STATE OF NORTH CAROLINA
UTILITIES COMMISSION
RALEIGH

DOCKET NO. E-100, SUB 190

BEFORE THE NORTH CAROLINA UTILITIES COMMISSION

In the Matter of Biennial Consolidated Carbon Plan and Integrated Resource Plans of Duke Energy Carolinas, LLC, and Duke Energy Progress, LLC, Pursuant to N.C.G.S. § 62-110.9 and § 62-110.1(c)	)))))))	**REBUTTAL TESTIMONY OF SAMUEL HOLEMAN III AND PATRICK O'CONNOR ON BEHALF OF DUKE ENERGY CAROLINAS, LLC AND DUKE ENERGY PROGRESS, LLC**

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I. INTRODUCTION AND OVERVIEW

Q. MR. HOLEMAN PLEASE STATE YOUR NAME, BUSINESS ADDRESS AND POSITION WITH DUKE ENERGY CORPORATION.

My name is John Samuel Holeman III (Sam), and my business address is 526 S. Church Street, Charlotte, North Carolina, 28202. When Direct Testimony was filed, I was the Vice President of Transmission System Planning and Operations for Duke Energy Corporation. Since then, my title has changed to Vice President, Special Projects, Grid Planning and Integration.

Q. WHAT ARE YOUR RESPONSIBILITIES IN YOUR NEW ROLE?

A. In my new role, I provide support for strategic projects related to future operations and planning. These projects include the Companies' planned Balancing Authority Consolidation, Distributed Energy Resources ("DERs") integration and operations, storage integration and operations, as well as operational readiness planning industry energy transition related to the Companies' 2023-2024 Carbon Plan and Integrated Resource Plan ("CPIRP" or the "Plan") and South Carolina Integrated Resource Plan ("IRP").

I am providing rebuttal testimony on behalf of Duke Energy Carolinas, LLC ("DEC") and Duke Energy Progress, LLC ("DEP" and, together with DEC, "Duke Energy" or the "Companies"), together with Patrick O'Connor as the "Reliability and Operational Resilience Panel" ("Panel").

Q. ARE YOU THE SAME RELIABILITY AND OPERATIONAL RESILIENCE PANEL THAT FILED DIRECT TESTIMONY IN THIS CASE?

A. Yes.

Q. IS THE RELIABILITY AND OPERATIONAL RESILIENCE PANEL INTRODUCING ANY EXHIBITS IN SUPPORT OF THE REBUTTAL TESTIMONY?

A. Yes. Reliability and Operational Resilience Panel Rebuttal Exhibit 1 provides graphics and figures presented in the Panel's testimony in a larger, more readable format.

Q. MR. HOLEMAN ON BEHALF OF THE PANEL, PLEASE SUMMARIZE THE KEY TAKEAWAYS OF THE PANEL'S REBUTTAL TESTIMONY.

A. The purpose of this Panel's testimony is to respond to certain issues raised by intervenors that implicate the Companies' ability to maintain or improve the reliability of the grid as required by North Carolina Session Law 2021-165 ("HB 951"). This testimony seeks to ground these issues in the operational and planning realities that the Companies face each and every day as they plan and operate to provide reliable and secure electric service to customers in North Carolina and South Carolina during the ongoing energy transition. Beyond responses to specific intervenors, key take-aways of this Panel's testimony include:

1. The energy transition requires utilities to rewire the house while living in it, and the Companies' "all of the above" strategy during the transition will provide system operators with the diverse mix of resource capabilities needed to ensure operational reliability.

2. The North American Electric Reliability Corporation's ("NERC") 2023 Reliability Risk Priorities Reports identifies the changing resource mix as the top risk to the grid with resource adequacy as the second highest risk. The Companies' CPIRP appropriately reflects the industry's guidance to navigate the increasing complexity of the system, including adopting an orderly pace of transition and planning for resource diversity.
3. Dispatchable resources allow system operators the flexibility to address real-time system needs. As the Companies retire the entirety of their existing, but aging coal fleet, new dispatchable resources like natural gas that can "turn on" and ramp quickly are necessary tools to keep the lights on 24 hours a day, 7 days a week, 365 days a year.
4. Grid Edge programs are an important part of the Companies' plan for the future. At present, however, they do not provide the same capabilities, or "tools," as generating resources that a system operator can depend on to serve the system in real time.
5. From a system operator's perspective, the Companies' recommended Portfolio P3 Fall Base presents a diverse mix of resources that includes the dispatchable capabilities that system operators need to reliably operate the grid in the face of growing load. This adequate mix of resources, incorporated at an orderly pace, will ensure that the Companies have the tools needed to maintain or improve reliability during the energy transition.

Overall, the Companies' CPIRP plans for an orderly transition that will provide system operators with the tools needed to meet customer demand 24x7 and maintain or improve upon system reliability as required by HB 951. As the Companies continue taking steps to execute the CPIRP, the opportunity to check and adjust every two years ensures an intentional, deliberate, and disciplined manner that will ensure a continued reliable system.

II. AN "ALL OF THE ABOVE" STRATEGY IS NEEDED TO MAINTAIN OR IMPROVE RELIABILITY

A. Duke Energy's All of the Above Approach

Q. SEVERAL INTERVENORS RECOMMEND THAT THE COMPANIES FURTHER ACCELERATE THE DEVELOPMENT OF RENEWABLE RESOURCES.[1] DO YOU BELIEVE THE COMPANIES CAN INCREASE THIS PACE WHILE MAINTAINING OR IMPROVING GRID RELIABILITY?

A. The electric grid is one of the most critical infrastructures, supporting the vitality of the individual customers and communities who rely on electricity to maintain their health, well-being, livelihood, profitability, etc. on a millisecond-by-millisecond basis. Unlike any other party to this proceeding, DEC and DEP have the real-world obligation to provide reliable electric service to their customers, 24 hours a day, 7 days a week, 52 weeks a year. The Companies'

[1] *See, e.g.*, Attorney General's Office ("AGO") Burgess Direct Testimony at 48-51 (proposing to increase the total amount of solar available on the system by 2032); AGO Burgess Direct Testimony at 54-56 (advocating for accelerated development of onshore wind); TotalEnergies Tanner Direct Testimony at 4 (arguing for accelerated development of offshore wind); Carolinas Clean Energy Business Association ("CCEBA") Hagerty Direct Testimony at 9-10 (suggesting that the Companies' modeling assumptions disadvantage solar over other resources).

System Operators manage this complex ecosystem through their Control Centers, relying on decades of experience deploying proven technologies with dependable attributes to meet the expected and real-time energy needs of their customers.

As explained in this Panel's Direct Testimony, the energy transition necessarily requires the introduction of newer technologies with different capabilities as legacy resources, like coal plants, are retired. Transitioning the system to rely more heavily on renewable resources to meet customer demand introduces significant additional complexity to the existing grid, changing the mix of tools available to system operators to meet load and requiring utilities to rewire their house while living in it.

The CPIRP already plans for development and interconnection of an unprecedented amount of renewable resources in the near-, intermediate-, and long-term. An "all of the above" strategy will allow the Companies to accommodate and incorporate significant new renewable resources while approaching this transition in an orderly, realistic, and judicious manner, which is the only way the Companies can meet HB 951's CO_2 emissions reductions targets while maintaining or improving upon the reliability of the grid.

