are currently negotiating similar issues with other states and utilities for other OSW projects they are developing. Accordingly, if the Commission expedites the ARFI process and adopts our recommendations, we believe that the Commission can both receive preliminary results to inform their decision-making in this proceeding and have a durable process for reviewing the status and progress of OSW throughout the near- and intermediate-term.

Q IN THE EXPERT REPORT, AS PART OF YOUR RECOMMENDATIONS REGARDING THE MODIFIED ARFI, YOU DISCUSS THE SMART POWER MOU. CAN YOU ELABORATE ON ITS INCLUSION?

A Yes. The SMART-POWER MOU is a formal, non-binding arrangement with the explicit purpose of reducing administrative burdens, producing regulatory certainty, and sharing information to develop best practices for OSW deployment. The SMART-POWER MOU is also specifically designed to promote, develop, and expand OSW electric generation and the accompanying industry supply chain and workforce along the Southeast and Mid-Atlantic portions of the Eastern Seaboard. We view this collaborative as another important avenue for the Commission to collect information on the deployment of OSW elsewhere. As

discussed in the Expert Report, although North Carolina has greater potential for OSW generation, neighboring states are advancing this resource sooner. We recommend, that should the Commission find good cause to convene a technical conference on OSW, representatives from the North Carolina SMART-POWER MOU leadership team be invited to advise the Commission on the learnings from this multistate collaborative. The perspective of an uninterested third-party may further enhance the Commission's decision-making.

Q HOW WILL THE ARFI, AS PROPOSED BY DUKE, AFFECT THE TIMING OF THE DEPLOYMENT OF OSW?

A As stated, we find that the Companies' proposal creates a substantial execution risk to the timely deployment of OSW. The proposed ARFI effectively delays any affirmative decision regarding the deployment of OSW to the conclusion of the next biennial Carbon Plan IRP proceeding, which specifically affects the ability of the WEA leaseholders to timely procure the needed materials and resources, and reserve space in the already-significant queues for specialized maritime vessels necessary to the installation of OSW facilities. *See, e.g.,* Appendix III, at 24–25.

Additionally, this delay may affect the Companies' and the WEA leaseholders' ability to maximize the federal incentives found in the Inflation Reduction Act ("IRA"). As discussed, the technology-neutral Clean Electricity Tax Credits, that will replace the legacy investment tax credit and production tax credit that OSW was eligible to receive, are in effect through the later of 2032 or the year when emissions from electric generation facilities are 25% of 2022 emission levels.

Although there is debate regarding when electric generating facilities achieve the emission reduction levels, it is our understanding that WEA leaseholders would like to begin construction on their OSW facilities prior to the time the Clean Electricity Tax Credits become conditional. Moreover, the phase-out of other financial incentives in the IRA, like the advanced manufacturing tax credit, are not conditioned. The advanced manufacturing tax credits for companies that domestically manufacture and sell clean energy equipment—covering certain OSW components like blades, nacelles, towers, etc.—begin to phase out starting after 2030 and will entirely expire following December 31, 2032. *See* Appendix III, at 25–27. Accordingly, the proposed ARFI causing the delay of a substantive order on OSW until the conclusion of the next biennial Carbon Plan IRP proceeding may limit the magnitude of subsidized materials the WEA leaseholders could procure, to the detriment of North Carolina ratepayers.

Q CAN YOU ELABORATE ON RECOMMENDATION 3 AND THE NEED FOR EARLY DEVELOPMENT ACTIVITIES FOR OSW BEING AFFIRMATIVELY AUTHORIZED BY THE COMMISSION?

A Yes. In the Expert Report, we provide a detailed summary of the new and prior regulations governing the site assessment and site characterization studies required for federal approval to develop a WEA by the BOEM and BESS. *See* Appendix III, at 14–18. The early development activities we recommend are necessary for the WEA leaseholders to submit, and receive approval of, their construction and operating permits ("COP"). The COP requires certain site characterization surveys, like geotechnical exploration, "to assess the suitability

of shallow foundation soils for supporting a structure or transmission cable under any operational and environmental conditions that might be encountered (including extreme events), and to document soil characteristics necessary for the design and installation of all structures and cables." *Id.*, at 14–18. Since these surveys are directly tied to the design and installation of the structures and cables needed to generate and transport electricity from an OSW facility, these surveys must be completed to determine the quantity and type of resources a WEA leaseholder must procure. Accordingly, delay in these studies, which may take several years to complete, also impinges the WEA leaseholders' ability to procure federally subsidized materials.

Importantly, these early development activities can occur in parallel to the modified ARFI. Meaning, if the Commission authorizes the ability to incur costs earmarked for these activities, the Commission should receive far more accurate and realistic updated costs than through either Duke's proposed ARFI or our modified ARFI. Authorizing these early development activities for the Companies and WEA leaseholders also further ensures that the deployment of OSW outpaces or meets Duke's proposed timeline for the resource in its supplemental portfolio, P3 Fall Base.

Q WHAT CONCLUSIONS DOES YOUR EXPERT REPORT MAKE REGARDING NEW NUCLEAR RESOURCES, LIKE SMALL MODULAR REACTORS AND ADVANCED NUCLEAR TECHNOLOGIES?

