Jack E. Jirak
Deputy General Counsel

Mailing Address:
NCRH 20 / P.O. Box 1551
Raleigh, NC 27602

o: 919.546.3257

jack.jirak@duke-energy.com

March 2, 2022

VIA ELECTRONIC FILING

Ms. A. Shonta Dunston
Chief Clerk
North Carolina Utilities Commission
4325 Mail Service Center
Raleigh, North Carolina 27699-4300

RE: Carolinas Carbon Plan - Second Stakeholder Meeting Summary Report
Docket No. E-100, Sub 179

Dear Ms. Dunston:

Duke Energy Carolinas, LLC ("DEC") and Duke Energy Progress, LLC ("DEP" and together with DEC, "Duke Energy" or the "Companies") hereby provide this update to the North Carolina Utilities Commission ("Commission") regarding the Companies' ongoing Carbon Plan stakeholder engagement process as contemplated by Part I, Section 1.(1) of Session Law 2021-165 ("HB 951") and the Commission's November 19, 2021 *Order Requiring Filing of Carbon Plan and Establishing Procedural Deadlines* ("Carbon Plan Procedural Order"). Among other things, the Carbon Plan Procedural Order directs the Companies to conduct at least three stakeholder meetings targeted to gather and incorporate stakeholder input as the Companies develop their initial Carolinas Carbon Plan to be filed with the Commission on May 16, 2022, and to file a report with the Commission within five business days after each stakeholder meeting.

On February 23, 2022, the Companies held the second Carbon Plan stakeholder meeting. At this second meeting, the Companies responded to questions addressing a number of topics raised in the initial stakeholder meeting and provided opportunity for stakeholders to provide input on: desired outcomes from the Carbon Plan; the Companies' proposed principles for portfolio development and evaluation; and the general modeling framework and considerations driving Carbon Plan portfolio options. Approximately 100 Duke Energy personnel and 300 external stakeholders attended the session, and stakeholders once again engaged in a robust dialogue.

As directed by the Carbon Plan Procedural Order, the Companies hereby submit their Second Carolinas Carbon Plan Stakeholder Meeting Summary Report ("Summary Report"), which provides an overview of the second Carbon Plan stakeholder meeting and a summary of topics discussed. As previously explained, the Companies have retained Great Plains Institute ("GPI") to serve as the facilitator of the stakeholder process, and GPI prepared the Summary Report for the Companies (included as Attachment 1). In addition to the Summary Report, the Companies are submitting the materials presented to stakeholders (included as Attachment 2) during Stakeholder Meeting 2.

In addition to the second stakeholder meeting, on February 18, 2022, the Companies hosted a series of three technical subgroup meetings focused on the following modeling assumptions: (1) solar interconnection forecast; (2) solar/wind technology operational/cost assumptions; and (3) storage operations/cost assumptions and system configurations. These technical meetings were planned in response to stakeholder feedback requesting an opportunity for more technical engagement on certain topics. Approximately 50 Duke Energy personnel and 180 external stakeholders attended one or more of the subgroup meetings. Additional details on the technical subgroup meetings is included on pages 36-64 of the Summary Report. The Companies are submitting the materials presented to stakeholders (included as Attachment 3) during the three technical advisory meetings. The materials in Attachment 1, Attachment 2, and Attachment 3 will also be posted on the Companies' dedicated website (www.duke-energy.com/CarolinasCarbonPlan).

Like the first stakeholder meeting, the second stakeholder meeting and the technical subgroup meetings received substantial participation, and the Companies appreciate the engaged participation and diverse feedback that has been provided throughout each meeting. The Companies look forward to further engagement with interested stakeholders across the Carolinas as these critical issues related to the Companies' system-wide energy transition are considered. The third stakeholder meeting is scheduled for March 22, 2022, and the topics for this meeting are currently being developed based on feedback provided by stakeholders and will be announced in advance of the meeting. Interested stakeholders may contact GPI at DukeCarbonPlan@gpisd.net to receive future communications about the ongoing stakeholder process.

If you have any questions, please do not hesitate to contact me. Thank you for your attention to this matter.

Sincerely,

Jack E. Jirak

cc: Parties of Record

Enclosure

CERTIFICATE OF SERVICE

I certify that a copy of Duke Energy Carolinas, LLC and Duke Energy Progress, LLC's Carolinas Carbon Plan – Second Stakeholder Meeting Summary, in Docket No. E-100, Sub 179, has been served by electronic mail, hand delivery or by depositing a copy in the United States mail, postage prepaid, to parties of record.

This the 2nd day of March, 2022.

Jack Jirak

Jack E. Jirak
Deputy General Counsel
Duke Energy Corporation
P.O. Box 1551/NCRH 20
Raleigh, North Carolina 27602
(919) 546-3257
Jack.jirak@duke-energy.com

Duke Energy's Carolinas Carbon Plan Stakeholder Meeting Summary Report

Meeting 2 – Stakeholder Desired Outcomes and Modeling Frameworks

February 23, 2022 | 9:30 am to 4:30 pm ET

Contents

Meeting Summary

On Wednesday, February 23, 2022, the Great Plains Institute (GPI)[1] convened the second of three stakeholder meetings to inform the development of Duke Energy's Carolinas Carbon Plan. The meeting was held virtually from 9:30am to 4:30pm Eastern. There were approximately 398 individuals who attended the meeting. The full list of attendees is attached to this summary document.

All interested parties were welcome to attend this meeting. To solicit participation, GPI initially sent invitations to a list of over 750 stakeholders provided by Duke Energy and those that have asked to be added to the email distribution list. Recipients were encouraged to pass on the invitation to other stakeholders who they felt may be interested in the process.

An additional series of three technical subgroup meetings were held on Friday, February 18, 2022. These meetings were held in response to stakeholder feedback asking for deeper dives into the modeling inputs and assumptions. The three topics were:

- Solar Interconnection Forecast (10:00am-12:00pm)
- Solar/Wind Technology Operational/Cost Assumptions (1:00pm-3:00pm)
- Storage Operations/Cost Assumptions and System Configurations (3:30pm-5:00pm)

Additional details on and notes from the subgroup meetings are attached to this summary report.

Process Employed

PROCESS OBJECTIVES

Overall, this series of three meetings is being designed to meet the following objectives:

1. Ensure the Carolinas Carbon Plan is informed by input from a wide range of stakeholders.
2. Enable a transparent conversation about how to plan an energy transition that prioritizes affordability and reliability for North Carolina and South Carolina customers.
3. Build on areas of agreement, clarify areas of disagreement, and seek opportunities for collaboration in advance of filing the Carolinas Carbon Plan.

MEETING 2 OBJECTVIES AND CONTENT COVERED

This second stakeholder meeting was designed to build on the content covered in the first meeting and allow more time for stakeholders to share their perspectives and insights to inform development of the Carbon Plan. Below, we have described each major section of the agenda and highlights of the content covered.

[1] GPI has been hired by Duke Energy to serve as a third-party convener and facilitator for the stakeholder engagement process to inform development of the Carbon Plan.

1. **Response to Questions from Meeting 1**

This section of the agenda allowed Duke Energy staff to respond to a number of themes raised in questions in the first meeting, including the following topics:

- Approach to initial selection and modeling of technologies
- Modeling approach to coal securitization
- Consideration of combining balancing areas
- Consideration of consolidating future IRPs
- Approach to considering load growth from electric vehicles
- Accounting for cost impacts

2. **Stakeholder Desired Outcomes**

During this section of the agenda, facilitators from GPI put on screen a consolidated list of desired outcomes for the Carbon Plan that stakeholder had raised in the first meeting, and asked participants to identify clarifying questions and improvements to the list. The list of desired outcomes had been drafted by GPI staff and sent to attendees in advance of the meeting. The list from the first meeting was split into two sections – the first was desired outcomes for the Carbon Plan, which the second was resource or modeling suggestions. This session focused only the first list; in other words, the goal was to identify what should come about from the Carbon Plan development process and the plan itself regardless of the resources or portfolios being modeled or considered.

GPI staff solicited feedback on the list of desired outcomes and made live edits to the list during the meeting so that participants could ensure their suggestions were captured accurately. The list, as edited during the meeting, has been included in the meeting notes below.

3. **Principles for Portfolio Development and Evaluation**

This section of the meeting provided an opportunity for stakeholders to provide feedback to Duke Energy's proposed objectives for any portfolio to be modeled in developing the Carbon Plan (in alignment with and in addition to the objectives set forth in HB 951) and their proposed metrics for evaluating different portfolios of resources that could achieve the carbon reduction targets.

Duke Energy staff presented four high-level objectives: CO_2 reductions, reliability, affordability, and executability. In addition, Duke Energy staff presented a series of standards that any resource portfolio must meet, as well as factors for comparing different resource portfolios.

4. **Considerations Driving Different Portfolio Options**

The section of the agenda provided an opportunity for Duke Energy staff to solicit stakeholder questions and feedback on a general framework for developing modeling scenarios in response to the requirements outlined in HB 951. Key issues discussed included consideration of the emissions impacts of siting resources in or outside of North Carolina and consideration of HB 951 language around flexibility to meet the interim 70% by 2030 target if new nuclear or offshore wind are being deployed to meet that target.

GROUND RULES

To support a constructive meeting environment, GPI established and asked all attendees and panelists to agree to the following ground rules for this and future meetings:

- **Respect each other**: Help us to collectively uphold respect for each other's experiences and opinions, even in difficult conversations. We need everyone's wisdom to achieve better understanding and develop robust solutions.
- **Focus on values and outcomes**: Today's discussion is about what stakeholders value in the energy future, and how the Carolinas Carbon Plan can align with those values. Pending legal issues are outside the scope of this conversation.
- **Chatham House Rule**: Empower others to voice their perspective by respecting the "Chatham House Rule;" you are welcome to share information discussed, but not a participant's identity or affiliation (including unapproved recording of this session).
- **Respect the time**: Our time together is limited and valuable, and we have a large group, so please be mindful of the time and of others' opportunity to participate.
- **Use the chat:** Please submit your comments and questions in the chat. GPI staff will monitor the chat to pull out questions for Q&A portions. Please be respectful and focus on issues, not people.
- **Raise your hand**: During dedicated Q&A portions of the meeting, use the "Raise Hand" feature to indicate you would like to voice a question or comment.

MEETING LOGISTICS AND PARTICIPANT INTERACTION

The meeting was held via Zoom Webinar. Stakeholders were allowed to freely chat one another and speakers and facilitators. They were also allowed to raise their hand to be unmuted and ask questions or provide their thoughts orally during Q&A and discussion portions of the meeting. Staff from GPI facilitated the meeting and took meeting notes, which are included in this summary. In keeping with the ground rules detailed above, the meeting notes have been anonymized. GPI will also be sending an anonymized export of the meeting chat to meeting attendees. The meeting was recorded for the purpose of sharing the presentations, however in keeping with the ground rules, the Q&A and discussion portions of the recording will not be shared. The meeting recordings will be posted on the Duke Carbon Plan webpage[2]

Identifying Points of Consensus

As with the first stakeholder meeting, this meeting was not designed to drive towards consensus given the large number of participants. Instead, facilitators sought to provide the opportunity for stakeholders to express their thoughts through the chat and orally during the Q&A and discussion portions of the meeting. All comments and questions have been recorded so that Duke Energy can consider them in developing the Carbon Plan.

---

[2] www.duke-energy.com/CarolinasCarbonPlan

While stakeholders were not asked to reach consensus in their feedback, GPI staff noted the following themes that emerged throughout the meeting:

- **Desire for transparency:** When discussing their desired outcomes for the Carbon Plan, several stakeholders asked for transparency in both the modeling inputs and assumptions, as well as Duke's approach to developing and implementing the Carbon Plan and requested more detailed information in advance of the May 16 filing. Duke indicated that it is developing plans to facilitate information sharing but is unable to share detailed information prior to filing because the modeling and other work will not be completed in time to do so. Duke intends to share further information on potential decarbonization pathways at the final stakeholder session.
- **Risk mitigation and resiliency as objectives:** In assessing Duke Energy's four objectives for the modeling scenarios of carbon emissions reductions, affordability, reliability, and executability, several stakeholders suggested that risk mitigation should be considered as either a fifth objective or be names more explicitly under each of the four objectives presented. Duke Energy staff agreed that risk mitigation was a key objective and thanked stakeholders for the feedback. In addition, some stakeholders suggested that resiliency should be considered parallel to reliability. Duke Energy staff agreed that resiliency was important, but saw it as a separate grid consideration that would not influence resource selection for decarbonization.
- **Request for modeling RTO impacts:** Several stakeholders requested, in the meeting chat, that Duke Energy consider modeling the impacts of joining a regional transmission organization (RTO) and also requested a RTO sub-group to be established. Duke Energy staff responded that this was out of scope for this Carbon Plan.
- **Fair consideration of all resources:** Some participants raised questions or comments to ensure that various resources would be included and considered fairly by the model. Duke Energy staff explained that all resources will be considered, but the consideration will depend on when those resources are available at different points in time and finding a pace of deployment that can be executed upon, especially for meeting the interim 70 percent target.
- **Clarification of approach to siting:** In the final agenda session, several participants asked for clarification of Duke Energy's approach to siting resources between North Carolina and South Carolina, given that HB 951 directs carbon emissions reductions from plants sited in North Carolina. Many stakeholders expressed a concern at the possibility of siting gas plants in South Carolina in order to avoid counting those emissions in North Carolina. Duke Energy staff clarified that the capacity expansion and production cost modeling being conducted to develop resource portfolios and pathways for the Carbon Plan does not take state-specific siting into account; moreover, Duke Energy staff clarified that they will report total emissions for North Carolina, as well as for the system as a whole, so that stakeholders may assess emissions changes at both levels for different resource portfolio options.

Accessing Meeting Materials

All meeting materials, including the agenda, slide decks, recordings of the presentations, and meeting summaries will be posted on the Carbon Plan website at www.duke-energy.com/CarolinasCarbonPlan.

In addition, stakeholders are encouraged to send additional feedback and comments to inform the development of the Carbon Plan to DukeCarbonPlan@gpisd.net.

Meeting Notes

I. Welcome, Introductions, Process Updates

Doug Scott, Great Plains Institute

1. Overview of today's agenda and meeting ground rules.
2. Participant introductions via chat.

Julie Janson, Duke Energy

3. Duke Welcome: Julie Janson, Executive Vice President & CEO, Duke Energy – Carolinas Region
    a. Thanks to everybody for joining, both for this process and others that many organizations are participating in.
    b. Looking forward to your thoughts on developing the carbon plan and getting more into the details of portfolio development and carbon plan evaluation.
    c. Recent climate commitments
    d. Coal less than 5% of generation by 2030, and fully exit coal by 2035.
    e. Federal relicensing process for hydro projects – Duke required to follow a very prescriptive and lengthy process, which is in place to ensure hydro assets are run a collaborative way with attention to water resources and biodiversity. Those assets will help with achieving carbon goals, so beginning the process of relicensing the Bad Creek hydro station. Will be filing the pre-application today with FERC. Pre-application includes reference to a second power house, just to keep that option open. An example of the investments Duke is prepared to make.

Rebecca Dulin, Duke Energy

4. Stakeholder Process Updates
    a. This is the second of three meetings, next meeting scheduled for March 22nd. Trying to get as much stakeholder engagement completed on the front end so that April can be committed to working on the development of the Carolinas Carbon Plan, with stakeholder input in mind.
    b. Heard feedback that these large meetings don't allow more technical, in-depth conversations about the modeling inputs and assumptions. Taking that into account, held three technical subgroup meetings on February 18th where technical experts served as panelists to discuss the inputs and assumptions and provide feedback to Duke staff on the following topics:
        i. Solar interconnection forecast
        ii. Solar and wind cost and operational assumptions
        iii. Storage cost and operational assumptions
    c. Also considering the need for future subgroups – please provide feedback on that.

d. Appreciate the process feedback as well. Working to provide the meeting agendas farther in advance so that participants can determine who from their organization should attend. Also working to provide the slides before the meetings.

II. Presentation and Q&A: Respond to Key Questions from Meeting 1

Glen Snider, Duke Energy (and other Duke Energy staff)

Facilitated by Doug Scott, Great Plains Institute

1. Initial selection of technologies: Can you share how the regulatory uncertainty and maturity of technologies plays into your modeling process? Is there an earlier "qualification" stage by which you make decisions about which technologies proceed to your modeling process, or do you run all technologies in the model and later subtract those you don't believe will meet regulatory or technology readiness requirements?
    a. Carbon Plan is a long-range plan that incorporates an interim plan to achieve 70% reductions as a check point to net zero by 2050. Need to think about which technologies are commercially available, or have a pathway to commercial availability, in the next decade in our service territory – these are a subset of the total technologies that will be available by 2050.
    b. Use reports from Burns & McDonnell and Guidehouse to look at the latest technology costs. Also have an Emerging Technology Assessment team that looks at how different technologies are maturing.
    c. Also look at IRP's from other utilities
    d. Use all of those resources to figure out which technologies are mature enough to be included in the process. Also look at the economic side of the technologies, which takes into account the levelized cost of energy over a range of capacity factors of each technology. Those are used to determine which technologies are put into the model for selection to meet the carbon goals.
    e. Advanced nuclear – seeing four different small modular reactor designs that are viable from a technical standpoint
2. Modeling coal securitization: Will coal retirement analysis take into account the reduced revenue requirements available through securitization of remaining coal plant costs?
    a. Yes, legislation calls for the ability to securitize 50 percent of North Carolina retail allocated net book value of coal plants that are subject to retirement. In other words, if you accelerate a retirement such that you haven't fully depreciated the asset (i.e., there's still book value), securitization lets you pay it off at lower cost to consumers.
    b. Working to quantify the benefits of securitization and include those in the analysis of early coal retirements.
3. Combining balancing areas: Does Duke plan to pursue consolidating its balancing areas as a part of its strategy to achieve the carbon reductions contemplated under the Carbon Plan? And if there is no plan to do so, why not?
    a. Yes, we do think this is the appropriate time to consider this – essentially consolidating transmission planning and operations to bring about more efficient

dispatch and incorporate intermittent resources across the system. Plan on pursuing the necessary federal and state regulatory approvals to do this. Believe this will bring additional value to Duke's customers.