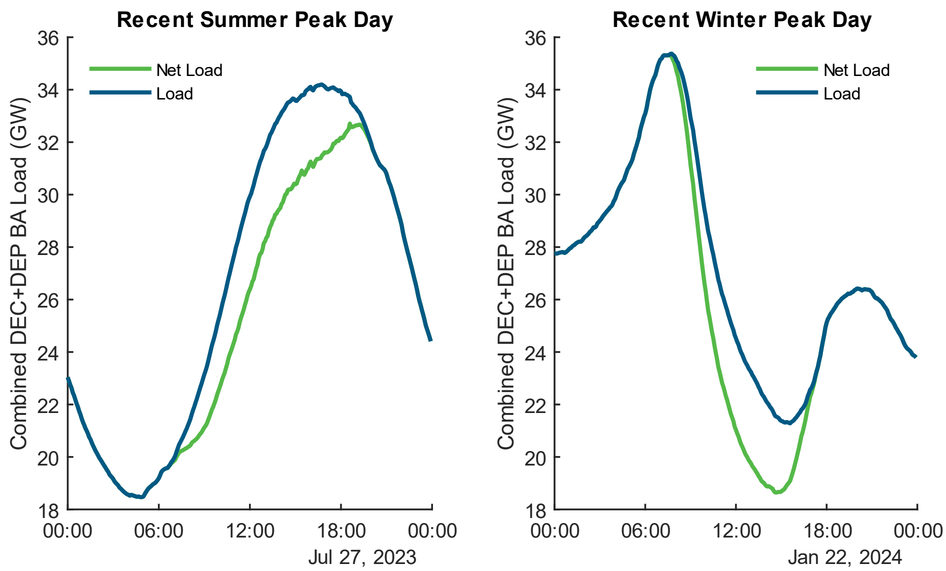
From a System Operator's view, an "all of the above," orderly transition ensures that when over 8,000 megawatts ("MW") of dispatchable coal-fueled generation is retired over approximately the next decade, there is a robust mix of resources that replace the operational capabilities that coal currently provides—particularly in capacity constraint conditions and prolonged weather events.

Q. WHAT DOES DUKE ENERGY MEAN BY "ALL OF THE ABOVE" STRATEGY?

A. The Companies' "all of the above" energy transition strategy plans for the development of a diverse and expansive mix of new and existing resources—including renewables, energy storage, advanced nuclear, hydrogen-capable gas, and grid edge resources and customer programs—to meet the rapidly growing energy needs in the Carolinas. This "all of the above" approach is critically necessary to ensure that the Companies can prudently retire and replace 8,400 MW of aging coal-fired generation while maintaining or improving system reliability and prudently managing risks and uncertainties.

Utilizing all available types of resources—now and in the future—is critical to maintain 24x7 reliability as customer demands increase and the mix of generating resources experience significant change. It is this need for a diversity of capabilities from all types of system resources that defines the Companies' "all of the above" strategy. To provide a simple illustration of the range of power demands the Companies must serve on their systems, Figure 1 shows the actual load and net load of solar energy on representative winter and summer peak days from the last year.

Figure 1: Load on Winter and Summer Peak Days[2]



As shown in Figure 1, the demands on the Companies' resource mix can vary dramatically between periods of high and low needs—often rapidly changing—even within a single day. While system operators ultimately seek to match electricity supply to customer load, net-load represents the demands placed on non-variable sources of generation to additionally match the weather-dependent output from renewables which may not align with customer demand.

As discussed further in Appendix M (Reliability and Operational Resilience) and illustrated later in this testimony, load growth and the deployment of increasing amounts of variable renewable energy—particularly solar—will increase the complexity of matching customer loads with reliable generation. No single technology can provide the attributes and capabilities necessary to ensure system reliability, and system operators must rely on a

[2] Figure 1 is replicated in Reliability and Operational Resilience Panel Rebuttal Exhibit 1.

diversity of technologies to serve load in real-time. To maintain operational reliability, system operators must have access to a balanced mix of proven capabilities from available resources—tools in a system operator's toolbox—to preserve reliability under a range of conditions and increasing uncertainties. Each of the varied resources in the Plan contributes a unique blend of energy, capacity, dispatchability, predictability, and other essential capabilities that when deployed in concert ensure reliability for the Companies' customers.

Q. BEFORE ENGAGING WITH SPECIFIC INTERVENOR RECOMMENDATIONS, CAN YOU PLEASE BRIEFLY EXPLAIN FOR THE COMMISSION THE RESOURCE CAPABILITIES THAT ARE ESSENTIAL TO A RELIABLE GRID?

A. System operators have gained operational experience to manage the grid over decades using a fairly stable and established set of tools to generate power and deliver reliable electric service. However, through retiring coal units and adding unprecedented variable energy and energy limited resources to the system over a very short period of time, the ongoing energy transition presented in the CPIRP is rapidly changing the tools in the toolbox that are available to system operators to ensure system reliability.

Duke Energy believes that dispatchability is one of the most key resource capabilities necessary to ensure reliability of the grid. In a broad sense, dispatchability refers to the capability of a resource to respond to operating instructions from system operators—a capability that becomes more and more critical as additional complexity is introduced to the grid. Different resources have different levels and dimensions of dispatchability. The quintessential dispatchable resource is the combustion turbine ("CT"), which can turn on and off quickly at the operator's direction and move rapidly from one generation setpoint to another (*i.e.*, ramping). The on-demand nature of a CT's dispatchable capabilities allows system operators to adjust and meet system needs as they arise in real time.

In contrast, renewable resources do not offer the same array of dispatchable capabilities. Solar resources, for example, will only generate energy when solar radiation is present and will typically do so at their weather-dependent maximum capability. As such, solar resources cannot dispatch upwards, meaning that a system operator cannot "turn on" a solar resource at any time to meet system demand. Importantly for reliability, however, solar resources are generally capable of responding to dispatch instructions to reduce output (*i.e.*, "curtail") when needed by system operators. Energy storage holds promise as a uniquely dispatchable technology—with faster (near-instantaneous) and more precise response to dispatch instructions than even CTs—but as a net consumer of energy, is dependent on time periods of excess generation to recharge (therefore, is not available to operators) and enable these capabilities.

Ideally, a dispatchable resource is a highly reliable power source that utilizes a predictable fuel supply. It can be ramped up or ramped down to meet demand as needed, and it is available in all weather conditions. Beyond CTs and energy storage, examples of resources considered to be dispatchable include combined cycle ("CC") units and coal (with or without dual fuel capability), although, relative to CTs, these resources (particularly coal/dual fuel) take longer to start and must remain online between starts and stops (i.e., cycling) to maintain unit reliability. Although not as quick to dispatch, nuclear resources also provide important base load capability that is key to maintaining reliability.

Q. CAN YOU PLEASE DESCRIBE THE SPECIFIC "BUILDING BLOCK" CAPABILITIES THAT ARE ESSENTIAL TO DISPATCHABILITY?

This broader umbrella of dispatchability can be broken down into three "building block" capabilities that system operators leverage to ensure power supply reliably meets customer demand.

1. The first of these capabilities is ***Regulation***, which describes the ability of a resource to respond to dispatch instructions to raise or lower generation to match changes in system demand at the timeframe of seconds to minutes. Operationally, the Companies' Energy Management System monitors DEP's and DEC's supply-demand balance, reissuing generator set points every 6 seconds to ensure each Balancing Authority remains within NERC reliability standards. Resources providing regulation capability must have predictable, proven, and reliable response to these operating instructions as unexpected behavior from regulating resources can diminish system response or even unintentionally exacerbate supply-demand imbalances.
2. ***Load Following*** captures the ability of grid assets to respond to

operating instructions to follow changes in load over longer time-periods, spanning from sub-hourly redispatch intervals of 5-10 minutes to hours or days where unit commitment decisions (*i.e.*, to bring units online or take them offline) influence system supply-demand balance.

3. System Operators must also hold ***Contingency Reserves***—additional generation capacity above current output levels—to respond to system contingencies, such as the loss of a large generation unit. Under NERC reliability standards, the Companies must return Balancing Authority Area Control Error back to pre-contingency levels within a defined timeframe. The assets used to serve contingency reserves can be "spinning" (that is, online and actively interconnected to the grid) or "non-spinning" (not actively connected), which influences the speed with which the system is returned to pre-event frequency. Resources with "fast start" capabilities such as batteries, pumped storage, and some CTs give system operators additional resources to call upon during contingency events in addition to actively generating units.