A Regarding Small Modular Reactors ("SMRs"), we have comprehensively considered relevant industry history and data as well as the Companies' statements in the Plan. See Appendix III, at 44–54. We have concluded that 2039 is the earliest likely Commercial Operation Date ("COD") of the first New Nuclear unit in North Carolina, as opposed to the Companies' COD estimate of January 1, 2034. In part, this conclusion was made considering Duke's preference not to be first in developing and funding a New Nuclear project. We agree with that posture. It is our experience that First-of-a-kind ("FOAK") projects face uncertainties in costs and timelines, limited access to traditional financing due to perceived risks, lack of historical data for accurate estimates, and the presence of unknown and unknowable risks that are hard to identify and mitigate. However, it is important to note that this will leave the timing of New Nuclear capacity in North Carolina in the hands of other developers and utilities and leave the Commission with significant uncertainty concerning deployment timing. The Companies cannot control the timing of others' efforts to develop the FOAK New Nuclear project.

We also have noted that recent trends for the construction of a nuclear facility require approximately 91 months. Incorporating our assessment of a 30-month NRC licensing process for the second-of-a-kind reactor and average nuclear

reactor construction history, we estimate an optimistic schedule for a new, second-of-a-kind reactor could achieve commercial operation in 10 years, or approximately 121 months, from project approval. This includes the assumption that the facility receives either a Combined Operating License Application (10 CFR 52) or an individual construction permit pursuant to 10 CFR 50 in 30 months. Further, other than NuScale there are no New Nuclear SMR or AR technology designs presently certified by the NRC. Statements in the Companies CPIRP suggest that the Companies have not selected the type of reactor technology that represents their first SMR and do not plan to do so until at least 2026. The Companies also stated that they are working with multiple vendors to monitor and track leading designs, with the last design's evaluation to be completed in 2027. Therefore, we assume the nominal 10-year schedule begins when a technology is selected, and that technology is then submitted for a COLA or a construction permit. Stated differently, if a design-certified technology was chosen by Duke Energy in 2027, the optimistic commercial operation date (COD) for New Nuclear would be 2037. However, that optimistic COD assumes no delays in the permitting and licensing for the construction of the selected technology. Since there has also been a consistent pattern of delays in U.S. nuclear construction, for planning purposes it would be a reasonable practice to add a 20% schedule contingency—or approximately two years—to the estimated completion date for the Companies' first New Nuclear facility.

Our Expert Report provides greater substance and support for our conclusion that the Companies' proposed timeline for a New Nuclear facility is aggressive and that a more realistic timeframe for the Companies' first New Nuclear facility is 2039. Our suggested, likely delay of New Nuclear deployment puts the consideration of earlier deployment of OSW generation in a clear perspective regarding the need to employ low-carbon generation to comply with state law. It appears likely that OSW generation can be available before New Nuclear generation.

Q WHAT OTHER COMPARISONS DOES YOUR EXPERT REPORT MAKE BETWEEN OSW AND NEW NUCLEAR RESOURCES?

A Chapter 4.0 of the Expert Report summarizes our "apples-to-apples," side-by-side comparison of these two long-lead time generation assets. Although we disagree with the Companies' proposal, as filed on August 17, 2023, that the deployment of OSW be considered at some point in the future while New Nuclear is being actively pursued, we conclude that both resources are ultimately needed to achieve the requirements of state law and reliably serve the Companies' customers. These generation options serve similar needs and are both capable of contributing substantial carbon-free generation for Duke's customers. We have not found any significant basis for distinguishing the substantive initiation of development between the two technologies on the basis of execution risk. Both technologies have their execution challenges. Therefore, if the two resources are pursued on parallel tracks and one technology experiences execution difficulties, the other can continue to support North Carolina's growing economy and citizens.

Q ARE THERE ANY OTHER POINTS YOU WANT TO EMPHASIZE FROM YOUR EXPERT REPORT?

A Yes. In consideration of design maturity, there is little doubt concerning the maturity of OSW technology as it has been fully deployed and operational in many regions of the world. New Nuclear designs are tested; however, we anticipate significant progress by the FOAK developers before the relevant regulatory bodies and utilities, before we can fully realize and analyze the construction cost and schedule for these resources. Once the New Nuclear FOAK designs are approved for construction, we anticipate that the Companies will move expeditiously to submit their applications to the relevant permitting and licensing authorities for approval.

Our Expert Report emphasizes the benefits associated with being a second mover. Today, the Companies are certainly second movers with regards to OSW. As detailed in the Expert Report, many facilities are beginning operation and/or construction across the Eastern Seaboard. Accordingly, the challenges of deploying OSW are being experienced outside of the context of the Companies' ratepayers, and the Companies' and WEA leaseholders are benefitting from the learnings from those earlier projects.

For New Nuclear, it is unclear when the Companies will be a second mover. As discussed, the only approved project design for SMRs has been cancelled, and the

next closest designs for an SMR are under development by TerraPower and the Tennessee Valley Authority. Appendix III, at 52 n. 163.

Q DOES THIS CONCLUDE YOUR TESTIMONY?

A Yes.