4. Consolidating future IRPs: Does Duke plan to combine future Integrated Resource Plans for DEC and DEP?
    a. Duke Energy Progress and Duke Energy Carolinas are two separate legal entities, so required to file independent resource plans. Each utility has its own assets and obligations to reliably and affordably serve load while reducing carbon footprint. Do not plan to consolidate – plan to continue to file two separate IRP's that take the whole system into account.
5. Electric vehicles and decarbonization: Are you modeling the shift from internal combustion vehicles to electric in your demand projections? Can you discuss the tension between pursuing vehicle electrification (which increases load) with the need to decarbonize (which is served by a reduction in load)?
    a. We are supportive of electrification for its economy-wide benefits and see Duke as having a role to provide the infrastructure to support electrification and meet load growth.
    b. Tension between electrification and decarbonization – this is something we have to contend with, similar to factors like economic development and population growth that can change and increase load. Want to ensure we're meeting load while doing everything we can to increase efficiency and meet our carbon goals.
    c. How electric vehicle (EV) growth is incorporated into the load forecast (Matt Kalemba, Duke Energy)
        i. EV growth is included in the carbon plan load forecast, including light, medium, and heavy duty electric vehicles:
            1. Currently EVs account for 0.1% of Carolinas energy demand. In carbon plan forecast, that grows to 1.5% by 2030 and 5.5% by 2040.
            2. Base Forecast -- 12% of new vehicle sales are EVs by 2030.
            3. Also looking at a high electrification case, which would reflect President Biden's goal of 40 to 50 percent of new vehicle sales being electric by 2030.
6. Carbon plan cost impacts: Can you please describe how the Carbon Plan will account for costs to customers? What steps are being taken to consider cost impacts to low income customers? When will stakeholders have more information about the costs of the Carbon Plan to customers?
    a. Looking at the costs of the entire system – long-range perspective on a present value basis (present value of revenue requirements), as well as a snapshot in time of annual costs or bill impacts that could be expected as the system transitions.
    b. The planning framework is multi-faceted. Some parts are addressed in the carbon plan and some parts are addressed downstream of the carbon plan. For example, one of the objectives is to decarbonize in the lowest cost manner

possible at the system level. But the plan doesn't get into the details on how those costs are borne by customer classes – that will happen downstream.

   c. Low Income Affordability Collaborative (Conitsha Barnes, Duke Energy)

      i. Comprised of individuals representing over 30 organizations approved by the NCUC. Members provide diverse perspectives and experience from state agencies, utilities, consumer protection agencies, and environmental advocates. Has been meeting since July 2021, and has held 5 of 9 workshops. Actions to date include:

         1. Assessment of residential low income customers
         2. Explored definitions of affordability
         3. Investigation strengths and weaknesses of existing rates and programs in addressing affordability
         4. Collaborative has filed several progress reports with NCUC, and will soon file the final report in July 2022.

7. Q&A and Discussion

   a. Some questions better suited to the afternoon session (including on advanced nuclear)

   b. Securitization – from a dollars standpoint, what do you expect?

      i. Securitization is a mechanism for recovering remaining net book value for sub-critical coal plants. The further you accelerate from the planned retirement date to an early retirement date, the net book value grows, so the benefit of securitization also grows. It's a dynamic number that changes each year as you accelerate depreciation.

      ii. We don't have securitization in place yet. It will happen at some future point when plants are retired. As we get more details on the mechanisms and parameters for securitization, we'll update our analysis. We are included our initial estimates in the Carbon Plan.

   c. What were the four types of advanced nuclear deployed this decade?

      i. There are 4 technologies that appear to be on the path to be deployed this decade.

         1. NuScale Power VOYGR in Idaho – 2029 timeframe
         2. GE-Hitachi BWRX-300 in Ontario – as early as 2028 timeframe
         3. TerraPower/GE-Hitachi Natrium in Wyoming – 2028 timeframe
         4. X-Energy XE-100 in WA State -- 2028 timeframe

   d. More detail on what the balancing authorities are and what combining them might mean for the carbon plan?

      i. Would allow us to more efficiently commit and dispatch resources. Lends itself to doing the follow: flexibility to optimize existing resources, reduce solar curtailment, lower production costs, aggregate more variable generation and load, and lower day-ahead reserve that we need to maintain for load forecast error, contingencies, etc.

ii. Main benefits are cost reduction, efficiency, and variable energy integration.

e. Estimates and forecasts on costs and prices of generation resources – what are you using for your assumptions?

   i. In planning phase, trying to get representative costs of resources in the specific region. Comparing those representative costs to try and come up with a total system that is least cost. However, actual costs at a specific facility will depend on site-specific factors, like land costs, surrounding infrastructure, etc. In the planning phase, don't have the ability to consider where resources will be sited, so use market information to develop representative costs that can take general site considerations into account. Resources will ultimately be above or below the representative costs.

   ii. Costs are being benchmarked against both private and public data sources.

   iii. There are many issues affecting costs right now, including labor rates, supply chain, and geopolitical factors.

   iv. Factor in assumptions about how we might see costs decline over time.

f. Energy efficiency (EE) and demand side management (DSM)

   i. Duke has an existing EE and DSM stakeholder collaborative, joint between North and South Carolina. Has been in place for several years and has been a successful working group. Have scheduled a meeting of that group to address the inputs and assumptions in the Carbon Plan.

g. How does consideration of joining or forming a regional transmission organization (RTO) factor into the modeling?

   i. There's a lot of complexity in how this would be modeled, depending on your assumed structure for an RTO, so it could derail the good work that's happening to develop the carbon plan. It is out of scope for this effort.

h. Are distributed energy resources being considered in the EE/DSM collaborative?

   i. Will check to see to what extent it's been part of the conversations, and if it's not part of it, will look at how to address this.

i. Definition of "sub-critical" coal plants?

   i. Has to do with the steam pressures and the older units running at lower pressures. Super critical plants are more efficient and built later in time – they use higher pressure steam. Sub-critical are older, less efficient units that use lower pressure steam.

   ii. In Duke's IRPs these units are listed in Appendix D:

      1. Super critical: Cliffside 6, Belews Creek 1-2, and Marshall 3-4.

      2. All others are sub-critical.

j. How do you avoid favoritism in assessing emerging technologies?
    i. All resources have quantitative and qualitative advantages and disadvantages. There is no one resources that can reliably and affordably meet all of the needs we have, given the dynamic nature of customer demand from an hourly, daily, and seasonal perspective. The further in time or space that you have to move energy to meet demand, the higher the costs will be. It can appear that there's an inherent bias, but in the planning process there are engineers and finance experts trying, without bias, to find the best way to meet the carbon goals at least cost.
    ii. Try to be very upfront about the quantitative and qualitative costs and benefits of each technology being considered.
    iii. Need to develop a diverse set of options from which the model can choose, including resources that can complement solar and storage and solar+storage as needed.

III. Discussion: Stakeholder Desired Outcomes

Facilitated by Doug Scott and Trevor Drake, Great Plains Institute

This list is intended to describe, at a high level, what stakeholders would like to see reflected in Duke Energy's Carolinas Carbon Plan and included in the process to develop the plan. During this session, facilitators presented an initial draft based on feedback received at the first meeting on January 25, 2022, and asked attendees to suggest improvements to the list. The list below represents the list as edited on-screen during the meeting.

Importantly, these outcomes are:

- *intended to represent the collection of different stakeholder desired outcomes for the Carbon Plan (these are not consensus);*
- *numbered for reference purposes only (the numbers do not represent a ranking or prioritization); and*
- *assumed to be in addition to the expectation that the Carbon Plan will comply with North Carolina Session Law 2021-165 and all relevant regulatory requirements.*

STAKEHOLDERS' DESIRED OUTCOMES OF THE CARBON PLAN

1. Engagement:
    a. Consider input from stakeholders and recognize where input changed assumptions, and what those changes were.
    b. Identify areas of consensus on as many issues as possible prior to filing.
    c. Incorporate recommendations from related stakeholder engagement processes, including but not limited to the Clean Energy Plan stakeholder process, the Low Income Affordability Collaborative, and the Working Group on Climate Risk and Resilience.
    d. Consider the carbon reduction goals and plans of cities and businesses in Duke's service territories.

2. Emissions:
    a. Reflect the critical role that the electric system has in solving the economy-wide emissions problem by considering the electrification of sectors and end uses served by fuels other than electricity. Recognize the benefits in terms of customer total cost (not just electric) of electrification of end-uses.
    b. Address all greenhouse gas emissions beyond carbon dioxide, including upstream methane leakage from natural gas being delivered to electric power plants.
    c. Address the urgency of the climate problem by reducing emissions as soon as possible and by considering options that will achieve greenhouse gas emissions reductions more rapidly than the required targets. Avoid exporting emissions/pollution.
    d. Maintain a long-term view towards achieving a net-zero system (keep the end goal in mind).
    e. Consider life cycle assessment of all system resources, including but not limited to construction of infrastructure, etc., to get to net zero.
3. Customer and community impacts:
    a. Take a holistic and intentional approach to the siting of new facilities, avoiding areas already disproportionately impacted by energy generation or other industrial facilities.
    b. Provide support for coal plant host communities to address the economic and community impacts of plant retirements.
    c. Support the ability of businesses and industries to operate competitively, preserve existing jobs, and/or to create new jobs.
    d. Strive to achieve fair and affordable rates and total costs for all customers, including at-risk/low- and moderate-income households and communities.
    e. Center environmental justice communities in the development of the carbon plan.
    f. Consider new or expanded customer-facing programs for energy efficiency, DSM, and renewables.
4. Transparency:
    a. Clarify the approach to siting facilities between North Carolina and South Carolina.
    b. Transparently present modeling and measurement assumptions, inputs, and tools to the extent possible while protecting trade secret and copyrighted information. Ensure no inherent bias. Include analysis of improvements to the transmission grid.
    c. Transparently present metrics and principles being used to develop pathways and make modeling decisions.
    d. Transparently present the impacts of the plan, including costs.
    e. Clarify policy and regulatory interdependencies with the other components of HB 951.

f. Consider a modeling approach that begins with a few alternative end states that meet the goal.

g. Clarify consideration of carbon costs and carbon policies in the selected scenarios.

h. Clarify definition of net zero.

5. Grid Impacts

    a. Enhance resilience and grid hardening through changes over time.

IV. Presentation and Discussion: Principles for Portfolio Development and Evaluation

Nate Gagnon, Duke Energy (and other Duke Energy staff)

Facilitated by Doug Scott, Great Plains Institute

1. Goal of this session: Want to get specific about the actual measurable criteria by which we'll judge success by 2050 – what are the specific accomplishments and how will we measure them? Also, what are the risks and uncertainties we face moving forward, and how do we design a pathway that achieves the goals and mitigates against the risks and uncertainties?

2. Objectives for an energy transition pathway

    a. CO_2 reduction: purpose of this process is achieving carbon neutrality by 2050, while also achieving the 70% interim goal. Prudent business practices that serves our customers by increasing sustainability and hedges against cost risks and potential changes in the federal regulation of carbon.

    b. Reliability: Need to serve customers under a wide range of conditions and ensure there is capacity at all times of the day and year. Also need flexible, fast-ramping resources to match intermittent generation from renewables.

    c. Affordability: In the planning stage, we're talking about the sum total of the many different system costs. Will look at cumulative costs of a given plan over time, and also a forecast of customer bill impacts at different points in time.

    d. Executability: Need to be able to deliver the plan that we lay out on paper. Need to be able to bring new resources online according to the planned timeline and at expected costs. Need to be able to receive the appropriate regulatory approvals to do this.

3. Portfolio evaluation and comparison

    a. Minimum standards – These are the minimum criteria that any potential resource portfolio needs to meet to be considered in the first place. After meeting these, the rest of the criteria serve to help compare different portfolios against one another. These are built into the quantitative analysis as constraints and include environmental standards, CO_2 targets, and reliability requirements.

    b. Quantitative and descriptive factors are used to assess all portfolios that meet the minimum standards. These are used to guide the decision about which pathways to recommend.

i. Quantitative: can be boiled down to a single number (e.g., forecasted costs, expected operating characteristics)

ii. Descriptive: Can be qualitative or quantitative, but are too complex to be described in a single number. May be represented in charts or narrative text (e.g., trends, uncertainties).

4. Proposed metrics for evaluation and comparison

    a. Minimum standards: any potential pathway has to maintain adequate reserves and environmental standards and achieve decarbonization targets.

        i. Reserve requirements – preserving reliability falls into two categories:

            1. Planning reserves: Used to make sure we can serve customers during peak demand periods, also known as reserve margin, which is the capacity carried above peak lead. This is carried for three reasons:

                a. When actual load exceeds forecasted, weather-normalized peak load.

                b. Backup in case of outages during times of peak demand

                c. Rapid economic growth that is greater than forecasted.

            2. Balancing and regulating reserves: Used to ensure we can align supply and demand in real time. Need to be able to quickly increase or decrease energy supply in response to fluctuations in supply or demand, to keep the whole system in balance. This about both the types and amount of resources on the system.

    b. Quantitative comparison metrics:

        i. Affordability

            1. Present value of revenue requirements (PVRR): Measure of cumulative costs. Adds up all of the costs (capital, operating, maintenance, etc.) for each of the years of a particular pathway and converts them to a revenue requirement, and then discounts that revenue requirement back to today's dollars. Rolls costs up into a single number for comparison between different pathways. But this doesn't give a good sense of costs at the customer level.

            2. Average bill impact at points in time: used to supplement the PVRR by looking at estimated bill impacts.

        ii. System operations/reliability

            1. Forecasted curtailment: less curtailment of renewables is more desirable.

            2. Forecasted flexibility requirements: related to reliability and about risk and system operability. A plan with more starts and stops of resources may be riskier than a plan that has fewer. Also consider how much ramping up and down of generation is required to keep supply and demand in alignment.

iii. Total system CO_2 emissions: objective is to achieve carbon neutrality by 2050 across the full service territory. A pathway that achieves more rapid carbon reductions is preferable.

c. Descriptive comparison metrics:

i. Reliability:

1. Portfolio diversity: limits exposure to risk in any one area, and also limits exposure to execution risk

2. Extreme weather performance: all pathways will include planning and operating reserves, but still want to analyze how each portfolio will operate under challenging weather conditions.

ii. Executability:

1. Pace of new interconnections: the more new capacity we plan to bring online in a certain period of time, the more difficult it might be.

2. Reliance on new-to-the-Carolinas resource types

3. Reliance on regulatory changes and approvals

5. Clarifying Q&A

a. Can Duke define “adequate?” Will this threshold be based on NERC and/or other well established industry standards?

i. Yes, those are established standards. For planning reserves, it’s 1 event in 10 years – system will only expect 1 loss of load event in a decade.

ii. Also standards around operating reserves to ensure you have the required system flexibility. NERC balancing standards for second-to-second, minute-to-minute, and hour-to-hour.

b. How are you calculating lowest cost for purposes of the carbon plan? Are you calculating a social cost of carbon, and at what point does that figure into the cost determination?

i. There are a couple ways you can do this in a modeling framework:

1. You can set a mass cap that is a physical limit on emissions and serves to help the model select the most optimal set of resources while staying under that cap.

2. Or you can increment up on a carbon price until you see the desired carbon reductions you’re looking for in the model.

ii. Important to note that the carbon price is used only for the modeling – it drives the optimal portfolio selection in the model, but it’s not a tax that is actually being applied to customers; it wouldn’t show up in the assessment of costs (though this could change if there were future policies developed on carbon pricing). Important to stress test the portfolios against the future possibilities of carbon pricing policies.

iii. We also look at to what extent the outputs are changed by the input assumptions.

c. What are you looking at in terms of what might happen to costs in the future (for example, variable natural gas prices)?

    i. Two things here:

        1. We need to evaluate different potential pathways that rely more or less on different types of resources.

        2. What are the outcomes we're seeking, and what are the risks around those outcomes? As part of this, we will assess sensitivities around costs.

d. How are we planning for potential disruptions from growing intense weather patterns?

    i. Good question and there are two issues:

        1. Resiliency: The physical characteristic of the grid. There's a separate initiative on grid resilience -- that's related to but different from long term adequacy of resources. Important to look at how transmission and distribution systems are susceptible to weather events.

        2. Reliability: Long term reliability is about the probability of extended periods of extreme load due to the weather (e.g., very cold or very hot days) and the availability of all resource types during those high load events. Also consider the forecast risk uncertainty – what is the load that you will actually have to serve? This includes things like electrification, economic development, and migration.

e. As you're trying to align supply and demand and meet the carbon goals, how are you looking at things on the demand side like electric vehicles and efficiency?

    i. We have a load forecasting group that is increasing integrated with other parts of the company and receiving information from them. Two factors here:

        1. We have different customer programs for energy efficiency and distributed energy resources that help to minimize the size of the problem.