In addition to the three building blocks mentioned above which rely on the dispatchability of generators to respond to operating instructions, a fourth building block rests on the capability of grid resources to inherently and/or automatically respond to abnormal system conditions without real-time input from a central dispatcher:

4. ***Frequency Response*** describes how grid assets change operation when the frequency of the broader grid deviates from its intended operating

point of 60hz due to a sudden supply-demand imbalance (such as the loss of a large generator). Frequency response can be subdivided into two types of contributions. First, *inertia* references the physical response of synchronous generators (such as coal, pumped storage, CCs and CTs, and nuclear) to "push back" against the drop in frequency by transferring their rotational energy to the grid, slowing the rate of the frequency drop caused by the loss of generation. Second, the control systems of generation resources actively *arrest and stabilize* the frequency deviation ("stop the drop") by increasing active power output to the grid. After online resources automatically stabilize grid frequency, it is restored to pre-event levels by coordinated deployment of resources providing regulating and contingency reserves.

Q. FROM AN OPERATIONAL PERSPECTIVE, EXPLAIN HOW DUKE ENERGY RELIES ON EACH OF ITS RESOURCES AND THEIR UNIQUE CAPABILITIES.

A. To illustrate how different types of resources contribute to reliably meeting system demands, Figure 2 below shows hypothetical generation resource dispatch across a high load week in both the summer and winter seasons based on historical weather patterns. The summer week captures an extreme heatwave in June/July 2012 and the winter week shows a "polar vortex" cold weather event during early January 2014. The two resource mix examples used to illustrate dispatch patterns below are representative of present day and the resource mix for 2038 projected by Portfolio P3 Fall Base.

Figure 2: Illustrative Summer Peak Dispatch[3]

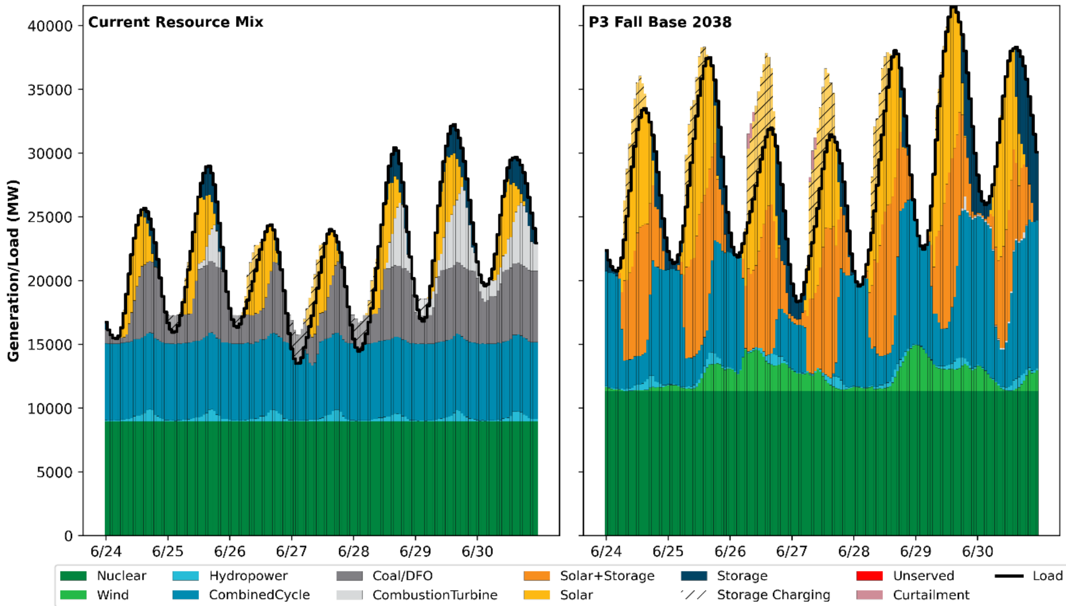
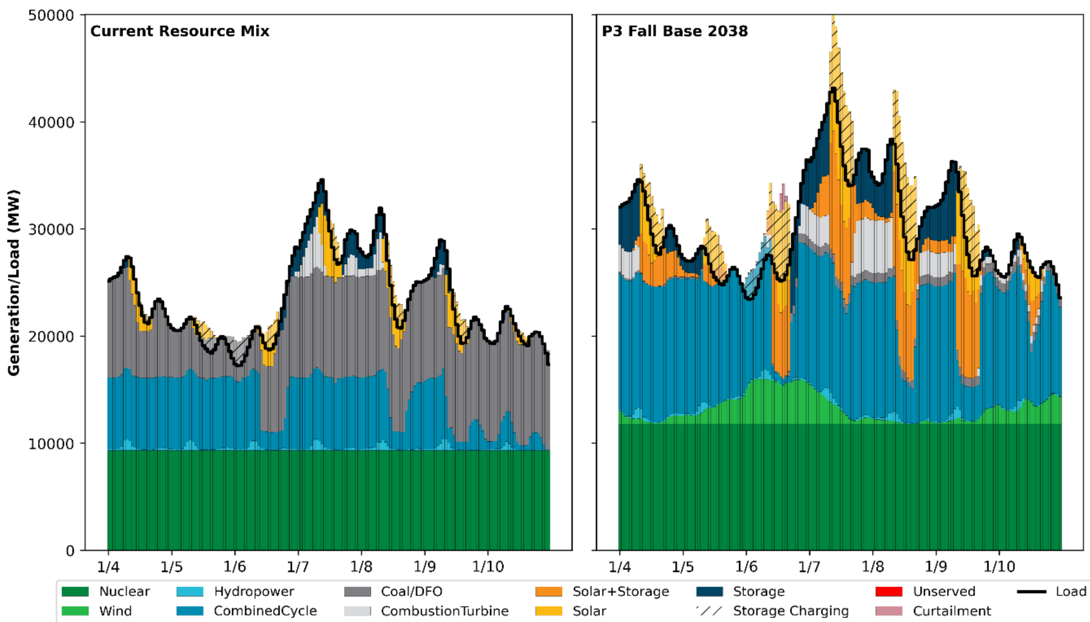


Figure 3: Illustrative Winter Peak Dispatch[4]



[3] Figure 2 is replicated in Reliability and Operational Resilience Panel Rebuttal Exhibit 1.

[4] Figure 3 is replicated in Reliability and Operational Resilience Panel Rebuttal Exhibit 1.

Q. HOW IS THE EXISTING AND FUTURE DIVERSE RESOURCE MIX DISPATCHED TO RELIABLY SERVE THE SYSTEM IN THE ILLUSTRATIVE SUMMER PEAK DISPATCH?

A. In the summer peak week illustrative example, with the current resource mix the Companies' nuclear fleet provides a foundation of around-the-clock, carbon-free generation. Efficient CC units and the coal and dual fuel steam units operate continuously but ramp down during overnight periods of low demand, while highly dispatchable CT units are brought online across peaks during the highest load days if needed to meet peak demands. The current levels of solar on the Companies' system provide energy during daylight hours and help shave the direct load peak typically expected at 4:00 PM during the hottest part of the day. The Bad Creek and Jocassee pumped storage plants charge overnight from coal/dual fuel units (which must remain online as they cannot cycle within a day and are needed to meet peak demand) and during the day from any excess solar energy. A combination of the CCs, CTs, coal, and pumped storage share the dispatchable reliability "building block" duties necessary to match the second-by-second and minute-by-minute fluctuations in customer demand.

By 2038, projected load growth will increase overall energy demands. New, higher capacity CC units will be critical to meet the growing energy needs of the system, serving as the foundational replacement of the energy and dispatchability contributions of the retired coal fleet. Storage and additional CT units will provide additional flexibility to meet peak loads and the changing net-load profile. The buildout of solar capacity provides substantial energy during daylight hours, leading to the regular use of storage resources (including new capability from the Bad Creek II expansion, stand-alone storage, and solar paired with storage) to shift energy into the evenings and through the night. Given the change in system resource mix, charging during the day becomes the normal mode of operation to maximally utilize solar output, even on many of the highest load days. Wind resources are variable throughout the week but provide energy that directly meets customer demands or is stored for later use.