        2. Also need to consider the rate of electric vehicle adoption, building electrification, economic development, and other factors that increase load.

    ii. There is increasing interaction to figure out the balance between things that minimize load growth, and things that increase it.

    iii. In that list of grid edge resources, we should also include distributed solar and rooftop solar as one of the factors being considered in the analysis.

f. How is the company considering regulatory risk for existing fossil plants that could end up becoming stranded?

    i. It's not just one asset type – a lot of assets have expectations of useful life that will change due to different factors. We've been engaging with stakeholders to find different ways to stress the projected useful life horizons, and assess what that does to the value of that resource.

g. What do you use for the data on weather on climate? Do you use the data provided by the North Carolina Climate Office?

   i. For reliability work, we stress different sources of data to see if there's a long term drift one way or another. Don't know what the standard source is.

   ii. We use the historical weather data from the National Oceanic and Atmospheric Administration (NOAA) in developing the load forecast.

h. What's the level of energy efficiency savings from a C&I customer standpoint, including opt-outs?

   i. We'll show, within the load forecast, how much reduction we expect to be able to achieve to minimize the amount of hourly demand we have to serve. We'll be transparent in showing how much EE will be assumed in the base case. However not sure if we've ever shown how much EE will be from each customer class. We'll take that suggestion and look into it.

   ii. We will assume the opt-out provision is still in place in establishing our base case. That's one of many things that influence how much efficiency we can achieve.

i. Are you factoring in utility and non-utility EE savings?

   i. Yes, we get expectations for savings from the programs that the company offers, but we're fully aware that's not the only way efficiency occurs. The load forecast team is also looking at natural occurring efficiency (outside of utility sponsored programs). We can look for a decline in the use per customer over time to assess this.

j. How do you define affordability?

   i. We have those minimum standards that every portfolio must meet, and then beyond those, we need to minimize costs and risks. It's a comparison metric – not a specific number that is or isn't acceptable, but an assessment of which portfolios or pathways are more affordable than others in meeting those minimum standards. Would really like feedback on how best to measure that.

k. Are you looking at evolving building codes?

   i. Yes, enhanced building codes are something the load forecasting team is looking at in their modeling, including turnover of housing stock. We don't have the right experts from the company in the room today so can follow up with more details

l. HB 951 is asking Duke to accelerate the rate of solar photovoltaic (PV) adoption because you want to reduce emissions, but the net metering proposal in E 100 Sub 180 is decelerating the rate of PV adoption. How does that work?

   i. 951 sets important goals and there are many tools to achieve those goals. There are also regulatory proceedings happening in parallel to development of the carbon plan. This comes into the load forecast, but it's a separate docket with its own issues. We'll seek to integrate the results of that proceeding into the carbon plan as timing allows.

m. How are you assessing risk?

   i. Some of it is quantitative and baked into the process upfront, other parts of it are qualitative, in terms of questions we ask of the modeling results. Some examples are…

      1. Deciding what reserve margin we need to maintain to achieve the 1-in-10 standard.

      2. Assessing the risk in achieving a certain outcome based on the modeling inputs.

      3. For the carbon reduction targets and new resources needed to meet those targets, there are new and different kinds of risks. The slides here are focused on outcomes, but would probably be good to also clarify the risks we're concerned about. Some of those show up in the descriptive comparison list – portfolio diversity, pace of technology deployment, etc.

      4. Different levels of potential carbon caps in the modeling.

      5. Considering different ways of achieving portfolio diversity.

n. Is Duke planning to use minimax regret analysis or other risk metrics in its portfolio analysis, as it was directed to do in its SC IRP?

   i. Yes, we intend to look at that. It's a good metrics, but it has its pros and cons.

o. Are you looking at the individual risk factors for each resources into account?

   i. Yes, that's right. "Portfolio diversity" is shorthand for looking at risks of different resources in the portfolio (generally, more diversity means less risk).

6. Discussion of objectives and metrics

   a. Comment: Should mitigating risk be added to the list of objectives, especially risk to customers?

      i. We're trying to get the inputs as accurate as possible based on what we know today, and then we're going to be updating the carbon plan every two years based on new information and changes over time.

      ii. Comment: Thinking about a different form of risk mitigation – one option has high capital costs, lower operations and maintenance costs; and the other option has the opposite. Feel like it's important to identify risk as an objective of what we're doing here.

         1. Yes, that's good input.

   b. Comment: Two things that are missing, though they may come under executability:

      i. Measurability: we can have metrics, but need to be able to measure against those.

      ii. Transparency: if we're getting towards a sustainable solution, who measured it and how, and how is it being shared with stakeholders?

c. Comment: Would like to push back on two bullets under the reliability objective. With renewables, when you need capacity may no longer align to the peak demand hours. You could just keep the second bullet to maintain flexibility and respond to real-time operating conditions. The question is, can you serve load at every hour given solar and wind output data?
    i. Good feedback. Our process does look at loss of load probably in every hour of the year, including considering solar and wind output.
d. Question: Will you look at the health benefits of residents using Duke services?
    i. Lots of debate about how to calculate that, but we'll take that input and consider it.
e. Question: How can we say if these are the right objectives if we don't know what the costs and emissions will be of different options?
    i. That's why we're having this conversation – the objective we're pursuing is lower cost to customers, and then we can discuss different portfolio options to achieve that.
    ii. We also need to consider how quickly different pathways reduce carbon across the planning period.
f. Comment: Duke is not willingly sharing data and information with parties. I can't make an assessment if I don't know what assumptions Duke is using for different resources.
    i. Question to stakeholder from facilitator: Isn't the objective different from the means to achieve that objective? The question here is, is lowest cost over time to achieve the targets the right objective? Does that make sense?
        1. Yes, but different scenarios can have the same cost results, so we need the data to be able to evaluate that.

V. Presentation and Discussion: Considerations Driving Different Portfolio Options

Glen Snider, Duke Energy

Facilitated by Trevor Drake, Great Plains Institute

1. Details of legislation will shape portfolio analysis
    a. HB 951 focus is CO2 emitted in North Carolina:
        i. Duke's system across North and South Carolina provides a scale and scope that will be beneficial for achieving carbon neutrality at lowest possible cost.
        ii. HB 951 asks specifically to achieve carbon emissions reductions targets in North Carolina. As has always been the case, resources may or may not be sited in North Carolina, which can created a different carbon accounting impact when you're looking at North Carolina emissions only. When we set up a model, we don't site resources. That happens downstream. When we show carbon emissions, we will show North

Carolina emissions, South Carolina emissions, and total system emissions

b. Timing dependent upon technologies approved by the NC Utilities Commission:

   i. The legislation allows the North Carolina Utilities Commission some flexibility in achieving the interim 70% target, if specifically nuclear or offshore wind are being authorized (these resources are references in the legislation)

   ii. Today we're not deciding on a path or which resources or good or bad; we're deciding on a framework for evaluating different pathways.

2. Carbon reduction target and toolbox

   a. 24 Million ton reduction required in NC to achieve 70% target

      i. Duke has been reducing its carbon emissions, and there's still significant work remaining, and it will take a mix of different resources. The question is how to develop those portfolios.

   b. Estimated potential NC CO2 reduction (first 1,000MW)

      i. This is showing that different resources available to meet this goal have different impacts and different characteristics. This is very high level and depends on several factors, including what the resource is displacing on the system. Also, as you add more of any of these resources, their carbon reduction potential decreases (bar moves to the left) because you're saturating the part of the load profile that that resource decarbonizes.

      ii. For the combined cycle plants sited in North Carolina versus not in North Carolina -- we're not siting resources as part of this modeling; we're just saying that, due to the way carbon accounting works, a combined cycle plant sited outside of North Carolina reduces carbon for the system, but has a bigger impact on North Carolina reductions than one sited in North Carolina.

      iii. we're looking at this from a total system perspective and will report that, but according to HB 951 we also need to report on NC emissions, so we'll report that too.

      iv. This is all part of a much bigger plan to reduce emissions system-wide.

3. Two main paths on the way to carbon neutrality

   a. How do you organize those resources into pathways to achieve carbon neutral by 2050? There are two sets of portfolios that need to be examined with respect to the interim goal:

      i. Those that include either of the two technologies called out in HB 951 as allowing flexibility in the timing – new nuclear and/or offshore wind. You could have portfolios with only one of these resources, or with both of them.

      ii. Those that don't include those two specific resources. You would have all other resources, but just not including new nuclear nor offshore wind.

b. Within each of those, not pre-judging which resources are best – that's part of the evaluation process. For all portfolios being evaluated, they'll be assessed based on the minimum standards and comparison factors discussed earlier.

c. Overall, all portfolios are being designed to achieve carbon neutral by 2050. This is just about considering the tools that could be available to get there, and the mixes of resources at different points in time.

d. No decisions have been made on which resources are going to be part of the preferred plan. This is just showing our thinking about how the portfolios will be developed and organized to ensure we've taken a holistic approach.

4. Q&A and Discussion

   a. In the chart showing estimated potential NC CO2 reduction (first 1,000 MW), why are the estimates for a combined cycle plant sited in North Carolina versus outside North Carolina different?

      i. This is showing emissions from the North Carolina perspective only. If a combined cycle plant is being selected by the model, that's because it's more efficient than the resource it's replacing. At the system level, no matter where it's sited, it's going to displace a resource with higher carbon emissions and therefore reduce emissions. If the old resource is in North Carolina, and the new resource is also in North Carolina, then you're only going to see the net savings from the less efficient plant to the more efficient one. If the old resource is in North Carolina, and the new resource is outside North Carolina, you're going to see the reduction in emissions of the entire old plant that was retired (not just the net savings).

      ii. Again, we're going to report emissions for both North Carolina and for the system as a whole.

      iii. To be clear, we are not going to select a portfolio that would raise emissions in South Carolina just so we can lower them in North Carolina.

   b. On the same chart, how can solar and wind have a lower carbon reduction potential than a combined cycle plant?

      i. It's a difference in the savings per unit generated, and the number of units generated. Solar and wind have greater savings per unit generated, but they have a lower capacity factor than a combined cycle plant. In other word, they don't produce as much energy per the 1,000MW block.

   c. Is the efficiency utility, non-utility, or both?

      i. It's a broad range of all types of efficiency. And again, we're using efficiency to reduce the need for new generation resources.

   d. Does this include embodied carbon or lifecycle assessment?

      i. No, this considers reductions in direct (on-site) emissions only.

   e. In addition to offshore wind and advanced nuclear, are other emerging technologies like hydrogen and advanced storage considered?

      i. Yes, the reason we called out those two resources are because they're mentioned in the legislation. Hydrogen will begin to have an impact, likely in later 2030's or 2040's, and will be considered. We don't see it playing a major role in the interim 70% target. The same is true for long duration storage – it will play a role long-term, but it's not likely to be commercially available in the near term.

f. Could you speak to the rationale of bucketing new nuclear and offshore wind together?

    i. The legislation called these out as specific resources that, if being considered, would give the commission some flexibility on the timing of the interim goal. We also heard from stakeholders that they wanted to see portfolios that don't include these resources, so we're trying to be responsive to that request here.

g. Does Duke have intention to meet the North Carolina emissions targets in HB 951 by building facilities in South Carolina, and taking the emissions reduction as a credit against North Carolina emissions?

    i. When you're operating the total system, even if you site resources in South Carolina, you're going to drive total system emissions to an industry-leading level of reductions. We are committed to reducing total system emissions.

    ii. At this time we do not have plans to build in any specific location, however if it turns out that the most optimal path to reducing system-wide emissions is to site a plant in South Carolina we would consider it. But we're not picking portfolios or strategies as part of this, it's just a framework for the evaluation.

    iii. Stakeholder comment: If we're going to look at whether North Carolina's emissions are reduced by building plants in South Carolina, you also need to look at purchases from RTO's.

    iv. Stakeholder comment: You're showing a need to reduce a certain amount of emissions, and that a plant built in South Carolina goes farther in achieving that reduction target. If that's the company's position, you'll have unhappy stakeholders.

        1. Total emissions are going down. We're obligated to look at this because HB 951 calls for reduction in emissions from plants sited in North Carolina. But we're also going to show total system emissions and NC-level emissions. We are not looking to increase emissions. It just means we need to report emissions as required by the law, and we're showing here how different tools in the toolbox would contribute to that metric.

h. It seems like there are a lot of additional considerations given the focus on North Carolina emissions. I could envision an exercise where a gas plant in South Carolina is ramped up to reduce emissions in North Carolina. This approach seems to raise additional questions.

    i. We're not thinking of other levers like that. That's not one of the things we'd do to hit the North Carolina targets.

i. How are you planning to ensure, in the modeling, that emissions don't increase in South Carolina to the benefit of the North Carolina targets? Will you impose constraints on South Carolina emissions to hold them to historical levels?

i. Theoretically, if a combined cycle plant is selected to replace a coal plant, we'll need to go through a siting process. If it turns out the best site for that is outside of North Carolina, we're still going to operate in economic merit order regardless of where it's located. We'll look at carbon emissions for that plant wherever it's sited. It's possible you may end up with a 70% reduction in North Carolina and 68% total system reductions. At this point, it's a reporting issue, not a strategy.

j. If you impose emissions constraints on North Carolina, without doing anything for South Carolina, you're going to impose a shadow price on emissions in North Carolina and that will lead to dispatch in South Carolina. So how will the modeling approach avoid that outcome?

   i. The carbon constraints will be assessed at the system level, and the dispatch will be looked at system-wide. The modeling will look at, once resources are in service, how much reduction do you get in each state. We will not run out-of-state generators out of merit just to meet the targets.

k. So you'll impose a shadow price on the whole system, and goal-seek until you get a portfolio that meets that shadow price and achieves the North Carolina targets?

   i. Yes, that's right.

l. Why are you looking at portfolios that don't include offshore wind?

   i. The legislation speaks directly to the ability for the commission to have some flexibility in meeting the 2030 goal if offshore wind or new nuclear are being approved. Assuming the intent there is a recognition that developing offshore wind or new nuclear by 2030 will be challenging, so it's worth looking at options that do and do not include those resources. The approach is based on the legislation, not technology maturity.

m. Offshore wind is available today, so why not let the model select offshore wind if it wants to?

   i. We are letting the model select it; it's just not available until a date; for example we couldn't have it in 2026. By "currently available" in the slide we mean available for deployment in North Carolina prior to 2030.

   ii. Offshore wind is certainly being deployed globally and nationally, but looking at realistic timelines for North Carolina, it doesn't make sense for deployment by 2030.

n. What is the limiting step in not being able to deploy offshore wind by 2030, such as by 2029?

   i. We're evaluating the different levers and timelines that would be needed to deplore offshore wind by 2030. Some things are out of our control, including offshore wind leases, maturity of supply chain, and costs. We could put offshore wind in the model, but we don't think it's realistic.

   ii. Stakeholder comment: Those elements that you mention, such as supply chain, will be addressed in the next few years. There are regional investments already happening, and the leases are available. And the technology is available. All you need is to trigger the offtake.

1. Yes, there's a lot of progress, but all of those pieces need to come together.

o. So much of what we're seeing today depends on how reliably we can forecast outcomes that are many years away. How mature are your modeling and simulation efforts?

   i. There was a lot of discussion about the need to stress test different portfolios against different factors. Running the sensitivities and comparisons is really important, and a sophisticated exercise. That's especially important today with how fast things are changing.

   ii. We are trying to get insights into the inputs and stress tests. We had good discussions on Friday about this. We do use a very mature modeling framework and the tools have been evolving. The underlying concepts of the tools have been around for decades, but they're much more sophisticated.

   iii. We are going to continue to update this every two years as well and incorporate new information.

   iv. Stakeholder comment: So many pieces of this are considered intangible, like regulatory risk, community engagement, permitting. All of this is vulnerable to being able to build these resources.

      1. Fully agree, and that's one of the benefits of a diverse portfolio. Also some risk factors are not best addressed by a quantitative model. There is no risk-free path. This is a big lift.

p. Natural gas this past month in Zone 5 was incredibly expensive. A new gas CC is going to be expensive for consumers if it's on Zone 5. So where will the gas be coming from?

   i. That all needs to be taken into consideration. When we look at different portfolios, having too much Zone 5 exposure might be too much risk, and that will certainly be taken into account. The same goes for other risks like land availability.

   ii. Stakeholder comment: we need to address this because it's hurting industrial customers; Zone 5 is only going to get worse.

q. It seems there's a problem that any time you build anything outside of North Carolina, this issue is going to come up, which may be a fundamental flaw in HB 951. The loophole in the regulation is that you're not assigning any carbon to the imports coming into North Carolina. Seems that you should count those imported emissions anyways, even though it goes beyond the requirement of the law.

   i. We put resources all over the grid to serve customers all over the grid. Resources in both states serve customers in both states. We're looking to meet the needs of both states in the most carbon and cost effective manner. This issue exists throughout the industry.

   ii. Stakeholder comment: My suggestion is considering an accounting framework that matches North Carolina generation with North Carolina demand, and if North Carolina is in an import situation, then assign it some more carbon.

r. Is Duke currently or has it recently taken any steps to develop a combined cycle plant in South Carolina?

    i. No, we do not have a specific project planned.

s. Given the fact that 951 is a North Carolina specific law, how are you evaluating the risk that you may not be able to convince the South Carolina regulators to pay for compliance with HB 951?

    i. We're thinking about this and recognize the need for alignment between states, which is in the best interest of our customers. We've always operated our system to achieve state alignment. That's also why we've invited South Carolina stakeholders to be part of these meetings. We also recognize the full jurisdiction that each of the commission have over our system in their respective states, which is why alignment is critical to this transition. In addition, the North Carolina commission recognized in its order the need for alignment.

t. Does Duke acknowledge there is a risk to North Carolina customers?

    i. We don't see this as a risk to any customers as no decisions have been made. We don't want to see any customers face an unreasonable amount of risk in this process.

u. I thought this session was going to tell us in some detail what the scenarios will be. Will we know what those portfolios or modeling scenarios will be before this is submitted?

    i. We laid out a framework at this stage. Our current thinking is to develop a finite number of portfolios that have certain elements in them. The feedback we're looking for is, what additional elements to these portfolios do stakeholders find important? We certainly hope to be able to share in the next meeting more detail about how much of different technologies and timing will be in the portfolios. However, we likely won't be ready to share modeling results.

    ii. Stakeholder comment: We're looking for a set of scenarios that we can track over time and that will teach about our barriers, so that we can work to overcome those things. I'd request a set of scenarios that can evolve to what will actually happen.

v. What is Duke's methodology for assessing the long term transition to carbon neutral by 2050? The transition plans will differ based on how you meet the interim goal.

    i. Your first 10 years has to be very executable. As you move toward 2050, we'll be look at nascent technology like hydrogen and long duration storage. We will include a broader array of technologies and more penetration of technologies. The problem is we won't have as much certainty in the timing or costs. But we'll model getting to get neutrality by 2050.

VI. Next Steps

Trevor Drake, Great Plains Institute

1. Next meeting will be on March 22. Look for an email from GPI soon with the link to register.
2. Information and feedback can be sent to DukeCarbonPlan@gpisd.net.

List of February 23 Stakeholder Meeting Attendees by Organization

Name	Organization
Joe Bearden	350 Triangle
Lib Hutchby	350Triangle
Patrick Cobb	AARP SC
Donald Zimmerman	Alder Energy Systems, LLC
Sarah Cabot-Miller	Ameresco
David McGowan	American Petroleum Institute
Scott Conklin	APCO
Moji Abiola	Apex Clean Energy
Rory McIlmoil	Appalachian Voices
Josh McClenney	Appalachian Voices
Elizabeth Ratner	Atrium Health
Michael Roberts	Atrium Health
Bradley Williams	Audubon SC
Christina Cress	Bailey & Dixon, LLP
George Baldwin	Baldwin Consulting Group
Jon Vague	Birdseye Renewable Energy
Jenise Clancey	Birdseye Renewable Energy
Heyward Lathrop	Birdseye Renewable Energy
Nakiya Smith	Black Voters Matter
Brad Rouse	Blue Horizons Project
Oliver Twitchell	BP
David Gordon	Bright Blue Door, LLC
Marcus Trathen	Brooks Pierce
Craig Schauer	Brooks Pierce
Joshua Brooks	Brooksform, LLC
Harvey Richmond	Capital Group of the Sierra Club
Kevin Martin	Carolina Utility Customers Association
Chris Carmody	Carolinas Clean Energy Business Association
John Burns	Carolinas Clean Energy Business Association
John Richardson	Carolinas Friends School
Joshua Harris	Cary Chamber of Commerce
Mason Milligan	Central Electric Power Cooperative
Mark Svrcek	Central Electric Power Cooperative, Inc.
Robert Kaineg	Charles River Associates
Kevin Lindley	Chatham County
Charles Cooper	Chatham County Climate Change Advisory Committee
Randy Strait	Chief, Planning Section, NC Division of Air Quality/NC Dept. of Environmental Quality
Preston Howard	CIGFUR
Nick Phillips	CIGFUR
Dean Kluesner	Citizens Climate Lobby
Bridget Herring	City of Asheville
Heather Bolick	City of Charlotte
Jason Spriggs	City of Henderson, NC
David Ingram	City of Wilmington
Brian Morgan	Clean Energy Buyers Association
Joel Porter	CleanAIRE NC
Mark Johnson	Clemson University

Thomas Suttles	Clemson University
Amelia Covington	Climate Action NC
Bob Rodriguez	Concerned Citizen
Jalen Brooks-Knepfle	Conservation Voters of South Carolina
John Gaertner	Consultant
Stavros Polyzoidis	Continental Tires
Zander Bischof	Cypress Creek Renewables
Heinz Kaiser	DHEC
Sarah Cosby	Dominion Energy
Warren ReBarker	Draughon Farms, LLC
Ladawn Toon	Duke Energy
Mark Oliver	Duke Energy
Winston Yau	Duke Energy
Tim Duff	Duke Energy
Matt Kalemba	Duke Energy
Sam Wellborn	Duke Energy
Chris Nolan	Duke Energy
Conitsha Barnes	Duke Energy
Heather Smith	Duke Energy
Mike Quinto	Duke Energy
Brett Breitschwerdt	Duke Energy
Sammy Roberts	Duke Energy
Clift Pompee	Duke Energy
Rebecca Dulin	Duke Energy
Julie Janson	Duke Energy
Jack Jirak	Duke Energy
Camal Robinson	Duke Energy
Nate Gagnon	Duke Energy
Kendal Bowman	Duke Energy

Glen Snider	Duke Energy
Adam Reichenback	Duke Energy
Dan Reilly	Duke Energy
Jason Handley	Duke energy
Maura Farver	Duke Energy
Michael Rib	Duke Energy
Randall Heath	Duke Energy
Bill Currens	Duke Energy
Caryn Neff	Duke Energy
Steve Immel	Duke Energy
John Lyerly	Duke Energy
Blain Atkins	Duke Energy
Robert McMurry	Duke Energy
Patrick Louka	Duke Energy
Evan Shearer	Duke Energy
Susan Snow	Duke Energy
Catherine Goza	Duke Energy
Ryan Mosier	Duke Energy
Steven West	Duke Energy
Jim Umbdenstock	Duke Energy
Stephanie Switzer	Duke Energy
Bill Norton	Duke Energy
Grace Rountree	Duke Energy
Nate Finucane	Duke Energy
Brian Lusher	Duke Energy
Andrew Clarke	Duke Energy
Tom Davis	Duke Energy
Jonathan Landy	Duke Energy
Brant Werts	Duke Energy
Terri Edwards	Duke Energy

Bailey McGalliard	Duke Energy
Ryan Minto	Duke Energy
Whitney Gann	Duke Energy
David Johnson	Duke Energy
Ryan Boyle	Duke Energy
Mark Goettsch	Duke Energy
Bobby Moore	Duke Energy
Israel Cortes	Duke Energy
Elaine Jordan	Duke Energy
Emily Felt	Duke Energy
Lee Mitchell	Duke Energy
Jeffrey Day	Duke Energy
George Brown	Duke Energy
Ravi Mujumdar	Duke Energy
Tyler Cook	Duke Energy
Michael Callahan	Duke Energy
Scott Lewter	Duke Energy
Jason Higginbotham	Duke Energy
Graham Tompson	Duke Energy
Melissa Murphy	Duke Energy
Jason Martin	Duke Energy
Kenneth Jennings	Duke Energy
John Shuler	Duke Energy
Angela Tabor	Duke Energy
Mark McIntire	Duke Energy
Chris Hixson	Duke Energy
Bob Donaldson	Duke Energy
Michael PIrro	Duke Energy
Ameya Deoras	Duke Energy
Jay Oliver	Duke Energy

Lizzy Underwood	Duke Energy
Thomas Beatty	Duke Energy
Daniel Donochod	Duke Energy
Marcus Preston	Duke Energy
Meredith Archie	Duke Energy
Benjamin Passty	Duke Energy
Gerald Morgan	Duke Energy
Sarah Kutcher	Duke Energy
Carl Phipps	Duke Energy
Pedram Mohseni	Duke Energy
Bryan Wright	Duke Energy
Justin LaRoche	Duke Energy
Bryan Dougherty	Duke Energy
Joe McCallister	Duke Energy
David Hinkle	Duke Energy
Mike Ruhe	Duke Energy
Chris Edge	Duke Energy
Jennifer Canipe	Duke Energy
Brian Bak	Duke Energy
Jeffery Cardwell	Duke Energy
Stephen De May	Duke Energy
Michele deLyon	Duke Energy
Mark Tabert	Duke Energy
Eric Barradale	Duke Energy
Tobin Freid	Durham County Government
Brad Slocum	East Point Energy
Jevonté Blount	Eckel & Vaughan
Harris Vaughan	Eckel & Vaughan
Ed Ablard	Ed Ablard Law Firm
Kathy Moyer	ElectriCities of North Carolina

Elaine Durr	Elon University
Shelby Green	Energy and Policy Institute
Ajulo Othow	EnerWealth Solutions, LLC
Swati Daji	Enterprise Strategy & Planning
Michelle Allen	Environmental Defense Fund
Drew Stilson	Environmental Defense Fund
Neil Kern	EPRI
Tracy Leslie	EPRI
James West	Fayetteville Public Works Commission
Morgan Hylton	Fayetteville Public Works Commission
Keith Lynch	Fayetteville Public Works Commission
Ben Snowden	Fox Rothschild LLP
Taylor Speer	Fox Rothschild, on behalf of Vote Solar
Laura Bain	Furman University
Holly Garrett	Gaia Herbs
Amy Wallace	GE
Brian Smith	GE
Donna Robichaud	Geenex Solar LLC
Lesley Williams	Geenex Solar LLC
Fred Hanna	GMC Consulting Engineers
Jamey Goldin	Google LLC
Beryle Lewis	Granville-Vance District Health Department
Alissa Bemis	Great Plains Institute
Doug Scott	Great Plains Institute
Trevor Drake	Great Plains Institute
Sam Ruark	Green Built Alliance
Michael Kline	Guidehouse

Jamie Bond	Guidehouse
Danielle Vitoff	Guidehouse
Alexis Wright	Guidehouse
Jennifer Ahearn	Guidehouse
Curt Anderson	Guidehouse
Ann Thompson	Guidehouse
Latisha Younger-Canon	Guidehouse
Chip Wood	Guidehouse
Shalom Goffri	Guidehouse
Curt Geller	Hitachi Energy USA Inc.
Mark Nichols	Individual
Anne Lazarides	Individual
TJ Cawley	Individual
Ryan McAward	Individual
William Blaine	Individual
Rosemary Robinson	Individual
John Downey	Individual
Russell Outcalt	Interfaith Creation Care of the Triangle
Thomas Peacock	KinderMorgan Inc.
Jim Seay	Lockart Power
Nathan Adams	Longroad Energy
Matthew Thornton	Longroad Energy
Andrea Kells	McGuireWoods LLP
Tracy DeMarco	McGuireWoods LLP
Nick Dantonio	McGuireWoods LLP
Erin Stanforth	Mecklenburg County
Sam Kliewer	Meridian Renewable Energy
Steven Castracane	Messer North America
Dennis Derricks	Meta

Joseph Sticca	Mitsubishi Power
Julie Mayfield	MountainTrue
Erniko Brown	NAACP
Greg Andeck	National Audubon Society (NC Office)
Cathy Buckley	NC Alliance to Protect Our People and the Places We Live
Tirrill Moore	NC Attorney General's Office
Stephen Kalland	NC Clean Energy Technology Center
Heather Brutz	NC Clean Energy Technology Center
Will Scott	NC Conservation Network
Jennifer Mundt	NC Department of Commerce
Michelle Boswell	NC Department of Commerce
Katherine Quinlan	NC Department of Environmental Quality
Teresa Townsend	NC Department of Justice
Margaret Force	NC Department of Justice
Francisco Benzoni	NC Department of Justice
Tiffany Lucas	NC Department of Justice
Jen Weiss	NC Dept. of Transportation
Michael Abraczinskas	NC Division of Air Quality
Dionne Delli-Gatti	NC Governor's office
John Rees	NC Interfaith Power & Light
Susannah Tuttle	NC Interfaith Power & Light
Stephen Jurovics	NC Interfaith Power & Light
Gary Smith	NC Interfaith Power & Light
Robin Smith	NC League of Conservation Voters
Cassie Gavin	NC Sierra Club
Paula Hemmer	NC State Energy Office

Robert Bennett	NC Sustainable Energy Association
Daniel Brookshire	NC Sustainable Energy Association
Peter Ledford	NC Sustainable Energy Association
Benjamin Smith	NC Sustainable Energy Association
Ward Lenz	NC Sustainable Energy Association
Josh Bartlett	NCDAQ
Ming Zheng	NCDEQ-DAQ
Dianna Downey	NCUC Public Staff
Jim Singer	NCUC Public Staff
Neha Patel	NCUC Public Staff
Phat Tran	NCUC Public Staff
David Williamson	NCUC Public Staff
Jeff Thomas	NCUC Public Staff
Dustin Metz	NCUC Public Staff
Tommy Williamson	NCUC Public Staff
June Chiu	NCUC Public Staff
Bob Hinton	NCUC Public Staff
Jay Lucas	NCUC Public Staff
Shawn Dorgan	NCUC Public Staff
William Zeke Creech	NCUC Public Staff
Nadia Luhr	NCUC Public Staff
Munashe Magarira	NCUC Public Staff
James McLawhorn	NCUC Public Staff
Lucy Edmondson	NCUC Public Staff
Jordan Nader	NCUC Public Staff
Layla Cummings	NCUC Public Staff

Scott Saillor	NCUC Public Staff
Robert Josey	NCUC Public Staff
Dana Villeneuve	New Belgium Brewing
Gayle Goldsmith	North Carolina Climate Solutions Coalition
Mark Schell	North Carolina Electric Membership Corporation
Lee Ragsdale	North Carolina Electric Membership Corporation
Khalil Porter	North Carolina Electric Membership Corporation
Tim Dodge	North Carolina Electric Membership Corporation
Deborah Britt	North Carolina Electric Membership Corporation
Richard McCall	North Carolina Electric Membership Corporation
Nicole Hensley	North Carolina Electric Membership Corporation
James Musilek	North Carolina Electric Membership Corporation
Claire Williamson	North Carolina Justice Cener
Ross Smith	North Carolina Manufacturers Alliance, CIGFUR
Lisa Poger	North Carolina State University
Hwa Huang	North Carolina State University
Kevin ODonnell	Nova Energy Consultants, Inc.
Mary Perkins-Williams	NPCIA, Inc
John Thigpen	NRDC
Luis Martinez	NRDC
Amanda Levin	NRDC
Kati Austgen	Nuclear Energy Institute
Christine Csizmadia	Nuclear Energy Institute

Connor Woodrich	Nuclear Energy Institute
Hayes Framme	Orsted
Mark Mirabito	Palladium Energy
Randy Doyle	Parkdale Mills
Merrick Parrott	Parker Poe
Katherine Ross	Parker Poe
Joseph Jacobs	Person County Chamber of Commerce, Roxboro N.C.
Sherry Wilborn	Person County Economic Development Commission
Pamela Senegal	Piedmont Community College
Steven Levitas	Pine Gate Renewables, LLC
Adam Stein	Pine Gate Renewables, LLC
Matthew LaRocque	PJM Interconnection LLC
Jeff Strickland	Plus Power
Cathy Ruth	Polk County Local Government - Planning
Bill Maloney	Regional activist in the Blue Horizons Project in Asheville, Net Zero Foundation, Duke ratepayer
Tom Delafield	RES
Deb Wojcik	Research Triangle Cleantech Cluster
Kirsten Millar	RMI
Becky Li	RMI
Julie Robinson	Robinson Consulting Group
Tommy Chapman	Rutherford Electric Member
James Sun	RWE
Will Brown	Santee Cooper
Jeff Solomon	Savion Energy
Joan Williams	SC Department of Consumer Affairs

Brenda C. Murphy	SC NAACP
Robert Lawyer	SC Office of Regulatory Staff
Gretchen Pool	SC Office of Regulatory Staff
Stacey Washington	SC Office of Regulatory Staff
Anthony Sandonato	SC Office of Regulatory Staff
Andrew Bateman	SC Office of Regulatory Staff
Heather Anderson	SC Senate
Marvin Neal	SC State Conference NAACP
Nicholas Jimenez	SELC
Sharon Allan	Sepa Power
Kelly Melton	Siemens Energy
Melissa Williams	Sierra Club
Justin Somelofske	Sierra Club
David Rogers	Sierra Club
Cynthia Satterfield	Sierra Club
Adam Foodman	Solar Operations Solutions, LLC
Jonathan Roberts	Soltage
Eddy Moore	South Carolina Coastal Conservation League
Ben Garris	South Carolina Coastal Conservation League
Ann Livingston	Southeast Sustainability Directors Network
Katharine Kollins	Southeastern Wind Coalition
Jaime Simmons	Southeastern Wind Coalition
Maggie Shober	Southern Alliance for Clean Energy
Hamilton Davis	Southern Current
David Neal	Southern Environmental Law Center
Kate Mixson	Southern Environmental Law Center

Gudrun Thompson	Southern Environmental Law Center
Simon Mahan	Southern Renewable Energy Association
Stephanie Eaton	Spilman Thomas & Battle (outside counsel to Walmart Inc.)
Edward Burgess	Strategen Consulting
Grant Millin	StratGen
Katherine Wyszkowski	Sunnova
Thad Culley	Sunrun Inc
Ethel Bunch	Sustain South Carolina
Tyler Fitch	Synapse Energy Economics
Christopher Fendley	TerraPower LLC
David Penskar	TerraPower LLC
John Hammerly	The Glarus Group LLC
Floyd Keneipp	Tierra Resource Consultants
Megan Pendell	Town of Apex
Alyssa Campo Bowman	Town of Cary
Katie Rose Levin	Town of Cary
Charlene Minor	Town of Davidson - Parks and Rec
Jack Shytle	Town of Polkville
Sean MacInnes	UNC Greensboro
Noah Upchurch	University of North Carolina at Chapel Hill
Melanie Elliott	University of North Carolina at Chapel Hill
Michael Mazzola	University of North Carolina Charlotte
Michael Coleman	Upstate Forever
Chip Estes	UtiliCom
Maged Sedarous	Wake County Goverment

Roger Ashby	Wake County Government
Lindsay Batchelor	Wake Forest University
Mike Draughn	Wake Forest University
David Boraks	WFAE
*There were an additional 20 participants who called in by phone that are not lists here as Zoom webinar cannot capture the names of dial-in attendees.	

February 18th Technical Subgroup Meetings

As part of Duke Energy's stakeholder engagement for the Carolinas Carbon Plan, the Great Plains Institute, hosted three Technical Subgroup Meetings on February 18, 2022, to discuss and receive technical feedback from stakeholders on the following topics:

• Subgroup 1: Solar Interconnection Forecast (10am-12pm)
• Subgroup 2: Solar/Wind Technology Operational/Cost Assumptions (1:00pm-3:00pm)
• Subgroup 3: Storage Operational/Cost Assumptions and System Configurations (3:30pm-5:00pm)

To help keep discussions on-topic and to a manageable size, only a limited number of stakeholders self- identified as experts were designated as "technical panelists" that were able to participate in discussion. All other stakeholders participated as observers, meaning they weren't able to participate in discussions, but were still able to submit questions/comments via the chat.

Those that were interested in participating as a "technical panelist" were asked to email a brief summary of their qualifications to GPI. All stakeholders that expressed interest in being a panelist were approved, however, we did ask organizations to designate only one representative per organization per subgroup.

Throughout the day, 229 participants attended the meeting.

Background (presented at the beginning of each meeting)

1. Two participant roles:
    a. Observers: Not able to participate in discussions, but can submit questions and comments in the chat. Also invited to send feedback via email to DukeCarbonPlan@gpisd.net
    b. Technical panelists: able to participate in discussions and can also submit questions and comments in the chat.
    c. Ground rules: uphold respect for different perspectives and opinions, feel free to use the chat, panelists should use the raise hand feature, and all attendees are asked to no share who said what without first obtaining their permission (including unapproved recording of this session).
2. This format is intended to complement the larger stakeholder meetings by enabling a more focused conversations about modeling inputs and assumptions among stakeholders with technical expertise on the specific topics at hand.
3. The meeting is split into three separate components – solar interconnection forecast, solar and wind technology operational and cost assumptions, and storage operations and cost assumptions and system configurations.