The substantial increase in the use of renewables and storage changes the necessary dispatch patterns for the Companies' natural gas resources. The operational profile of CC resources is expected to become increasingly variable as these resources are a necessity to meet the customer energy demands but must leverage their dispatchable characteristics to manage the new system net-load profile. A common future need for the CCs is to ramp down (or even fully turn off) capacity during the day when solar is abundant, and rapidly increase output as daylight fades. The flexibility provided by the CPIRP's planned CC and CT units—when working in tandem with storage—is necessary to respond to the day-night fluctuations in renewables output. The natural gas resources also serve as an energy backstop in the event of extended stretches of low sunshine or low wind to ensure the system has adequate resources from which to meet customer demand.

Q. HOW IS THE EXISTING AND FUTURE DIVERSE RESOURCE MIX DISPATCHED TO RELIABLY SERVE THE SYSTEM IN THE ILLUSTRATIVE WINTER PEAK DISPATCH?

A. In winter, the resources discussed above bring their same capabilities and constraints to the system but may operate differently than in summer as patterns of customer demands shift with multiple daily load peaks in the morning and evening, and shorter daylight hours for solar to generate. Notably, solar output is more variable day-to-day than in the summer. With the current resource mix the system will tend to ramp down natural gas or coal units (depending on relative fuel prices) when load is low and/or solar output is high. The existing pumped storage units will typically charge overnight when loads are low or opportunistically during the day if solar energy is abundant.

The dispatch of the system in winter changes substantially by 2038 given the retirement of the Companies' coal fleet and the build out of renewable and storage resources. Just as in summer, the CC fleet must utilize its flexibility to ramp down during periods of low load and high solar output while remaining available when loads are high and/or renewable output is low as these resources are essential to provide the energy and capacity needed to meet system demands. This results in varying operating modes for the CC fleet. For example, on relatively low solar output days as seen from 1/4 to 1/5 in the winter example week, the CCs operate continuously with a moderate ramp down during daily solar peak. Conversely, clear skies during the polar vortex event (1/6 to 1/9) cause solar output to be high, requiring the CCs to utilize their capability to cycle through daytime minimum net loads. Wind output in this example is variable but timely, as the arrival of polar vortex conditions is accompanied by high onshore and offshore winds as temperatures rapidly change, providing additional energy with which to charge the suite of storage assets essential to reliability in the future resource mix.

This 2038 winter example—and specifically the system dispatch necessary on January 6—also illustrates some of the new operating challenges expected in a high renewables future as a combination of high solar output and dropping temperatures leads to a potential net-load ramp (prior to employing storage or use of curtailment) of 17,000 MW between 4:00 PM and 5:00 PM. This is approximately the equivalent of turning on twice the capacity of the Companies' coal fleet across 60 minutes. Given this event and others caused by similar factors, by 2038 the dispatchability and rapid load-following capabilities provided by energy storage and the flexibility afforded by the Companies' natural gas CC and CT units becomes essential to manage such extreme system conditions.

B. Industry Guidance Supporting All of the Above Strategy

Q. PLEASE BRIEFLY REMIND THE COMMISSION OF THE COMPANIES' OBLIGATIONS UNDER NERC.

The electric grid in the United States is subject to federally mandated reliability standards developed and enforced by NERC. Over 400 million citizens in North America count on NERC to ensure the reliability, security, and resilience of the grid, nation-wide. Under the umbrella of NERC, DEC and DEP are members of the SERC Regional Entity, the reliability region comprised of utilities across states in the southeastern U.S.

The physics of power grids dictate that they operate as an interconnected whole, and as such the reliability of the entire power system is dependent on all components meeting their own reliability obligations. Any weak link decreases reliability for everyone. Accordingly, as Balancing Authorities interconnected into the Eastern Interconnection, DEC and DEP must be responsible for reliably meeting customer demands. Within the formal NERC regulatory framework, the Companies are required to comply with the NERC Balancing standards, which outline the appropriate physical tolerances within which the DEC and DEP regions operate. Ultimately, these standards dictate that the Companies provide their share of frequency support for the Eastern Interconnection, and by definition, maintain demand and resource balance.

Q. SINCE THE COMPANIES FILED THEIR INITIAL PLAN IN AUGUST 2023, HAS THE INDUSTRY ISSUED ANY ADDITIONAL GUIDANCE IMPORTANT TO MAINTAINING RELIABILITY THROUGH THE ENERGY TRANSITION?

A. Yes. NERC issued its 2023 ERO Reliability Risk Priorities Report[5] on the same day that the Companies filed their CPIRP in this proceeding. The Report identified the changing resource mix as the highest risk to maintaining system reliability and also highlighted resource adequacy and performance as the second highest risk. NERC CEO Jim Robb has further described the impact of a rapidly changing resource mix, extreme weather, policy uncertainties, and

[5] NERC, 2023 ERO Reliability Risk Priorities Report (July 24, 2023), *available at* https://www.nerc.com/comm/RISC/Related%20Files%20DL/RISC_ERO_Priorities_Report_2023_Board_Approved_Aug_17_2023.pdf.

evolving threats as creating a "hyper-complex"[6] risk environment.

As this Panel explained in its Direct Testimony, NERC is engaged in the ongoing development of standardized best practices—including standards for inverter-based resource ("IBR") interconnection and winter readiness—to address risks related to the energy transition. IBRs have caused a series of recent reliability events resulting in the unexpected and rapid loss of hundreds to thousands of MW of IBR output. Since filing our Direct Testimony in this docket, FERC has directed the standards be developed rapidly in the coming years, with additional standards targeted for release in 2024, 2025, and 2026.

NERC is also in the process of developing a set of requirements to address winter weather preparedness. Duke Energy representatives are participating in both of these task forces and actively engage with the groups that are studying these risks.

Q. DO RECOMMENDATIONS OF CERTAIN INTERVENORS TO SIGNIFICANLTY ACCELERATE COAL RETIREMENTS,[7] LOWER RESERVE MARGINS BEYOND THE STUDIED LIMITS,[8] OR RELY ON ALTERNATIVES TO DISPATCHABLE GENERATION THAT ARE

[6] NERC, Challenges to Reliability and Resilience at 5 (Dec. 7, 2023), *available at* https://cdn.misoenergy.org/20231207%20Board%20of%20Directors%20Item%2007a%20NERC%20CEO%20Update631092.pdf.

[7] AGO Burgess Direct Testimony at 5-6, 28-30.

[8] Clean Energy Buyers Association ("CEBA") Chen Direct Testimony at 19-21; Southern Alliance for Clean Energy, Sierra Club, Natural Resources Defense Council, and North Carolina Sustainable Energy Association ("SACE et al.") Roumpani Direct Testimony at 38-42; NC WARN Konedina Direct Testimony at 7-9.

NOT OPERATIONALLY EQUIVILENT[9] COMPORT WITH INDUSTRY GUIDANCE?

A. No. They does the opposite by directly increasing the bulk electric reliability risks that NERC and its leadership highlight—an energy transition that is not orderly, paced inappropriately, and that does not plan for and install in a timely manner the right types and amounts of generation that constitute a resource-adequate system. As NERC CEO Jim Robb noted in his recent testimony before the U.S. Senate Committee on Energy and Natural Resources, utilities must "identify new resources to replace retiring generation that provides both sufficient energy *and* essential reliability services (such as flexibility, voltage support, frequency response, and dispatchability) needed for stable grid operations." Acknowledging that new natural gas is essential to a reliable transition, Mr. Robb underscored that "[t]he criticality of natural gas as the 'fuel that keeps the lights on' will remain until very large-scale and long duration battery deployments are feasible or an alternative flexible fuel such as hydrogen or small nuclear reactors can be developed and deployed at scale."[10]

Q. DO THE COMPANIES AGREE WITH INTERVENORS WHO SUGGEST THAT THEY SHOULD BE ABLE TO RELY ON

[9] CEBA Davis Direct Testimony at 13; CCEBA Hagerty Direct Testimony at 9-10; AGO Burgess Direct Testimony at 42-43.

[10] The Reliability and Resiliency of Electric Service in the United States in Light of Recent Reliability Assessments and Alerts, Testimony of James B. Robb, President and CEO NERC, before the Committee on Energy and Natural Resources, U.S. Senate (June 1, 2023), *available at* https://www.energy.senate.gov/services/files/D47C2B83-A0A7-4E0B-ABF2-9574D9990C11 ("J. Robb Testimony").

NEIGHBORS FOR ASSISTANCE THROUGH THE ENERGY TRANSITION?[11]

A. Duke Energy is actively engaged in the marketplace, determining whether and when to purchase off-system energy to serve load and maintain the reliability of the system. From the Control Center perspective, off-system purchases equate to compounded risk—where System Operators now bear the risk of the neighboring system to deliver, of which they have no control and can be curtailed—firm or non-firm. When System Operators are faced with situations of relying on material amounts of imports to maintain NERC Reliability Standards, if adequate imports do not materialize due to neighboring system transmission or generation issues, or curtailment, there may be no other option but to shed load. Further, decarbonization of adjacent systems may limit the availability of firm, flexible, and dispatchable generation from neighbors during capacity constrained periods when needed the most, as all systems will be vying for those valuable reliability resources.

C. Maintaining Resiliency

Q. WHAT DOES RESILIENCY MEAN TO DUKE ENERGY?

A. As discussed in CPIRP Appendix M, resiliency refers to the ability of the grid to withstand or, if necessary, recover from extreme events.[12] Resiliency looks beyond the standard measures of resource adequacy to identify low-probability,

[11] CEBA Davis Direct Testimony at 5; CEBA Chen Direct Testimony at 14-16.

[12] CPIRP Appendix M at 21.

high-impact events that directly affect grid assets or disable critical enabling infrastructure such as transportation networks and fuel supplies.

Q. EWG WITNESS SMITH SUGGESTS THAT THE CPIRP DOES NOT ADDRESS RESILIENCY.[13] HOW DO YOU RESPOND?

A. The Companies disagree with that claim. The CPIRP was developed to support system resilience, and the all-of-the-above strategy will give operators the needed tools to ensure the system is resilient to and able to recover quickly from extreme events. As detailed in CPIRP Appendix M, the Plan strategically plans to accommodate high loads in both normal and extreme weather conditions. The diversity of resources—both technologically and geographically—planned for through the CPIRP will support resiliency of the system going forward, avoiding risks inherent to overreliance on any one resource. The measured pace of the P3 Fall Base Portfolio allows ample opportunity to check-and-adjust, giving the Companies the ability to be versatile as conditions evolve in the future to ensure reliability and resilience.

Q. CEBA WITNESS CHEN CHALLENGES THE COMPANIES' WINTER PREPAREDNESS, SUGGESTING IT POSES A THREAT TO RESILIENCY.[14] HOW DO YOU RESPOND?

A. NERC has focused on winterization since the polar vortex events of 2014 and 2015 with an emphasis on preparing for winter/low temperature generation performance and operational readiness. The Commission investigated the

[13] Environmental Working Group ("EWG") and NC WARN Smith Direct Testimony at 28-29.

[14] CEBA Chen Direct Testimony at 27-28.

Companies' system during Winter Storm Elliot and, on December 22, 2023, issued its related *Order Making Findings and Directing Actions Related to Impact of Winter Storm Elliott* in Docket No. M-100, Sub 163 ("WSE Order"), in which the Commission provided its assessment of the event. In the WSE Order, the Commission recognized the Public Staff's acknowledgement that lessons learned from extreme cold weather events in 2014 and 2015 were in place and most likely prevented the recurrence of similar issues that occurred in 2014 and 2015.[15] In addition, the Commission acknowledged the Companies' compliance with many of the requirements of NERC's EOP-011-02 (NERC's winter weatherization operating standards) in advance of the April, 2023 deadline.[16] Finally, the Commission acknowledged the Companies' report that they were on track to comply with NERC Standard EOP-012-2, which was developed in response to Winter Storm Uri, by the October 1, 2024, implementation date.[17] Duke Energy is in compliance with NERC's current winter weatherization operating standards. Coming out of Winter Storm Elliott, Duke Energy enhanced its winter and summer operational preparedness via formal pre-winter and pre-summer prep evaluation meetings involving a cross section of many business units. The group focused on improvements to generation preparedness and open work orders, system operator training for

[15] WSE Order at 42.

[16] WSE Order at 42-43.

[17] WSE Order at 43.

these high load conditions, controlled load shed training verification, as well as a variety of other threats.

The Companies have gained operating experience with both the Grid Risk Assessment Process and the Grid Threat Process since Winter Storm Elliott and are continuing to enhance the process.

Q. DO YOU AGREE WITH WITNESS SMITH THAT DECENTRALIZATION IS CRITICAL TO PROMOTING RESILIENCY?[18]

A. While there are times when decentralized resources can contribute to resiliency as part of the "all of the above" strategy, a strong network of centralized resources is critical to ensuring a reliable and resilient grid.

The unprecedented shift away from multiple decades of centralized generation to dispersed renewables, batteries, demand response, and other distributed and emerging technologies that rely on a robust communications infrastructure not only poses new challenges for operators and the protocols on which they rely but has implications for other risk areas identified by NERC that include extreme events, security, and critical infrastructure dependencies. As reiterated in NERC's 2022 State of Reliability Report, recent extreme events such as the 2020 western extreme heat event and the sustained severe cold weather in February 2021, which caused the largest manual load shed event in North American history of over 23,000 MW, demonstrate how a changing resource mix driven by decarbonizing operating fleets has implications on other

[18] EWG and NC WARN Smith Direct Testimony at 28-29.

risk areas and amplifies those risks.[19]

From a system operator's perspective, the distributed nature of renewable resources adds complexity to the grid, both in terms of the capabilities those resources offer and in the need for additional transmission to connect such resources to the grid. While decentralizing a utility's resources creates some geographical diversity, it also creates challenges for system operators because distributed resources offer less visibility and predictability as compared to centralized resources. At this time, distributed resources cannot provide the repeatable and dependable scale of centralized resources which provide practical deployment advantages.

For example, System Operators use the Contingency Reserve component of Operating Reserves to respond to a Reportable Balancing Contingency Event via the ramping up of MW. It is much more efficient for the System Operator to issue one Operating Instruction to Bad Creek or Jocasse pump storage hydro to get the needed generation ramping up at a very effective ramp rate (MW/Min) to ensure compliance with BAL-002 versus calling on 10 to 20 distributed assets to get the same amount of response. Duke Energy has decades of operating experience with the use of Pump Storage and Conventional Hydro assets during these time limited operating situations. Duke Energy has no operating experience in using distributed assets for these time

[19] NERC, 2022 State of Reliability Report (July 2022), *available at* https://www.nerc.com/pa/RAPA/PA/Performance%20Analysis%20DL/NERC_SOR_2022.pdf.

limited operating situations, and at the consistency and scale necessary to reliably operate a system the size of the Companies' combined system.

III. NEW NATURAL GAS IS A CRITICAL TOOL FOR MAINTAINING SYSTEM RELIABILITY

Q. SEVERAL INTERVENORS CHALLENGE THE NEED FOR NEW NATURAL GAS RESOURCES AS IDENTIFIED BY THE COMPANIES' MODELING AND EXECUTION PLAN. PLEASE EXPLAIN THE ROLE OF NATURAL GAS AS A TOOL IN THE TOOLBOX.

A. As discussed previously, power system reliability rests on foundational building blocks of regulation, load following, contingency reserve, and frequency response capabilities. Natural gas CC and CT units are direct, predictable, and proven providers of these capabilities. CT units are the most flexible fuel-secure dispatchable asset available to system operators, and CC units retain many of the dispatchable characteristics of CTs while increasing generation efficiency, creating balance between cost-effectiveness and capability within a single resource.