4. Thank you to all the technical panelists who took the time to apply to be part of this and lend their expertise today.

Subgroup 1: Solar Interconnection Forecast

Duke Presenters: Bailey McGalliard, Sammy Roberts, Matt Kalemba,

Facilitator: Doug Scott, Great Plains Institute

Panelists:

- *Tyler Norris, Cypress Creek Renewables*
- *Daniel Brookshire, North Carolina Sustainable Energy Association*
- *Jeff Thomas, NCUC Public Staff*
- *Dustin Metz, NCUC Public Staff*
- *Steven Levitas, Pine Gate Renewables*
- *Kirsten Millar, RMI*
- *Maggie Shober, Southern Alliance for Clean Energy*
- *Tyler Fitch, Synapse Energy Economics*
- *Ed Burgess, Strategen Consulting – on behalf of the NC AGO's Office*

Meeting Notes

1. **Background (Rebecca Dulin)**
    a. Goal is to discuss modeling inputs used to forecast how much new solar Duke can interconnect each year (annual interconnection limitation).
        i. Forecast: an estimate of future conditions, using the best information available today.
    b. Topics for today
        i. Historic pace of interconnection
        ii. Factors impacting the future pace of interconnection
    c. Out of scope for this session:
        i. Not here to debate the merits of solar as a resource – we need all low and zero carbon resources to be considered by the model to find the best path forward.
        ii. There is a separate session today on the cost and operational assumptions of solar in the model. This session is focused on interconnection.
        iii. Transmission investments are being considered through a FERC process, and should be left to be addressed in that process.

iv. Not seeking to discuss affected systems generator interconnection studies and policies.

v. Not seeking to have a policy debate

2. Historic Pace of Interconnection (Bailey McGalliard, Sammy Roberts)

a. Two most prominent configurations

i. Net metering – 97% of projects, 8% of capacity

ii. Purchased power – 3% of projects, 92% of capacity

b. US Interconnection Trends

i. As of 2010, NC and SC are not in top 10 states of interconnected solar.

ii. As of 2015, NC rises to 2nd in nation in solar connected facilities (CA is #1).

iii. As of 2021, NC still #2, and SC is now #7. Averaging 95kW/square mile, which means saturation of solar is increasing.

1. Q: What does “saturated” mean?
   a. Seeing an increase in solar

c. Duke Energy Service Area

i. Projects in the queue – between 2017 and 2019, the count of applications decreases by the hundreds, but capacity increases by tens of thousands. Larger projects in the queue translate to more intense grid impacts.

1. Q: What does “universal scale” on the slide mean?

   a. Greater than 1MW purchased power.

d. Distributed Generation and Transmission Transformation

i. Transmission system was built for delivering central generation to load centers is needing to adapt due to distributed generation.

ii. Transmission planning studies are becoming more difficult, but necessary to ensure reliable and safe deliverability to load.

iii. Pace of transformation has to accelerate to meet our clean energy transition objectives, but we can’t sacrifice reliability.

e. Unlocking the Red Zone

i. Red zones were used in CPRE procurement program to ID areas where solar facilities would probably not be competitive -- locating any incremental resource in a red zone would likely incur network upgrades for interconnection. In other words, we are running out of good places with grid capability is favorable for integrating solar and solar+storage.

ii. Need to unlock these red zones to meet our clean energy and carbon reduction goals.

f. Constructing Network Upgrades

i. The transmission system is having to be adapted to Distributed Generation

ii. Coal retirements to the north and west will look the same as adding more resources to the south and east and require a further transformation of our transmission system

iii. The pace of this transformation will need to accelerate, however, we will not sacrifice reliability during this transformation.

g. Challenges are not unique to Duke

i. PJM recently proposed two-year delay on approximately 1,250 projects in the queue

1. New projects not eligible for review until 4Q 2025

h. 2021 LBNL Report Shows Lengthy Interconnection Timelines

i. Solutions to Explore

i. Revised interconnection process (done)

1. Cluster studies with cost sharing mechanism for network upgrades

ii. Create efficiencies to reduce timeframe from Interconnection Agreement to COD

iii. Follow local transmission planning process to explore and facilitate transmission upgrades for public policy needs

j. OATT Attachment N-1 – Local Transmission Planning

i. FERC has exclusive federal jurisdiction over transmission planning

ii. Follow the FERC approved Orders 890 and 1000 Local Transmission Planning process in the OATT

1. North Carolina Transmission Planning Collaborative covers DEC and DEP transmission systems in NC and SC

a. OSC – Oversight Steering Committee

b. PWG – Planning Working Group

c. TAG – Transmission Advisory Group

iii. Process must consider all transmission customer stakeholders that wish to provide input

iv. Annual Local Transmission Planning cycle

v. Considers Reliability Projects, Economic Projects, and Public Policy Need

k. Q&A:

   i. Q: Has there been any proactive work to date in the North Carolina Transmission Planning Collaborative?

      1. Public Staff's request for policy needs study – high level study, not a generator interconnection study. Would need to be more rigorous if we want to identify the exact impacts and solutions to resolve those impacts.

      2. Looking at capacity purchases from the north – will be addressing that in the carbon plan.

   ii. Q: Struck by how essential adequate transmission planning is going to be for meeting HB 951. If that's out of scope, how are we going to meet the goals?

      1. FERC has total jurisdiction over transmission planning, so we have to follow FERC processes. But there is an avenue to become a Transmission Advisory Group (TAG) participant to be part of those discussions.

   iii. Q: Surprising to hear the FERC process is out of scope for this discussion. Could Duke ask the FERC process to study the carbon plan?

      1. Point taken. Duke will take this into consideration.

   iv. Comment: Would be good to get consensus on what Transmission Planning Collaborative should be doing.

3. Solar Interconnections in Model

a. Using EnCompass for modeling. Need to include explicit, discreet inputs into the model. If we don't have some level of detail on what we think interconnection limits will be in the future, then the model will say to just install all of the solar in the same year of the target, rather than deploying it in chunks over time.

b. This is true for all resources – there are constraints in the model for the number of gas combustion turbines that can be connected in a given time period.

c. Solar is unique in a number of ways:

   i. It's a carbon-free resource available between now and 2030.

   ii. Might take less than 2 years to construct a solar facility, but system upgrades can and do take longer than that. So the limiting factor is not solar, it's transmission to enable solar to interconnect. Other resources take longer to build, with timeline similar to the transmission upgrades.

   iii. Timing around interconnection and volume of solar seeking to interconnect needs to be modeled.

d. Model solves based on capacity -- # of MW. Looks are how many resources are needed to serve load.

4. **Annual Solar Interconnection Capability**

   a. Base case – Enhanced transmission policy. Provides some assumptions for when transmission projects might allow more solar to interconnect.

   b. Progressive case

5. **Discussion**

   a. Can you shed any light on the analysis you do for the transmission upgrade cost assumptions? And for the MW interconnection limit? Looking for analytical justification.

      i. Interconnection: historical trends, and then thinking about where projects might be sited in the future. If sited outside red zones, can maybe do more, but might still trigger system upgrades. Inside red zones there are a lot of hurdles to get upgrades completed, some more extensive than others.

      ii. From past generator interconnection studies, we know where the primary opportunities are for unlocking red zones. What's needed to meet the carbon plan goals is working through the local transmission planning process.

   b. Utilities generally view resource retirements as creating more space on the transmission system – does that factor into creating more interconnection capacity as Duke's coal plants retire?

      i. Yes, but it depends on where generation replacement is located. If replacement generation is located in a different place it could make the problem worse.

      ii. But isn't locating resources near retiring coal plants worth considering?

         1. Yes, but need to look at it closely.

   c. Transmission cost adder – will this be factored in for all types of generation?

      i. Yes, will do this for all resources. When we think about where solar has been historically and where it's likely to be in the future, that informs the transmission adders for solar specifically.

   d. This is about the technological issue of our time – we won't meet our policy goals without finding new and innovative ways to do things. This is equivalent to putting a man on the moon. That applies to all resources under consideration – all have massive technological challenges. Offshore is hugely challenging, small modular reactors are in their technical infancy. Respect the idea of practical constraints for the model assumptions, but we have to aim high and commit ourselves to innovation that's worthy of the cause.

i. Q to stakeholder: What might those innovations be on the solar side?

1. Ability to use outside parties to build stuff. Opportunities for that here.
2. Grid enhancing technologies – a whole cluster of non-bricks and mortar solutions to get more capacity out of the grid.
3. Utilization of storage in different ways to free up grid capacity.

e. Would like to understand how you've landed on the Enhance Transmission Policy scenario, and how we can increase those numbers.

f. Applaud recent work on queue reform. And, more volume of solar makes it more likely we can address transmission constraints. The more we can spread the costs of transmission upgrades across more MW, the faster we can make those upgrades happen.

g. How can we approach this with a better and more creative methodology? All resources entail uncertainty, but solar is the most available option we have right now. What Duke is proposing here is a very particular modeling methodology. What we're saying is the methodology is deeply flawed and untenable to comply with HB 951. Suggest to run the model in a least cost fashion. Identify how much solar is being selected, and THEN identify the constraints to deploying those levels of solar and figure out solutions to address those constraints. Also, let's explore the self-build option and let's figure out a plan to expand transmission construction efforts as needed, including third party construction crews.

i. Response from Duke:

1. We use a lot of third-party contractors, but they need to meet set of specific requirements.
2. We can't take 6-7 lines in close proximity out of service to perform upgrades without impacting reliability, so we need to space out the upgrade projects. Analogy is that were operating on a live body and need to keep that body alive while we operate.
3. Don't disagree that business as usual is not working. Curious about the thought that there would be larger projects over time and evaluating those impacts.
4. Numbers for 1300+ -- based on potential to get upgrades constructed and in service, and number of interconnections per year. Have an idea of how long it takes to construct projects and a general idea of what projects might be able to do in alleviating congestion. Certainly more to investigate there.

h. Recent study showed that proactively building transmission to support renewables could reduce electric rates by a third, as compared to piecemeal transmission upgrades project-by-project. Model sensitivities for solar interconnection – assume we'll see results on the costs of those transmission upgrades and how those costs will be allocated?

i. We don't have costs in the transmission cost adder chart. Looks like they're set to be linear, but in reality won't the first upgrades make it easier (less costly) to integrate future solar?

j. Note that Carbon Plan is filed very two years, so what is filed in this plan will be updated two years from now. There are a lot of ongoing process that will inform updated modeling and assumptions, so we'll be able to course correct over time.

k. Expect that Duke is already exploring non-wires alternatives for transmission upgrades. Those tools may help to integrate solar over time.

l. Looking at a limit on solar interconnection capacity based on the historical interconnection of resources, but in reality Duke is still interconnecting gas plants and making reliability upgrades. Is it reasonable to look at solar alone, or to look at all resources and all necessary system upgrades? May be value in a model run with no transmission system constraints, to understand the extent to which transmission constraints are binding on the outputs and limiting certain resources.

    i. Not sure if EnCompass can do an overarching transmission constraint, but willing to look into it.

        1. Understand you can get creative in how to set that up in the model.

m. In an ideal world, we would have a transmission plan to support decarbonization and be working today to build that out. We don't have that. What we have is a sub-optimal paradigm in which transmission gets built in response to generation projects being identified. Given that's what we're dealing with, in order to get on with identifying the upgrades needed and building them as fast and as cheaply as possible, we have to procure more generation on the front end earlier than later. Whatever the timing of interconnections, the procurements of generation resources should be greater rather than less so that we can understand the investments that need to occur, and so that we can forecast all of the upgrades that are needed over time.

n. Does this assume that all solar projects interconnect with only their full nameplate capacity, or does this allow them to adapt to the transmission limits with certain load shapes?

    i. Interconnection studies have a prescribed methodology for evaluating solar, and they do look at solar providing full output in determining needed upgrades. If you don't do that, there could be a lot of curtailment or other power flow issues that you otherwise wouldn't take into account.

That’s why there’s a prescriptive process, and it applies to all other generation resources too.

ii. Is that prescriptive process assumed in the sensitivities?

1. The sensitivities are not the output of interconnection studies, they’re informed based on the feasible number of interconnections we can do and outages we can take.
2. If stakeholders want to provide additional inputs to be considered, willing to look at those.

o. Q from Duke: Solar costs are declining over time – how should we think about balancing a large procurement upfront with potential cost declines over time?

i. Transmission costs are significant – they will go up, and probably dramatically. It seems possible the increased cost in transmission would offset any reduced cost in solar panels.

ii. Maybe we can analyze the cost decreases in solar against the cost increases in transmission to find the optimal path to deployment.

p. Several Duke presenters have said that they have to "follow the FERC process" on transmission issues. Not sure all stakeholders understand what that process is, and why it seems to be a challenge to integrate that into the Carbon Plan process. Can someone from Duke describe the "FERC process" and these challenges it presents?

i. FERC has jurisdiction over transmission planning, so we have the follow our OATT. There are avenues for stakeholder input as described in the OATT within that process. Duke needs to ensure it is complying with the FERC rules, and therefore have to comply with the rules of that process.

q. When Duke looks at this process, are there process revisions that can help with the things we’re talking about?

i. Yes, the jurisdictional North Carolina Transmission Planning Collaborative (NCTPC) process as written in our OATT works. Any thoughts we had about improving the process would have to be filed for comments. But don’t think that’s necessary in order to utilize the process to determine if there is public policy need for transmission projects to meet the legislation. We can use the process as it is, we just need to follow it.

ii. There is a public policy need request that has been submitted in relation to HB 951.

r. Accessibility – attachment N1 and OATT. Would be important, because this is so critical, what is this N1 process and what is an OATT, and how does it related to the carbon plan? What are the specific challenges to doing the transmission planning that would be beneficial to the carbon plan?

i. Good suggestion. We would be open to facilitating a conversation with stakeholder to do that.

s. How many and which lines are you looking at, and how are you staggering the outages across seasons, and what are the bottlenecks specifically to understand why you can't do more? This would help us understand the challenges so that we can bring forth more creative ideas for how to address those challenges.

i. Thanks. The whole process is very complex, both in the challenges and in meeting regulatory requirements.

t. Maybe what we need to do is a single carbon plan policy request submitted to the transportation planning collaborative every time a carbon plan is submitted – that can be studied, and then the results can be incorporated into the next carbon plan. If we did this iteratively over time it could help to improve the process.

i. Good idea, as long as we can do in time to meet the requirements of the legislation.

Subgroup 2: Solar/Wind Technology Operation/Cost Assumptions

Duke Presenters: Matt Kalemba, Adam Reichenbach, Clift Pompée

Facilitator: Doug Scott, Great Plains Institute

Panelists:

- *Moji Abiola, Apex Clean Energy*
- *Mark Johnson, Clemson University*
- *Zander Bischof, Cypress Creek Renewables*
- *Neil Kern, Electric Power Research Institute*
- *Jeff Thomas, NCUC Public Staff*
- *Dustin Metz, NCUC Public Staff*
- *Amanda Levin, National Resource Defense Council*
- *Steven Levitas, Pine Gate Renewables*
- *Kirsten Millar, RMI*
- *Katharine Kollins, Southeast Wind Coalition*
- *Tyler Fitch, Synapse Energy Economics*
- *Ed Burgess, Strategen Consulting – on behalf of the NC AGO's Office*

Meeting Notes

1. **Scoping:**

a. Specific cost information for solar facilities is confidential, but able to talk more broadly about cost.

b. Focused on utility scale solar in this discussion; will not be discussing net metered solar.

   c. For modeling purposes, need to come up with a specific generation/unit type that is representative of future installations on the system.

2. **Modeled solar versus selected solar**
   a. 4300 MW of utility scale solar on DEC and DEP systems. Expecting another 2200 MW to connect by 2025. Many have existing contracts and interconnection agreements, just not operational yet. Also include assumptions for CPRE tranche 3 coming online by 2025. These are inputs into the model, and will not be changed.
   b. Selected solar – additional solar that the model can select. Would not be expected to come online until 2026 and beyond.
      i. There is a difference between selected solar in the model and the optimal configurations of solar that will need to be determined in executing the plan.
   c. Utility scale solar profile development
      i. Match historical load and solar production to future load forecast.
      ii. Combine best fit and load match data to create final hourly profiles
   d. Solar technology key variables
      i. Panel mount – fixed tilt versus single axis tracking. In past fixed tilt have been more common, but moving toward more single axis tracking.
      ii. DC/AC ratio or overpanelling – the ratio of PV power to inverter power. In most cases, targeting high ratio with minimal clipping losses
      iii. Panel type – monofacial (one side of solar cells collect light) versus bifacial (two sides collect light)

3. **Solar PV technology assumptions**
   a. Standalone solar
      i. Use 75MW facility as the size, but that could change over time. That allows some economy of scale over smaller facilities.
      ii. Single axis tracking
      iii. 1.4 DC/AC panel ratio. Increases the cost, but provides a better profile for that cost.
      iv. Monofacial panels. Still seeing these as the best option. Acknowledge bifacial have better capacity factors and different profiles, but there's a cost to that.
      v. Carolinas regional costs given the ability to site in different areas
      vi. 26-27% capacity factor (as determined by the assumptions above)

b. Solar plus storage – same as standalone solar, except…
    i. 1.6 DC/AC panel ratio. More economical if paired with storage.
    ii. 30-32% capacity factor, given battery ability to capture clipped energy.

4. Solar PV data sources and process

a. Data sources
    i. Capital cost data from Guidehouse, updated fall 2021
    ii. O&M cost data from Duke solar development teams' internal model (based on actual installations), updated January 2022
    iii. Additional data sources considered:
        1. Private:
            a. Internal data
            b. Burns and McDonnell engineering study – contracted to do in Spring of every year.
            c. EPRI annual solar cost and performance data, used as a benchmarking source
        2. Public:
            a. NREL ATB 2021
            b. Lazard LCOE 2021
            c. EIA AEO 2021

b. Process
    i. Guidehouse puts together cost reports based on market data, then use that to come up with Carolinas specific costs (labor rates, module prices, shipping prices, anything that incurs cost)
    ii. Those are turned into an engineering, procurement, and construction (EPC) cost estimate.
    iii. Duke-specific owner's cost adder and transmission adder included with cost (this is the "overnight" cost, or the cost if you were to build it entirely overnight)
    iv. Overnight cost information converted to all-in cost including financing, inflation, and disposal/recycling.

5. Discussion -- Solar

a. Q: Monofacial versus bifacial – what are you basing the monofacial assumption on? Seeing developers doing 100% bifacial now, and expect the industry to move in that direction.

i. Good feedback. We'll go back and look at the model on that.

ii. Stakeholder comment: agree that bifacial is a better assumption.

b. Q: 75MW – AC or DC?

  i. AC for solar

  ii. For solar plus storage, battery sized to a smaller DC level than the solar.

c. Q: Solar plus storage battery is a 4 hour battery?

  i. Yes

d. Q: What does it mean to benchmark your data sources? Do you every make adjustment on the Duke side?

  i. We do high and low sensitivities for technology costs. We have a base assumption and then look at how a lower or higher options will change the model outputs.

  ii. If we see industry reports that show the assumptions are off mark, we will go back and try to bring them in line with the latest data, and also evaluate why the difference is occurring.

e. Q: I don't see an estimate what the costs might be. Will those be available?

  i. The costs themselves are confidential, though as part of IRP's in the past we've been able to share information through data requests, but that typically happens after submittal.

f. Comment: Would be very helpful if Duke can make the base case and sensitivity cases publicly available.

g. Comment: Difficult to give meaningful input when the discussion is as high level as it is here. Would be happy to sign an NDA to allow sharing of confidential information. Concerns about timing limitations if we follow the typical discovery process.

  i. Appreciate that, though making clear that we're within 5% of the NREL ATB moderate case, so wondering today if folks think the NREL ATB is about right or if it's way off the mark.

  ii. Q: Could Duke run some scenarios wholly based on publicly available information, as a point of comparison to the scenarios based on private information?

h. Q: How are disposal/recycling costs handled?

  i. EPRI looks at what it cost to dispose of an recycle facilities – percent of capital installation in the model. Ends up being a cost incurred at the end of the project that is spread out over the life of the asset.

i. Q: Can you provide the high/low range of costs being considered, at least for now until the Carbon Plan is filed?
   i. We'll check internally to see if we can do that.
   ii. NREL moderate case would be pretty close.
j. Q: What is the useful life you're using?
   i. The model is assuming a 30-year life for solar
k. Q: Is this analysis done with respect to a utility owned and rate-based asset? If so, how do you deal with PPA's in your cost analysis?
   i. Based on utility-owned. Trying to capture the fill life of the asset within the analysis or the full capital cost of the facility. If we're looking at 25 or 30 year PPA's we would hope our costs are getting pretty close to that.
   ii. Comment: that makes sense, given the transmission constraints around solar.
l. Q: We have successfully procured 1200 MW of solar through CPRE process, as a result of bids, and that process is ongoing. Why hasn't Duke decided to use some of that data in this Carbon Plan? What is the plan going forward to use real-world RFP results?
   i. Agree that actual market feedback is good as supportive information to validate projections. But those processes didn't yield a price, they yielded a range of project-specific prices, done at a point in time that's different from today, and the difference could be lower or higher depending on several factors.
   ii. Comment: To the extent RFP data can be used to verify the projections, would be interested in seeing that comparison.
   iii. Comment: It's appropriate, once we get into the 2-year planning process, to update projections based on real-world data.
m. Comment: Would be helpful to see a demand curve for solar at different price points, which would give flexibility in procurement. Also think you'll find there's a no-regrets amount of solar that will be needed in any future scenario, and begin planning for that.

6. Wind Resources

a. Background
   i. As of 1/1/2022 no utility scale wind resources in DEC and DEP territories
   ii. Wind viewed as a complementary resource at high solar build outs
   iii. Carolinas onshore wind assumed to be available as a selected resource beginning in 2028

iv. Considering including wheeled wind from PJM and other neighbors

b. Utility scale onshore wind profile development

    i. Develop a best fit year in same manner as solar

    ii. Use wind turbine power curves to develop wind speed profiles

c. Locations for modeled wind

    i. Follow NREL's exclusions for wind resources.

    ii. Ending up with Eastern fifth of North Carolina based on wind speeds in that area. Also other non-exclusive areas, but less conducive to higher capacity factor given today's wind turbine hub heights.

d. Onshore wind technology assumptions

    i. 150MW facility

    ii. 4MW turbines

    iii. 100-meter hub height. Evaluating higher heights (e.g., 160 meter)

    iv. Carolinas region

    v. 20-30% capacity factor

e. Onshore wind data sources and process

    i. Capital cost and O&M cost data from Burns and McDonnell engineering study, updated January 2022. Think this is good data, and the data isn't changing as much from year to year as solar.

    ii. Additional data sources:

        1. EPRI annual wind cost and performance data

        2. NREL ATB 2021

        3. Lazard LCOE 2021

        4. EIA AEO 2021

    iii. Process

        1. Costs based on current EPC estimates. EPC and owner's costs prepared by Burns & McDonnel for generic sites.

        2. Duke specific transmission adder included, and overnight cost info converted to all in, same as for solar.

f. Offshore wind technology assumptions

    i. 1600 MW

    ii. 12/15 MW turbines

    iii. Carolinas region

iv. 40-45% capacity factor

g. Offshore wind data sources and process

    i. Capital cost and O&M cost data from Guidehouse modeling tools. Same additional sources considered as for onshore wind, plus Burns & McDonnell.

    ii. Process similar to solar and onshore wind.

7. Discussion -- Wind

a. Q: What as the rationale for 2028 timing of onshore wind availability?

    i. Open to suggestions on what timing would be realistic.

    ii. Q: When looking at 2020 COD timeframe, that's specific to projects in Duke' territory?

        1. Yes

    iii. Q:There are projects available and in the queue that are ready before 2026, if wheeling is an option. Interested in knowing how that's considered in the least cost methodology?

        1. Working on assumptions for wheeled wind in the model.

b. Comment: Offshore wind turbine size – suggest would be about 20MW by the end of the decade

c. Q: Will underground transmission be needed for off shore wind?

    i. Underwater cabling that runs from offshore location to onshore landing point, then to the transmission system. That is built into the cost assumptions.

d. Q: Interconnection constraints for both types of wind?

    i. Currently thinking 2028 – 300MW/yr of onshore Carolinas wind (doesn't include wheeled wind).

    ii. Can't recall on offshore – will follow up. Not as granular for solar because there's less information about where it will interconnect.

e. Q: The all-in costs includes some adder component reflecting the resource interconnecting to Duke's system, then in addition to that there's potential Tx upgrade costs also factored into the model. Is that right?

    i. Yes, exactly. Assumed generic interconnection to facility, and then assumed transmission upgrades to accommodate.

    ii. Comment: Might be useful to have those component costs broken out to better understand the difference in costs between transmission upgrades versus the resource itself.

f. Comment: Need more clarity about which components of the publicly available resources are being used, and how – that will help stakeholders better engage.

g. Comment: 20-30% capacity factor seems extremely low at 100m hub height. NREL has maps of 100m hub height wind that are above 35% capacity factor. Acknowledge there are limitations, but 20% seems way too low.

    i. Agreed, 20% is more like central Carolinas, and 30% is more the Eastern part of the state.

h. Comment: 2028 timeframe – depends on Duke's willingness to buy because we've created a hostile environment for land-based wind in the state. Once Duke signals the desire to build onshore wind, you'll see more developers scouting for opportunities.

i. Comment: 1600MW is huge for offshore wind. 800MW is what's needed for economies of scale.

    i. That's total potential, not a single 1600MW project. That's short term potential, and expect more in the longer term.

    ii. Comment: In that case, would expect more like 3000MW in the near term.

j. Comment: The turbine size and the potential total in the near-term are interrelated, so would like transparency about the sensitivities that were explored on different turbines sizes and potential.

    i. We're comfortable with 15MW because there are 14MW turbines being deployed, and 18-20MW turbines are still being developed.

        1. Comment: Let's make sure we're assuming technological innovation with the future projections.

k. Comment: Commodity prices for onshore wind are increasing, so want to make sure the cost data is accurate.

l. Q: How is the least cost planning being factored into the modeling, and how is Duke planning to meet these targets? If transmission is not a part of the actual plan, how are we actually thinking these proposed plans will be implemented?

    i. Agree that's a challenge, and acknowledge that HB 951 has aggressive goals. One of the Duke principles is to identify the executability parameters for each resource in the plan, and what are the key enablers needed for execution (both internal to Duke and external, including transmission and policy).

m. Q: Has there been any specific definition of what least cost means, and how they will direct the generation mix?

    i. We'll be discussing that at large group Meeting 2 (this coming Wednesday 2/25), along with other metrics and definitions used in the planning process.

n. Q: Is Duke planning to incorporate carbon abatement as part of its FERC Order 890 responsibilities, or will that be separate?
o. Comment: NREL ATB hub heights – by 2030, in moderate case at 120m, and conservative case 110m, and advanced 135m. Suggest looking closer at this. Capacity factors for these hub heights are 35% or higher. Levelized cost falls about 30% this decade due to those hub height improvements.
    i. Comment: Have seen the higher hub heights can be more economical, but have also seen they are harder to get permitting approval for.
p. Q: Can you clarify the 1600MW number for offshore wind?
    i. Trying to model what we realistically think is achievable. There is currently a moratorium on offshore development that starts July 2022 and goes for 10 years. Looked at what would be available during that timeframe and modeled what would be achievable. Offshore wind is limited by available acreage, and can't assume all the available acreage will be available to Duke alone, so need to choose something that is realistic.
    ii. The model looks at chunks of offshore wind – 1600MW is the chunk available in the initial timeframe, split into two 800 MW blocks.
q. Comment: it feels like the combination of constraints on solar and wind are limiting the most readily available (today) zero carbon technologies.
r. Comment: Many of the projects you're using as your baseline for costs, those were locked in before the supply chain impacts and price inflation came into play. Are you factoring that in, and how do you see that changing over time?
    i. That's part of what we hope to get out of this call. It's a dynamic and challenging time right now to establish the cost estimates. Looking for people that have the expertise to give us some additional guidance.
    ii. Did our best to incorporate supply chain and inflationary factors, without making it too big of an impact considering the planning time horizon.
    iii. Comment: Think NREL ATB moderate case is reasonable. Seeing more differences in the soft costs.

Subgroup 3: Storage Operational/Cost Assumptions

Presenters:

Facilitator: Doug Scott, Great Plains Institute

Panelists:

- *Mark Johnson, Clemson University*
- *Neil Kern, Electric Power Research Institute*
- *Nathan Adams, Longroad Energy*
- *Brad Slocum, East Point Energy*
- *Jeff Thomas, NCUC Public Staff*
- *Dustin Metz, NCUC Public Staff*
- *Raafe Khan, Pine Gate Renewables*
- *Kirsten Millar, RMI*
- *Ron DeFelice, Southern Current*
- *Tyler Fitch, Synapse Energy Economics*
- *Ed Burgess, Strategen Consulting – on behalf of the NC AGO's Office*

Meeting Notes

1. **Scoping:**
    a. Expected to be an important resource in the carbon plan to support intermittent resources
    b. Use cases in the modeling may differ from use cases in implementation
    c. Discreet storage technology assumptions are required for modeling purposes; these will likely differ from storage actually constructed on the Duke system.
2. **Storage use cases for modeling:**
    a. Capacity – based on ELCC study
    b. Arbitrage – energy time shift
    c. Ancillary services – Regulation, balancing, and contingency
    d. Also considering:
        i. Some use cases complementary, others mutually exclusive
        ii. Grid reliability use cases also being considered
        iii. Site-specific use cases don't lend well to generic capacity expansion planning.
    e. Discussion:
        i. Q: You mentioned you're updating the ELCC study. Are you using the same regimes as used in the last IRP, and if so, is there a particular regime you're intending to use?
            1. Are you referring to preserved reliability versus economic arbitrage mode?
                a. Yes

b. Believe its economic arbitrage mode, but also capturing more benefit of solar.

ii. Ancillary services – are you considering the ability to site batteries at or near retired coal facilities?

1. Not sure if we're specifically looking at that as part of the carbon plan framework, but it's something even outside of the carbon plan that we look at with transmission needs, as a way to defer transmission upgrades.

3. **Storage technology key terms:**
   a. Duration – duration of time a battery can discharge at its rated power capacity
   b. Roundtrip efficiency – percentage of energy the system is able to discharge compared to the amount of energy charged. Assess at point of interconnection to distribution or transmission.
   c. Depth of discharge – amount of energy that is accessible and can be fully utilized (amount of energy that must remain in battery to maintain warranty)
   d. Degradation – ability of system to maintain initial energy capacity throughout its lifetime.
      i. Augmentation – replacing or adding cells
      ii. Overbuild – increasing nameplate capacity to account for degradation
   e. Discussion:
      i. Comment: Concerned about double-counting of losses. Developers account for those losses, so want to ensure they're not double counted.
         1. Have to account for any losses in getting the energy to its end use.
      ii. Comment: For round trip efficiency, point of interconnect makes a difference. Want to make sure this is clearly defined in the modeling.
4. **Energy storage system configurations**
   a. Referring mainly to lithium systems
   b. Requires inverters and/or transformers to get power to the grid
5. **Solar plus storage configurations**
   a. AC coupled – solar and storage are completely coupled. Separate bidirectional inverter. Charging from solar less efficient than DC coupled system. Mature technology.
   b. DC coupled

i. Sole solar charging – inverter is unidirectional, so storage system is limited to charging from the solar and discharge into the grid. Lose some of the battery's capabilities to provide ancillary services because charging limited to solar availability.

ii. Flexible charging – inverter is bidirectional, so it can charge from solar and from the grid, allowing more flexibility to provide ancillary services even outside of solar availability.

6. Lithium Ion Battery Technology Assumptions

a. Parameters:

i. 90% depth of discharge limit – 10% overbuild to accommodate

ii. 85% AC round trip efficiency

iii. LFP-quality chemistry. Not entirely based on LFP, but of similar quality.

iv. Annual replenishment – no overbuild for degradation, to try and reduce the cost of the battery.

v. Carolinas regional costs.

b. Standalone storage:

i. 50MW and 100MW facilities as base size

ii. 4, 6, and 8 hour durations for model to choose from

iii. NOTE: Need to limit the number of options for the model to choose from; this combination provides 6 options total.

c. Solar plus storage

i. 20MW

ii. 4 hour duration

iii. 1 mid-life rebuild of the batteries to match the life of the solar asset

7. Data sources and process

a. Guidehouse for capital and O&M costs (since limited data internally)

b. Additional sources considered:

i. Internal battery development and supply chain data

ii. Burns & McDonnell engineering study

iii. EPRI

iv. NREL ATB 2021

v. Lazard LCOE 2021

vi. EIA AEO 2021

c. Process very similar to solar and wind as described above.

8. Other storage options modeled

a. Li-Ion through 2030, then…

b. Flow battery

   i. 20 MW, 8-hour duration

   ii. Costs from Guidehouse and Burns & McDonnell

c. Advanced compressed air

   i. 300MW, 10-hour duration

   ii. Costs from Burns & McDonnell

d. Pumped hydro

   i. 750 MW, 10 hour duration

   ii. Costs from Burns & McDonnell

   iii. Siting concerns for new pumped hydro

9. Discussion:

a. Q: With regard to solar plus storage, struck by how small the 20MW assumption is relative to solar. Why is that?

   i. It's economic, trying to find the most economic size between the storage and solar.

b. Comment: The smaller the battery the lower the cost, but also need to consider value of the battery size. Encourage to look at an alternative larger size.

   i. Agree it's about value, not cost. East coast solar plus storage is different from west cost, so appreciate the feedback.

c. Comment: typically wouldn't rebuild a storage plant until about year 20.

d. Q: Assuming Duke will also be modeling stand-alone storage in the Carbon Plan - will the assumptions around stand-alone storage be similar to those around storage coupled with solar? And will either resource be subject to transmission upgrade cost adders?

   i. The model does have the option for standalone storage as well.

   ii. Transmission cost adders – still looking into that for storage. Might be able to locate it where you don't need the transmission upgrades, but in a lot of instances and depending on the use case, it could have upgrades associated with it. Trying to figure out how much to reflect the siting flexibility with respect to transmission upgrades.

iii. Trying to have representative batteries for all technologies, but batteries are most tricky given the flexibility in siting.

e. Comment: Would encourage Duke to consider one additional duration on the solar plus storage configuration. PacifiCorp IRP process recently adjusted to include additional configurations, and progressed to longer and longer durations. Reason was that it helps to maximize the firmness of each MW of capacity. If you have interconnection constraints, then oversizing give you more bang per MW buck on the interconnection upgrade side of things.

f. Comment: Suggest a 2-hour storage option given Duke is a winter peaking utility. Winter peaks are typically shorter duration, maybe 6am-8am in the morning.

g. Comment: Underutilizing the storage value in relation to solar will undervalue the system. Would recommend at least 50% storage to solar match, and 100% would be ideal for 2 and 3 hour duration, for solar 75MW nameplate. You'll need more storage, not less, as solar penetration increases.

    i. To confirm, we're talking about bidirectional configuration?