As a tool for meeting power system demands, CC units can provide both baseload energy and load following capability as needed to match the variable output profiles of renewables. CTs additionally provide essential capacity to meet high loads and bring fast response capabilities to bear when facing unexpected system events or the increasingly high ramping needs projected in future years. Additionally, both natural gas resources can provide on-demand output across multiple days if needed should energy needs remain high due to sustained weather extremes (such as the atypically cold first week of January

2018) or low renewables output.

These same attributes and capabilities are those that the Companies' coal fleet currently brings to operational reliability, and it would likely prove impossible to replace the dispatchable characteristics of this existing coal fleet without tapping the capabilities provided by natural gas resources, particularly when attempting to match near-term growing loads.

Over the long-term planning horizon, as seen in the example winter and summer weeks discussed above, CCs and CTs in a balanced portfolio provide a substantial portion of the system flexibility necessary to accommodate the daytime highs, nighttime lows, and day-to-day variability in output from the over 20,000 MW of solar envisioned by 2038 in the P3 Fall Base portfolio.

Q. IN YOUR OPERATIONAL EXPERIENCE, DO YOU BELIEVE NEW NATURAL GAS GENERATION IS NEEDED TO MAINTAIN OR IMPROVE GRID RELIABILITY?

A. Yes. As the Companies execute on their plans to retire 8,400 MW of dispatchable coal generation, new natural gas is critical to ensuring that system operators have access to both sufficient energy and the essential reliability capabilities described above that are needed to reliably operate the grid and respond to real-time system needs. In this Panel's view, natural gas is the only resource with the proven capabilities necessary to replace both the energy and dispatchability of coal. NERC CEO Jim Robb has identified the replacement of retiring generation with new resources that offer critical reliability characteristics as one of three reliability priorities that utilities must address.[20] As Mr. Robb notes:

> [N]atural gas-fueled generation is needed to meet energy demand during shoulder periods between times of high and low renewable energy availability, and to set frequency needed by IBRs until advanced grid forming inverters are in placed [sic] coupled with energy storage. And on a daily basis in areas with significant solar generation, the natural gas fleet is a flexible generation resource to fill the gap.[21]

Q. CERTAIN INTERVENORS QUESTION THE OPERATIONAL RELIABILITY OF NATURAL GAS RESOURCES DURING EXTREME COLD WEATHER.[22] WHAT IS THE COMPANIES' EXPERIENCE WITH NATURAL GAS DURING COLD WEATHER EVENTS?

A. Extreme cold weather can influence the reliability of natural gas assets directly via unit outages (such as those caused by frozen instrumentation), and indirectly if upstream gas production is negatively impacted by well-head freeze-offs or other cold weather issues.

From an operational perspective, natural gas generation is critical to preserving the reliability of the grid during cold weather events. The capabilities the Companies are losing with the retirement of coal are replaced by natural gas resources, which can provide dispatchable energy at any hour of the day and over multiple days. When load is high during extreme hot and cold events, dispatchable, load-following and fuel-secure natural gas generation is needed.

[20] J. Robb Testimony at 1.

[21] J. Robb Testimony at 8.

[22] *See, e.g.*, NC WARN Konidena Direct Testimony at 9, 33.

Unlike intermittent resources like solar, natural gas can be dispatched to conform to the load of the Companies' customers. Indeed, in the WSE Order, the Commission affirmatively acknowledged that the Companies "relied on significant natural gas-fired generating resources to get through the peak hours, as well as the load shed event, on December 24."[23] The Commission concluded that "[t]he Duke natural gas-fired fleet played a critical role in providing service during the storm, and the fleet will continue to play a critical role for customers in North Carolina."[24]

Q. FROM YOUR OPERATIONAL PERSPECTIVE, ARE THE NATURAL GAS UNITS IDENTIFIED IN THE COMPANIES' EXECUTION PLAN NEEDED TO PRESERVE RELIABILITY OF THE SYSTEM?

A. Yes. In our Direct Testimony, one of our concluding remarks emphasized the reality that the often seemingly abstract resource planning process ultimately determines the real-world resource mix—the tools in the toolbox—available to system operators in real time. At that time, we noted that:

> [F]or system operators, Plan execution risks can become operational reliability risks if adequate resources are not available to meet projected load growth or to replace the energy and capacity contributions of the Companies' coal units prior to their retirement.[25]

Since the filing of the initial Plan and our Direct Testimony, this observation has only become more important as the Companies have experienced

[23] WSE Order at 45.

[24] WSE Order at 46.

[25] Direct Testimony of Holeman and O'Connor at 15.

accelerating load growth from economic development as documented and modeled in the January 2024 Supplemental Planning Analysis.

This Panel defers to the IRP and Near-Term Actions Panel to discuss the methodology for selection of the optimal resource mix to meet this rapid, short-term load growth. However, from the perspective of a system operator, it is not surprising to see that the twin challenges of accelerated load growth and the retirement of the Companies' coal fleet are met in large part by new natural gas units. CC and CT technologies are proven, dispatchable technologies that contribute directly to the four reliability building blocks outlined at the beginning of the Panel's testimony.

Portfolio P3 Fall Base extensively deploys solar and storage throughout the planning horizon, and long lead-time wind and new nuclear resources play pivotal roles in meeting future system needs. However, the executable resources available to meet the Companies' forecasted load growth prior to 2030 are limited, and natural gas units are the necessary choice to meet growing loads and replace the reliability contributions of retiring coal generation. In sum, the diverse array of resources selected and planned for in Portfolio P3 Fall Base contain the capabilities—in both type and amount—that system operators need to manage the grid in real-time and to maintain or improve reliability of the system in the face of significant expected future load growth and facilitates an orderly "replace before retire" exit from coal generation.

IV. GRID EDGE AS A COMPONENT OF RELIABILITY

Q. SEVERAL INTERVENORS ASSERT THAT GRID EDGE PROGRAMS CAN CONTRIBUTE TO THE RELIABILITY AND RESILIENCY OF THE GRID. FROM AN OPERATOR'S PERSPECTIVE, HOW ARE GRID EDGE PROGRAMS USED AS A TOOL TO MEET CUSTOMER DEMAND?

A. Grid Edge programs are an important part of the Companies' plan for the future. As they exist today, however, these programs are not equivalent to traditional dispatchable generating resources. In other words, Grid Edge programs are not resources that a system operator can reliably call upon to turn on or off to meet load on demand such that they are part of the day-to-day tools used by system operators.

The Grid Edge and Customer Programs Panel can speak to specific operational attributes of existing and planned future Grid Edge programs. However, the current "Grid Edge"-like programs accessible to system operators—such as commercial/industrial and residential demand response—are situational resources. In other words, these resources are not intended for use at all times but may be called upon for certain limited use cases for limited durations. The typical use case of current programs would entail a limited number of calls or activations per year during significant system peaks or system emergencies. In the event of a system emergency, for example, Grid Edge programs may be called upon to limit usage in an effort to reduce overall system load. These tools have worked when called upon, but they are governed by a contractual relationship that may limit the capabilities available to an operator. While certain customer programs are dispatchable in the traditional sense, others are dependent on a customer's affirmative effort to comply with the program terms. All such programs are subject to and dependent upon a customer's willingness to participate and remain in the program.

Full integration of evolving Grid Edge resources will require significant additional control system infrastructure, the establishment of testing and validation protocol, and additional operator training on the deployment for such resources.

Q. WOULD YOU AGREE THAT VIRTUAL POWER PLANTS CAN BE USED TO INCREASE SYSTEM RESILIENCY IN EMERGENCY SITUATIONS?

A. Yes. Grid Edge programs are part of the Companies' "all of the above" approach. However, the scale and extent of their capability requires further study. This Panel generally defers to the Grid Edge and Customer Programs Panel to discuss the specifics of the evolving concept of virtual power plants. To be clear, however, although several intervenors use the term "virtual power plant," these programs are not "power plants" in the traditional sense. From an operations perspective, to call on a virtual power plant to serve the grid, operators much reach out to potentially thousands of customers through a centralized tool to request action. For this reason, virtual power plants are best suited as a tool for peak clipping, to reduce load at times of high need. They cannot replace the sustained energy output of dispatchable resources like CCs and CTs that can run as needed to offset the loss of large energy and capacity resources (e.g., unexpected nuclear outages, sustained low solar output, etc.). NERC has also identified that Grid Edge programs like virtual power plants as a reliability risk because their distributed nature makes them more susceptible to cyber-attacks than traditional resources.

In sum, the capabilities of virtual power plants are unproven and not predictable in real-time. While they can and will play a role in the planning and operation of the grid, the Companies cannot rely on them to take the place of proven assets like CTs and CCs that provide a predictable, reliable response when called.

Q. EWG WITNESS SMITH CLAIMS THAT "VPPS ARE AGGREGATED RESIDENTIAL AND/OR COMMERCIAL CUSTOMERS THAT ESSENTIALLY FUNCTION AS UTILITY-SCALE POWER PLANTS."[26] DO YOU AGREE?

A. No. As the Panel explained in response to the previous question, virtual power plants share little in common with a traditional generating resource. While the industry, generally, and the Companies, specifically, will continue to study the behavior of these programs over time and expect response patterns to become more predictable in the future, system operators simply cannot rely on these programs to keep the lights on at this time.

[26] EWG Smith Direct Testimony at 48.

V. RESPONSE TO OTHER RELIABILITY CONCERNS RAISED BY THE PUBLIC STAFF

Q. DO YOU AGREE WITH WITNESS METZ THAT THE COMPANIES COULD FACE AN "ALARMING SITUATION" DUE TO THE AMOUNT OF INTERMITTENT SOLAR PLANNED FOR DEVELOPMENT?[27]

A. Witness Metz is correct to identify that high levels of solar have the potential to introduce operating challenges during periods of low loads and when "net-load" is increasing or decreasing rapidly, requiring dispatchable resources to quickly ramp to meet changing grid conditions. However, the Panel disagrees that this constitutes an alarming risk that will likely jeopardize system reliability.

Throughout the Plan documents, the Companies have extensively discussed the future operating demands that intermittent renewables—particularly solar—will place on the grid. And while the growing magnitude of low net-load scenarios will pose a challenge to system operations, the balanced mix of resources envisioned in the Plan and measured pace of the energy transition mean these risks are foreseeable and manageable.

In particular, the Plan specifically includes substantial contributions to system flexibility from storage technologies that help address these future operating realities. By 2038, in Portfolio P3 Fall Base, the Companies will have added the 1,680 MW Bad Creek II expansion project, stand-alone storage, and storage paired with solar. When combined with the Companies' existing pumped storage assets, this gives the combined Carolinas systems over 10,000

[27] Public Staff Metz Direct Testimony at 140.

MW of storage assets which can absorb excess renewable energy during periods of low load. Together with fast ramping natural gas CT and CC units, these storage units form a portfolio of flexible resources which give system operators a variety of tools from which to manage challenging system conditions from the valleys of future system demands to its peaks.

The Companies' current on-the-ground operating experience integrating over 5,000 MW of solar on the combined systems—including the strategic use of solar curtailment as appropriate—provides a strong foundation from which to continue the reliable operation of the power system as new variable resources are added to the grid. Additionally, the Companies' reliability verification modeling has demonstrated that the resource mix envisioned in Portfolio P3 Fall Base can be reliably operated under foreseeable uncertainties, including very low net-load scenarios such as those discussed by witness Metz. These results support that the resources outlined in the Plan provide adequate tools for system operators to manage a wide range of future circumstances and address needs of customers in real- time. By verifying that the portfolios can operate reliably during resource planning, the Companies enable future system operations to operate to plan.

Witness Metz also shows that a hypothetical portfolio without new CCs must rely on ever-greater amounts of solar, increasing the depth of net-load valleys.[28] As amounts of renewables continue to increase, dispatchable CCs are

[28] This is shown in comparing the figures representing the Companies' "P3 Fall Base" Portfolio in Public Staff Metz Direct Testimony at 129-131 to those for the Public Staff's PS1F 2030 No CC High Grid Edge Portfolio at 139-140.

essential to balance the system and provide essential reliability services, along with important multi-day capacity and energy in all weather conditions. Portfolios deficient in the dispatchable building block capabilities provided by CCs would create a significant reliability risk, potentially jeopardizing the Companies to obligations to serve customer load 24/7 and maintain or improve reliability of the system. The mix of resources envisioned in Portfolio P3 Fall Base helps to mitigate the potential magnitude of these low net-load periods by balancing the DEC and DEP systems' reliance on renewables and natural gas.

Q. DO YOU AGREE WITH WITNESS METZ'S CONTENTION THAT THE COMPANIES WILL NO LONGER NEED TO EVALUATE SUMMER AND WINTER PEAKS?[29]

A. No. Winter and summer peaks are currently, and will remain into the future, some of the most challenging periods of time to reliably operate the Companies' systems. Extreme peak events require the deployment of most of the Companies' generating resources to meet customer demand, and should unexpected generator outages occur, DEP and DEC may potentially be forced to rely on the uncertain prospect of assistance from neighboring regions to avoid firm load shed.

While the increasing levels of variable renewables envisioned in the Plan will increase the complexity of system operations at all times of year, the unique challenges presented by high loads drive the need for additional resources to maintain system reliability and remain the focal points for long-

[29] Public Staff Metz Direct Testimony at 157.

term planning purposes. Of note, in the Companies' reliability verification modeling, winter peaks are the primary high-risk time frame to power system reliability, comprising 100% of simulated load curtailment events.

Q. DO THE COMPANIES SUPPORT THE SOLAR INTEGRATION STUDY THAT WITNESS METZ RECOMMENDS THE COMPANIES UNDERTAKE TO ASSESS THE MAXIMUM LEVELS OF SOLAR GENERATION ADDITIONS AND ASSOCIATED CURTAILMENTS?[30]

A. The Companies do not believe a formal study is necessary at this time as the Companies are already undertaking the type of inquiry witness Metz proposes as part of their resource planning process. CPIRP Appendix M describes the Companies' efforts to ensure an orderly pace of transition, including by planning for the development of a diverse mix of resources that contain the capabilities necessary to maintain grid reliability in all conditions. Going forward, the Companies will continue to focus on prudent planning and operational resilience as they check and adjust the CPIRP and associated NTAP in 2025.

VI. CONCLUSION

Q. DO YOU BELIEVE THAT RESOURCE MIX PRESENTED IN THE CPIRP WILL MAINTAIN OR IMPROVE THE RELIABILITY OF THE SYSTEM AND ENSURE DUKE ENERGY MEETS ITS RESILIENCY OBLIGATIONS?

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[30] *Id.*

A. Yes. The Companies' recommended Portfolio P3 Fall Base plans for a diverse mix of resources to be incorporated at an orderly pace, replacing critical grid capabilities with new resources before retiring aging generation. This Panel stands behind the recommended resource mix and believes that it addresses the two highest reliability risks identified by NERC—the changing resource mix and resource adequacy—as it plans for an adequate resource mix that includes the operating capabilities necessary to ensure the Companies can reliably meet growing system needs. Although the changing resource mix will certainly introduce additional complexity to a System Operator's job, the Companies' "all of the above" strategy ensures that Operators have access to the resource capabilities needed to manage the grid and meet demand in real time. The resources selected in the CPIRP include dispatchable capabilities that are critically needed to replace retiring coal generation. The Companies will check and adjust this strategy as needed when they file their 2025 CPIRP.