        1. Yes, bidirectional is better, but need to charge from solar to get the ITC so planning to do that with current projects.

h. Q: About 260MW of standalone storage in the queue. To what extent is Duke going into the queue to look at storage and solar+storage to get a baseline understanding? Or will you just let the model select?

    i. Letting the model select for both standalone and solar+storage. Working on directly modeling the individual projects and incorporating them into the model. Don't expect they will move the needle much though.

i. Q: Testimony from E3 for the IRP a few years ago about the diversity benefits of solar+storage, including peak capacity benefit. Is that included?

    i. Yes, in the ELCC study trying to capture the synergistic benefits of solar and storage together.

j. Q: Your projections for ELCC, which changes for each resource by penetration, how are you addressing that in the resource portfolio?

    i. Yes, currently discussing how to do that in EnCompass. One thought is start with the max, see what the ELCC and plug it into the model, then see what the model optimizes it at, then start to bring the ELCC down and run the model again to see the impact.

k. Q: As solar penetration increases, the afternoon peak narrows, and then as you deploy storage it broadens. Does the model capture that, and if so how?

    i. Know that it does capture that. The load profile is fixed; as you're dispatching storage at peak, it will lower the net peak and other resources will optimize for that new net peak.

l. Comment: Could see the longer duration storage assets getting more valuable over time.
    i. Yes, agree with that. All of these have an interactive effect that we do our best to capture in the model. But yes, as we have deeper penetrations of solar and storage, there's a greater need for long duration storage.
m. Q: Pumped hydro – is there any change in the way that's dispatched in the model over time? And are you able to use the South Carolina pumped hydro facilities in North Carolina to achieve the Carbon Plan goals?
    i. We operate the system as a whole across both states, so when we dispatch it flows to both states. We think it's prudent planning for the system across both states. When we think about how pumped hydro will operate, it will operate based on the system needs, so if those needs change, the optimal use of that storage will change to create the most benefit for all customers.
n. Q: What does it actually mean to consider the emerging storage technologies in the model?
    i. For the Carbon Plan, we have the options listed above. Everything else is what we're still evaluating for future modeling.
o. Q: Will the new ELCC study be published with the Carbon Plan?
    i. Yes, that's the plan
p. Q: Many of the IRP plans in 2020 with significant carbon reductions included a power house at Bad Creek with storage. Is that being considered?
    i. Yes, that will be an option for selection if economic, not forced in.
q. Q: There's an inherent advantage of storage that's co-located with solar. Is that reflected in the model in some way?
    i. Yes, from a cost standpoint it's considered. For example, we assume only one inverter instead of needing two for standalone resources.
r. Q: Does the model take into account specific sites?
    i. No, it's generic across the Duke system.
s. Q: Solar+storage – you mentioned new ELCC study. The optimum economic plant design will be contingent based on the capacity value you assign to it. That could be a changing target over time. Is the solar+storage design going to be iterated upon over time?
    i. You're right, the capacity value will change over time. The model will be able to select 4, 6, and 8 hour batteries over time and optimize on those, but for solar+storage we only have one or two technologies to select from. We're still discussing how to apply that ELCC.

ii. Seems like a good idea to have multiple solar+storage options. Will look at evaluating that.

t. Q: Given your recently announced MOU with Vote Solar to develop DER pilots, are you modeling any behind-the-meter storage that might provide grid services?

   i. We are starting to see penetration of storage behind the meter, and looking at how to incorporate those load profiles into the NEM forecast.

u. Q: Duke has touted 2 emerging technologies as candidate solutions for attaining its carbon intensity reduction targets: utility-scale energy storage and SMR. At this juncture, which as seen as the more promising technology?

   i. Need to look at both – that's the purpose of doing the modeling. All of these resources have different costs and values, and those change at depth of penetration.

v. Q from Duke: we're pretty premature on looking at storage and storage+solar because we haven't seen a lot coming through procurement, so really appreciate the feedback. If you're putting bids together in the Southeast region, we want your feedback on MW and duration combination that would make the most sense.

List of February 18 Technical Advisory Meeting Attendees by Organization

Name	Organization
Brian Nelson	ABB Inc.
Jayne Hickey	AES
Walter Crenshaw	AES
Moji Abiola	Apex Clean Energy
Elizabeth Ratner	Atrium Health
Michael Roberts	Atrium Health
Greg Andeck	Audubon North Carolina
Christina Cress	Bailey & Dixon, LLP
George Baldwin	Baldwin Consulting Group
Alan Merck	Blue Ridge Energy
Craig Schauer	Brooks, Pierce, McLendon, Humphrey & Leonard, LLP
Kevin Martin	Carolina Utility Customers Association
John Burns	Carolinas Clean Energy Business Association
Mason Milligan	Central Electric Power Cooperative
Mark Svrcek	Central Electric Power Cooperative, Inc.
Nick Phillips	CIGFUR
Preston Howard	CIGFUR
Shae Reinberg	Citizens' Climate Lobby
Heather Bolick	City of Charlotte
Joel Porter	CleanAIRE NC
Terry Walker	Clemson
PJ Klein	Corning
Dmitri Moundous	Cypress Creek Renewables
Nicole Miller	Cypress Creek Renewables
Peter Stein	Cypress Creek Renewables
Ryan Watts	Cypress Creek Renewables
Tyler Norris	Cypress Creek Renewables
Zander Bischof	Cypress Creek Renewables
Elizabeth McEldowney	Dominion Energy
Warren ReBarker	Draughon Farms, LLC
Adam Reichenbach	Duke Energy
Akiner Tuzuner	Duke Energy
Ameya Deoras	Duke Energy
Andrew Clarke	Duke Energy
Bailey McGalliard	Duke Energy
Bob Donaldson	Duke Energy
Bobby McMurry	Duke Energy
Bobby Moore	Duke Energy
Brant Werts	Duke Energy
Brian Lusher	Duke Energy
Bryan Dougherty	Duke Energy
Bryan Wright	Duke Energy
Catherine Goza	Duke Energy
Clift Pompée	Duke Energy
Evan Shearer	Duke Energy
Glen Snider	Duke Energy
Gray Tompson	Duke Energy
Jack Jirak	Duke Energy
Jacqueline Walker	Duke Energy
Jason Handley	Duke Energy
Jason Higginbotham	Duke Energy
Jason Martin	Duke Energy
Justin Brown	Duke Energy
Justin LaRoche	Duke Energy

Kendal Bowman	Duke Energy
Kenneth Jennings	Duke Energy
Kerry Powell	Duke Energy
Kevin Shelton	Duke Energy
Ladawn Toon	Duke Energy
Laurel Meeks	Duke Energy
Lizzy Underwood	Duke Energy
Mark McIntire	Duke Energy
Mark Oliver	Duke Energy
Mark Tabert	Duke Energy
Matt Kalemba	Duke Energy
Maura Farver	Duke Energy
Michael Rib	Duke Energy
Michele deLyon	Duke Energy
Mike Quinto	Duke Energy
Mike Rib	Duke Energy
Molly Suda	Duke Energy
Nate Gagnon	Duke Energy
Patrick O'Connor	Duke Energy
pedram Mohseni	Duke Energy
Randall Heath	Duke Energy
Rebecca Dulin	Duke Energy
Richard Knight	Duke Energy
Rhett Trease	Duke Energy
Ryan Roznovsky	Duke Energy
Sam Wellborn	Duke Energy
Sammy Roberts	Duke Energy
Sarah Kutcher	Duke Energy
Sherif Abdelrazek	Duke Energy
Susan Snow	Duke Energy
Thomas Beatty	Duke Energy

Tom Davis	Duke Energy
Tom Fenimore	Duke Energy
Casey Collins	Duke University FMD
Tobin Freid	Durham County Government
Laura Combs	Eagle Solar and Light
Brad Slocum	East Point Energy
Seth Studer	Ecoplexus
Mike Smith	Electric Cooperatives of South Carolina
Drew Stilson	Environmental Defense Fund
Neil Kern	EPRI
James West	Fayetteville Public Works Commission
Keith Lynch	Fayetteville Public Works Commission
Taylor Speer	Fox Rothschild on behalf of Vote Solar
Tae Wills	Freedom Forever
Holly Garrett	Gaia Herbs
Alissa Bemis	Great Plains Institute
Doug Scott	Great Plains Institute
Kate Sullivan	Great Plains Institute
Trevor Drake	Great Plains Institute
Ann Thompson	Guidehouse
Curt Anderson	Guidehouse
Danielle Vitoff	Guidehouse
Jamie Bond	Guidehouse
Jennifer Ahearn	Guidehouse
Latisha Younger-Canon	Guidehouse
Shalom Goffri	Guidehouse
Anne Lazarides	Individual

Rosemary Robinson	Individual
Rick Clemenzi	Intelli-Products Inc.
Brian Pattillo	Lockhart Power Company
Jim Seay	Lockhart Power Company
Kevin Hutchison	Longroad Energy
Nathan Adams	Longroad Energy
Andrew Coppola	Lowe's
Ben Edwards	Mathis Consulting Company
Andrea Kells	McGuireWoods LLP
Kristin Athens	McGuireWoods LLP
Nick Dantonio	McGuireWoods LLP
Tracy DeMarco	McGuireWoods LLP
Brett Breitschwerdt	McGuireWoods LLP
Steven Castracane	Messer North America
Gary Smith	Mindspring
Cathy Buckley	NC Alliance to Protect Our People and the Places We Live
Tirrill Moore	NC Attorney General's Office
Will Scott	NC Conservation Network
Francisco Benzoni	NC Department of Justice
Margaret Force	NC Department of Justice
Teresa Townsend	NC Department of Justice
Randy Strait	NC Division of Air Quality/NC Dept. of Environmental Quality
Dionne Delli-Gatti	NC Governor's office
Robin Smith	NC League of Conservation Voters
Paula Hemmer	NC State Energy Office
Daniel Brookshire	NC Sustainable Energy Association
Peter Ledford	NC Sustainable Energy Association

Robert Bennett	NC Sustainable Energy Association
Sally Robertson	NC WARN
Ming Zheng	NCDEQ - DAQ
Ross Smith	NCMA / CIGFUR
Bob Hinton	NCUC Public Staff
David Williamson	NCUC Public Staff
Dianna Downey	NCUC Public Staff
Dustin Metz	NCUC Public Staff
James McLawhorn	NCUC Public Staff
Jeff Thomas	NCUC Public Staff
Jordan Nader	NCUC Public Staff
June Chiu	NCUC Public Staff
Layla Cummings	NCUC Public Staff
Lucy Edmondson	NCUC Public Staff
Munashe Magarira	NCUC Public Staff
Nadia Luhr	NCUC Public Staff
Phat Tran	NCUC Public Staff
Robert Josey	NCUC Public Staff
Scott Saillor	NCUC Public Staff
William Zeke Creech	NCUC Public Staff
Katherine Quinlan	North Carolina Department of Environmental Quality
Deborah Britt	North Carolina Electric Membership Corporation
John Lemire	North Carolina Electric Membership Corporation
Khalil Porter	North Carolina Electric Membership Corporation
Tim Dodge	North Carolina Electric Membership Corporation
Robert Beadle	North Carolina EMC
Claire Williamson	North Carolina Justice Center

Amanda Levin	NRDC
Luis Martinez	NRDC
John Burke	Onward Energy
Skylar Drennen	Orsted
Mark Mirabito	Palladium Energy
Katherine Ross	Parker Poe
Sherry Wilborn	Person County Economic Development
Raafe Khan	Pine Gate Renewables, LLC
Steve Levitas	Pine Gate Renewables, LLC
Tom Delafield	RES
Kirsten Millar	RMI
Julie Robinson	Robinson Consulting Group
James Sun	RWE
Evan Racine-Johnson	RWE AG
Brian Burdyl	Santee Cooper
Clay Settle	Santee Cooper
Kyle Sheldon	Santee Cooper
Weijian Cong	Santee Cooper
Will Brown	Santee Cooper
Chantal Fryer	SC Commerce
Andrew Bateman	SC Office of Regulatory Staff
Anthony Sandonato	SC Office of Regulatory Staff
Omari Thompson	SC Office of Regulatory Staff
Lauren Bowen	SELC
Nicholas Jimenez	SELC
David Rogers	Sierra Club
Justin Somelofske	Sierra Club
William Maloney	Solar Consultant
Jonathan Roberts	Soltage

Dennis Richter	Solterra Partners
Ann Livingston	Southeast Sustainability Directors Network
Jaime Simmons	Southeastern Wind Coalition
Katharine Kollins	Southeastern Wind Coalition
Maggie Shober	Southern Alliance for Clean Energy
Hamilton Davis	Southern Current LLC
Ronald DiFelice, Ph.D.	Southern Current LLC
Emma Clancy	Southern Environmental Law Center
Gudrun Thompson	Southern Environmental Law Center
Kate Mixson	Southern Environmental Law Center
Michelle Boswell	State of NC Dept of Commerce
Marshall Conrad	Strata Clean Energy
Edward Burgess	Strategen Consulting
Iain Addleton	Synapse Energy Economics
Tyler Fitch	Synapse Energy Economics
David Penskar	TerraPower LLC
John Hammerly	The Glarus Group LLC
Chris McDonald	The Tiencken Law Firm, LLC
Megan Pendell	Town of Apex Sustainability
Marcus Hassen	Truist
Michael Mazzola	University of North Carolina Charlotte
Chip Estes	UtiliCom
Willem Lange	WaterFurnace International
*There were an additional 11 participants who called in by phone that are not listed here as Zoom webinar cannot capture the names of dial-in attendees.	

Duke Energy Carolinas Carbon Plan Stakeholder Meeting 2

Virtual Meeting – February 23, 2022

**Please note, this meeting is being recorded. Presentations will be posted on the Carolinas Carbon Plan website, and discussion portions will be kept for internal purposes only to ensure accuracy of meeting notes.*

GREAT PLAINS INSTITUTE

Better Energy. Better World.

Welcome!

Please introduce yourself (name and organization) in the chat.

GREAT PLAINS INSTITUTE | Better Energy. Better World.

Today's Agenda

9:30am:	Welcome and Introductions
9:45am:	Presentation and Q&A: Respond to stakeholder questions from Meeting 1
10:45am:	BREAK
11:00am:	Discussion: Stakeholder Desired Outcomes
12:00pm:	LUNCH BREAK
1:00pm:	Presentation and Discussion: Principles for portfolio development and evaluation
2:15pm:	Break
2:45pm:	Presentation and Discussion: Considerations driving different portfolio options
4:15pm:	Next Steps
4:30pm:	Adjourn

Duke Welcome

Julie Janson

Executive Vice President & CEO

Duke Energy – Carolinas Region

GREAT PLAINS INSTITUTE

Better Energy. Better World.

Meeting Ground Rules

- **Respect each other:** Help us to collectively uphold respect for each other's experiences and opinions, even in difficult conversations. We need everyone's wisdom to achieve better understanding and develop robust solutions.

- **Focus on values and outcomes:** Today's discussion is about what stakeholders value in the energy future, and how the Carolinas Carbon Plan can align with those values. Pending legal issues are outside the scope of this conversation.

- **Chatham House Rule**: Empower others to voice their perspective by respecting the "Chatham House Rule;" you are welcome to share information discussed, but not a participant's identity or affiliation (including unapproved recording of this session).

Meeting Ground Rules

- **Respect the time:** Our time together is limited and valuable, and we have a large group, so please be mindful of the time and of others' opportunity to participate.

- **Use the chat:** Please submit your comments and questions in the chat. GPI staff will monitor the chat to pull out questions for Q&A portions. Please be respectful and focus on issues, not people.

- **Raise your hand:** During dedicated Q&A portions of the meeting, use the "Raise Hand" feature to indicate you would like to voice a question or comment.

Stakeholder Process Update

Rebecca Dulin, Duke Energy

Director, Stakeholder Engagement

Stakeholder Process Timeline

Stakeholder Engagement

Jan. 25

Feb. 23

March 22

Proposed Plan Development

Finalize Proposed Plan

Supplemental Engagement

Carolinas Carbon Plan

January – March

April – Mid-May

Mid-May - December

Stakeholder Process Timeline

Stakeholder Engagement

Meeting 1

Jan. 25

Technical Subgroup Meetings

Feb. 18

Meeting 2

Feb. 23

Future Subgroups TBD

Meeting 3

March 22

GREAT PLAINS INSTITUTE

Better Energy. Better World.

Technical Subgroup Meetings

- Panel 1: Solar Interconnection Forecast
- Panel 2: Solar and Wind Cost/Operational Assumptions
- Panel 3: Storage Cost and Operational Assumptions

Stakeholder Panelists:

Mark Johnson, Clemson University
Zander Bischof, Cypress Creek Renewables
Neil Kern, Electric Power Research Institute
John Lemire, NC Electric Membership Corporation
Jeff Thomas, NCUC Public Staff
Dustin Metz, NCUC Public Staff
Amanda Levin, National Resource Defense Fund
Steve Levitas, Pinegate Renewables
Kirsten Millar, Rocky Mountain Institute
Katharine Kollins, Southeast Wind Coalition

Tyler Fitch, Synapse Energy Economics
Ed Burgess, Strategen Consulting
Tyler Norris, Cypress Creek Renewables
Steve Levitas, Pinegate Renewables
Maggie Shober, Southern Alliance for Clean Energy
Daniel Brookshire, North Carolina Sustainable Energy Assoc.
Nathan Adams, Longroad Energy
Brad Slocum, East Point Energy
Raafe Khan, Pinegate Renewables
Ron DiFelice, Southern Current
Moji Abiola, Apex Clean Energy

Presentation and Q&A:

Respond to stakeholder questions from Meeting 1

Initial Selection of Technologies

Can you share how the regulatory uncertainty and maturity of technologies plays into your modeling process? Is there an earlier "qualification" stage by which you make decisions about which technologies proceed to your modeling process, or do you run all technologies in the model and later subtract those you don't believe will meet regulatory or technology readiness requirements?

Modeling Coal Securitization

Will coal retirement analysis take into account the reduced revenue requirements available through securitization of remaining coal plant costs?

GREAT PLAINS INSTITUTE

Better Energy.
Better World.

Combining Balancing Areas

Does Duke plan to pursue consolidating its balancing areas as a part of its strategy to achieve the carbon reductions contemplated under the Carbon Plan? And if there is no plan to do so, why not?

GREAT PLAINS INSTITUTE
Better Energy.
Better World.

Consolidating Future IRPs

Does Duke plan to combine future Integrated Resource Plans for DEC and DEP?

Electric Vehicles and Decarbonization

Are you modeling the shift from internal combustion vehicles to electric in your demand projections?