Q. DOES THIS CONCLUDE THE PANEL'S REBUTTAL TESTIMONY?

A. Yes.

Figure 1: Load on Winter and Summer Peak Days

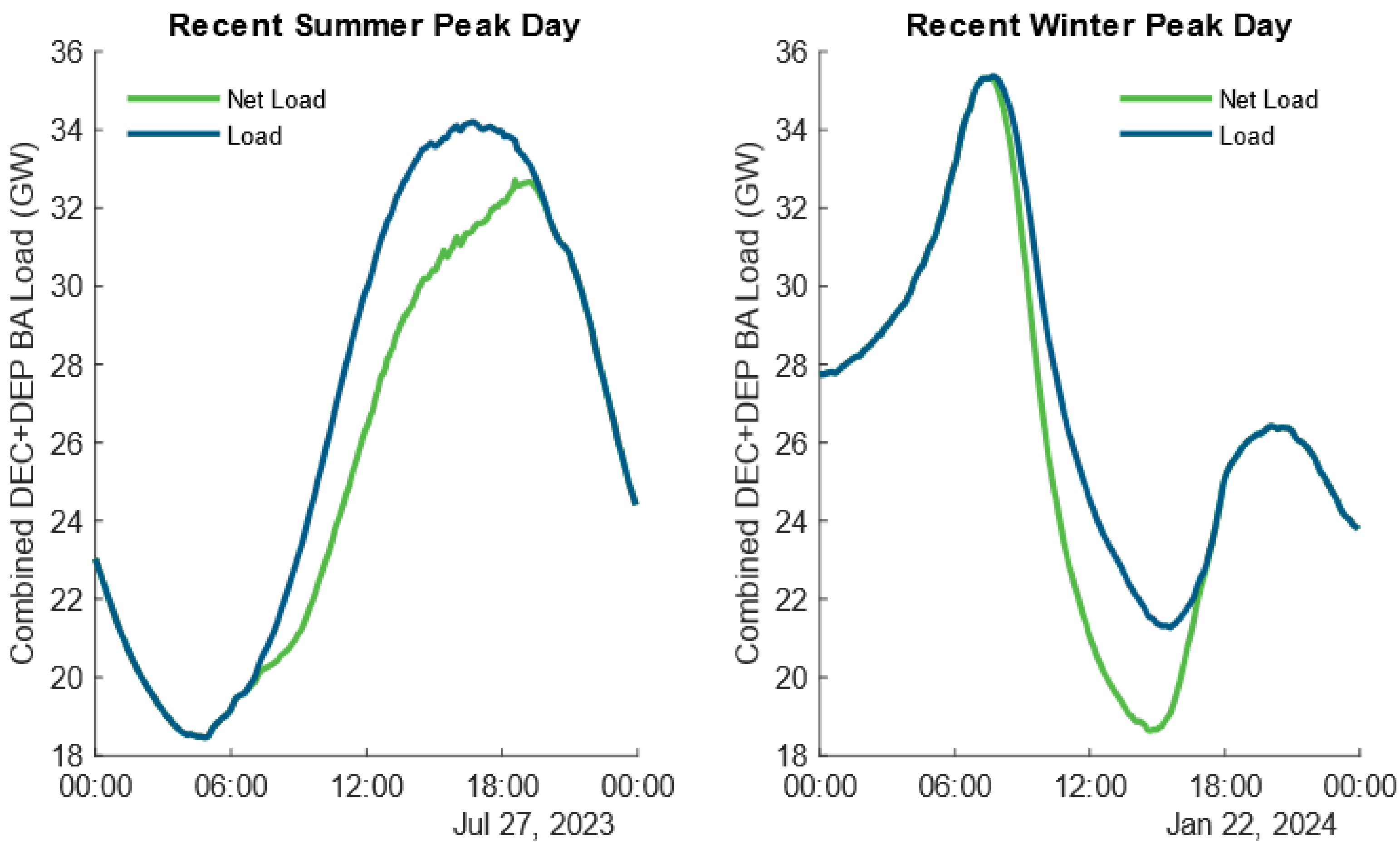

Figure 2: Illustrative Summer Peak Dispatch

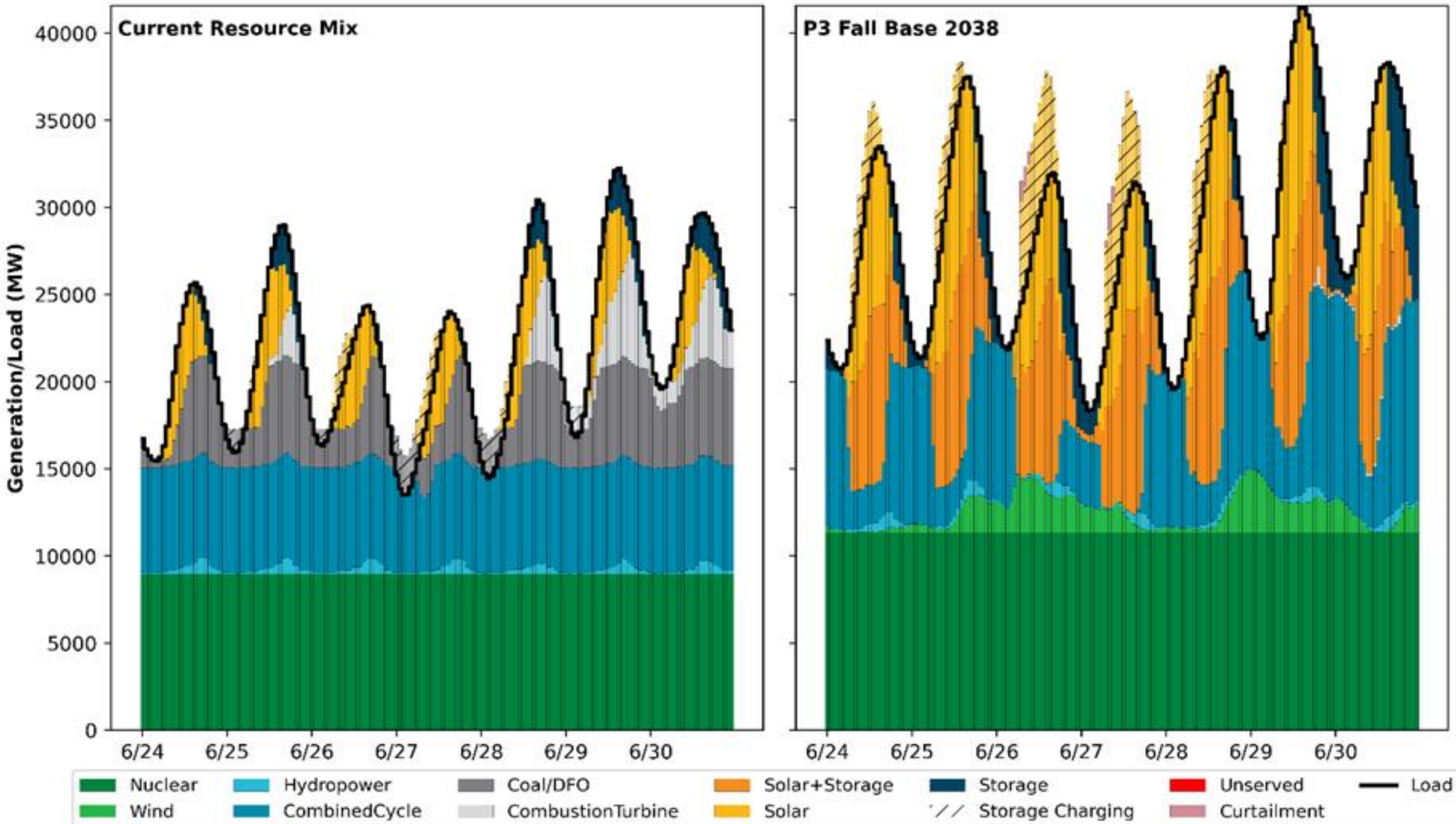

Figure 3: Illustrative Winter Peak Dispatch