Can you discuss the tension between pursuing vehicle electrification (which increases load) with the need to decarbonize (which is served by a reduction in load)?

Carbon Plan Cost Impacts

Can you please describe how the Carbon Plan will account for costs to customers?

What steps are being taken to consider cost impacts to low income customers?

When will stakeholders have more information about the costs of the Carbon Plan to customers?

Follow-up Questions

?

Break

Please return at 11:05AM.

GREAT PLAINS INSTITUTE

Better Energy.
Better World.

Discussion: Stakeholder Desired Outcomes

Lunch Break

Please return at 1:00PM.

GREAT PLAINS INSTITUTE

Better Energy.
Better World.

Presentation and Discussion:

Principles for portfolio development and evaluation

Portfolio Development Objectives & Evaluation Criteria

Nate Gagnon, Principal Planning Analyst, Carolinas Integrated Resource Planning

FEBRUARY 23, 2022

DUKE ENERGY®

BUILDING A SMARTER ENERGY FUTURE ®

Objectives for an Energy Transition Pathway

CO_2 Reduction

- 70% by 2030
- Net-zero by 2050

Reliability

- Maintain adequate system capacity to meet customer needs during peak demand periods
- Maintain adequate system flexibility to respond to changing real-time operating conditions

Affordability

- Aggregated capital, land, operations, maintenance, and fuel costs associated with alternative pathways
- Cumulative costs over time
- Forecasted customer bill impacts at points in time

Executability

- Deliverability of expected carbon reduction
- Ability to bring projects online according to plan timeline and cost estimates
- Ability to obtain necessary regulatory approvals for new projects and programs

Types of Portfolio Evaluation & Comparison

Minimum Standards

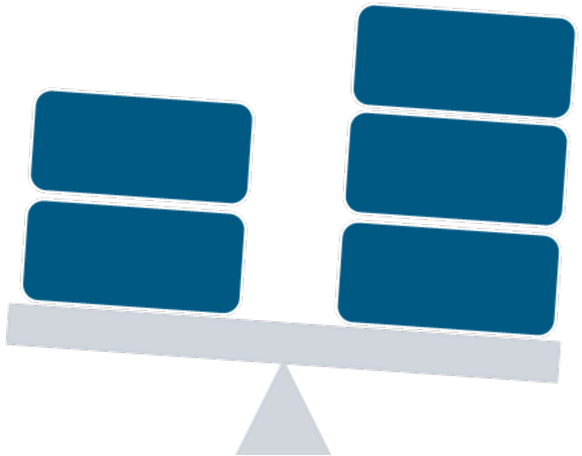
- Basic requirements for any potential resource portfolio
- Built into quantitative analysis as constraints
- Include environmental standards, CO_2 targets, and reliability requirements

Quantitative Comparison

- Measurable (forecasted) characteristics of potential resource portfolios
- Specific comparison with respect to a single criterion
- Include costs, operating metrics, etc.

Descriptive Comparison

- Complex concepts that cannot be distilled to a single number
- Trends over time
- Includes balancing multiple priorities



Proposed Metrics for Evaluation & Comparison

Minimum Standards

- Maintain adequate planning reserves
- Maintain adequate balancing and regulating reserves
- Maintain environmental standards
- 70% CO_2 reduction and net-zero targets

Descriptive Comparison

Reliability

- Portfolio diversity
- Extreme weather performance

Plan Executability

- Pace of new interconnections
- Reliance on new-to-the-Carolinas resource types
- Reliance on regulatory changes / approvals

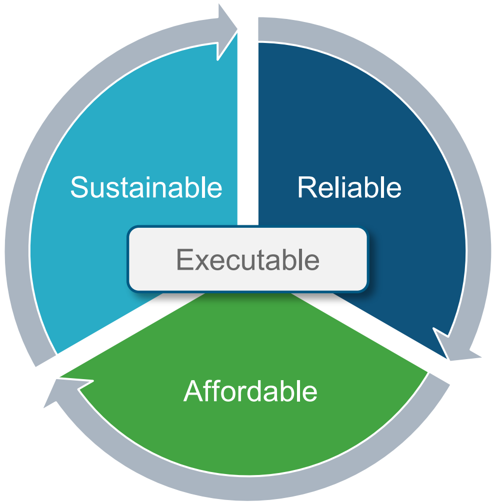
Quantitative Comparison

Affordability

- Present value of revenue requirements
- Average bill impact at points in time

System Operations / Reliability

- Forecasted curtailment
- Forecasted flexibility requirements



Break

Please return at 2:45PM.

Presentation and Discussion:

Considerations driving different portfolio options

GREAT PLAINS INSTITUTE

Better Energy. Better World.

Factors Differentiating Alternative Pathways

Glen Snider, Managing Director, Carolinas Integrated Resource Planning

FEBRUARY 23, 2022

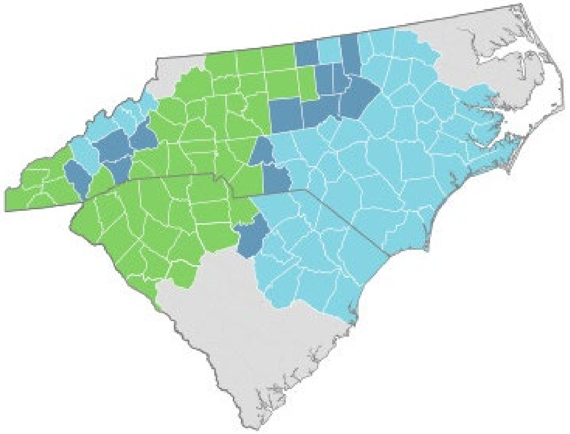
DUKE ENERGY®

BUILDING A SMARTER ENERGY FUTURE®

Details of Legislation Will Shape Portfolio Analysis

HB951 Focus is CO_2 Emitted in North Carolina

- The Utilities Commission shall 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



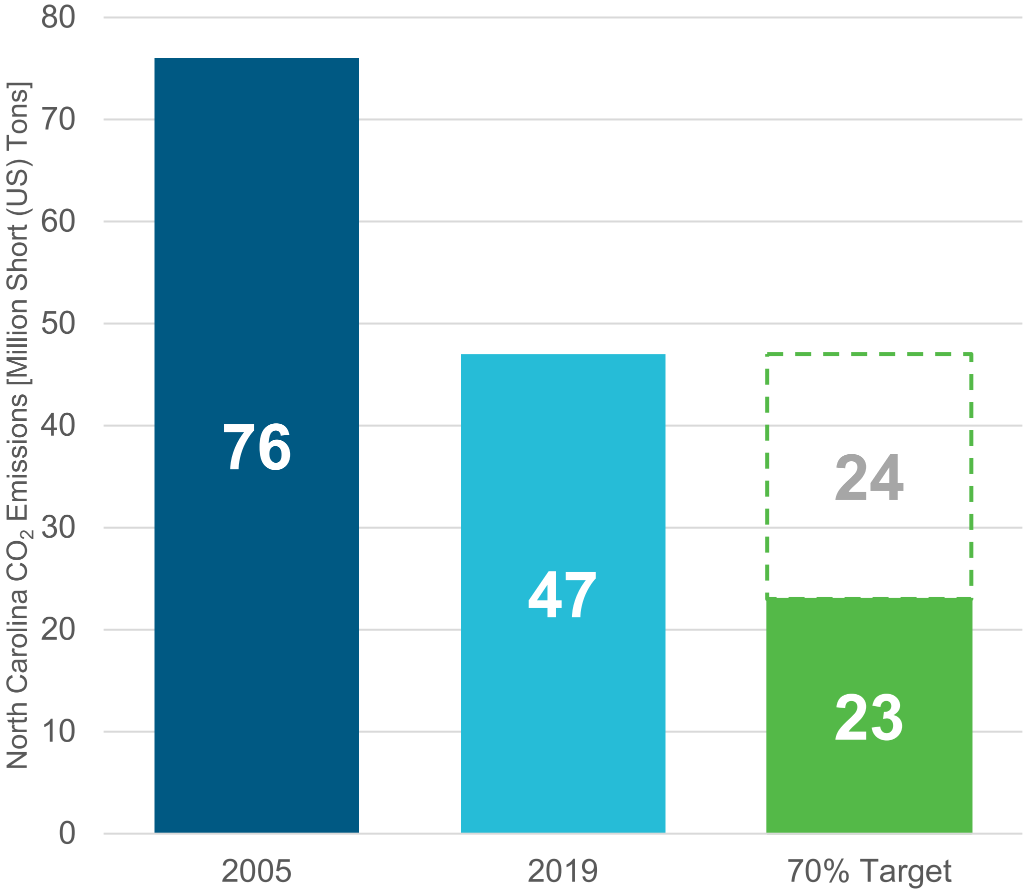
Timing Dependent Upon Technologies Approved by NC Utilities Commission

- In achieving the authorized carbon reduction goals, the Utilities Commission shall:
  - …Retain discretion to determine optimal timing and generation and resource-mix to achieve the least cost path to compliance
  - …provided, however, the Commission shall not exceed the dates specified to achieve the authorized carbon reduction goals by more than two years, except in the event the Commission authorizes construction of a nuclear facility or wind energy facility that would require additional time…

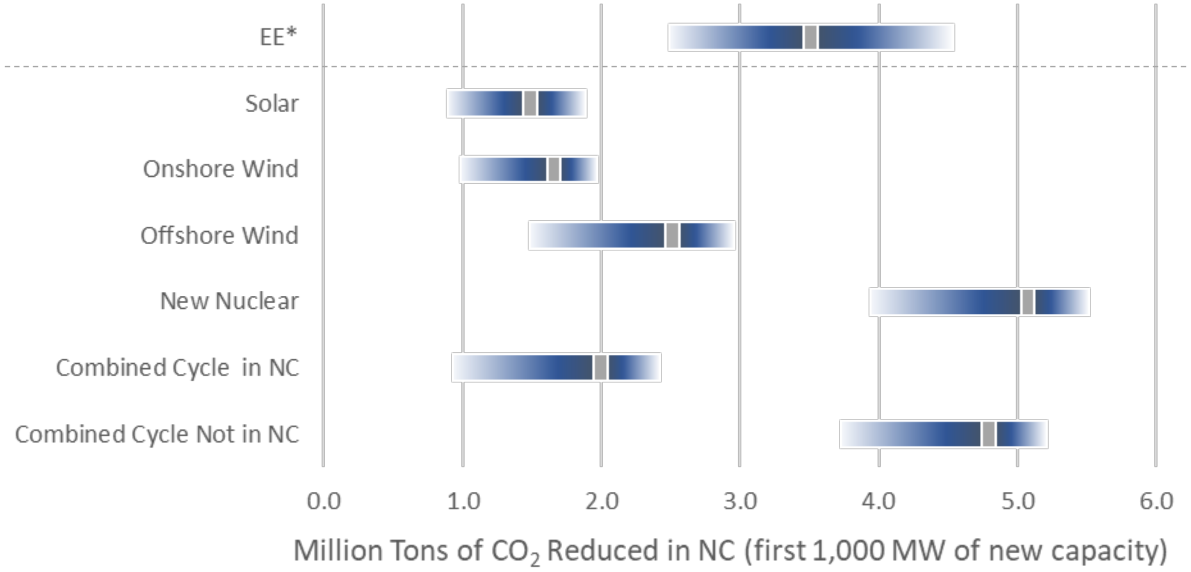
PSCSC will evaluate proposed resource portfolios in future dockets

Carbon Reduction Target and Toolbox

Recall: 24 Million Ton Reduction Required in North Carolina to Achieve 70% Target



Estimated Potential NC CO_2 Reduction (first 1,000 MW)



*EE range reflects estimated impact by 2030 across low through high deployment cases

Consider:

- CO_2 reduction varies according to annual energy production and carbon intensity of generation being displaced
- As emissions decrease, additional tranches of carbon-free resources displace lower-carbon generation, resulting in ever-decreasing CO_2 reduction impact

Two Main Paths on the Way to Carbon Neutrality

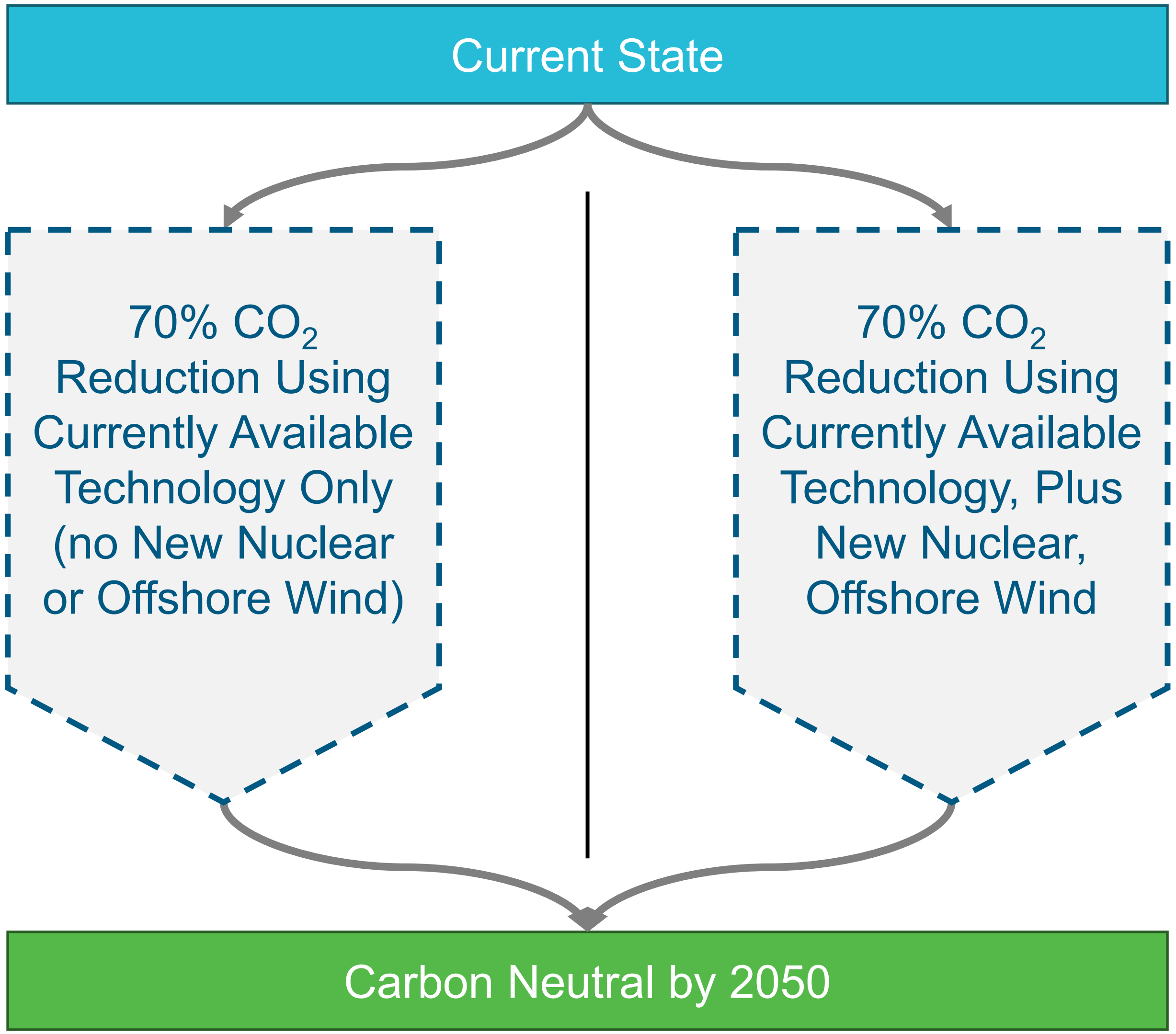
There are tradeoffs to consider

- Pace of CO_2 reduction
- Plan affordability
- Implementation feasibility
- Technology risk
- Portfolio diversity

Additional factors will further differentiate potential portfolios

- Degree of reliance on advanced technologies
- Pace of solar interconnection
- Fuel supply and pace technological development

All paths lead to carbon neutrality by 2050



Next steps:

- Information/feedback can be sent to DukeCarbonPlan@gpisd.net
- The next meeting will take place on Tuesday, March 22. GPI will be sending out an email with the link to register.

Meeting materials/recordings will be uploaded to the website:

www.duke-energy.com/CarolinasCarbonPlan

GREAT PLAINS INSTITUTE | Better Energy. Better World.

GREAT PLAINS INSTITUTE

Better Energy.
Better World.

THANK YOU

ATTACHMENT 3

Duke Energy Carolinas Carbon Plan Technical Subgroup Meeting

Virtual Meeting – February 18, 2022

**Please note, this meeting is being recorded for internal purposes only, to ensure accuracy of meeting notes.*

GREAT PLAINS INSTITUTE

Better Energy. Better World.

Participant Roles:

- **Observers:**
  - Not able to participate in meeting discussions
  - Can submit questions/comments to panelists using the chat function
  - Invited to send feedback via email (DukeCarbonPlan@gpisd.net) after the meeting

- **Panelists:**
  - Able to participate in meeting discussions
  - Can submit questions/answers using the chat function
  - Invited to send feedback via email (DukeCarbonPlan@gpisd.net) after the meeting

GREAT PLAINS INSTITUTE | Better Energy. Better World.

Today's Approach

- **Subgroup 1:**
  Solar Interconnection Forecast
  (10:00am-12:00pm)
- **Subgroup 2:**
  Solar/Wind Technology Operational/Cost Assumptions
  (1:00pm-3:00pm)
- **Subgroup 3:**
  Storage Operational/Cost Assumptions and System Configurations
  (3:30pm-5:00pm)

Meeting Ground Rules

- **Respect each other:** Help us to collectively uphold respect for each other's experiences and opinions, even in difficult conversations. We need everyone's wisdom to achieve better understanding and develop robust solutions.
- **Use the chat:** Panelists and observers can submit comments and questions in the chat. GPI staff will monitor the chat to pull out questions for Q&A portions. Please be respectful and focus on issues, not people.
- **Raise your hand:** During dedicated Q&A portions of the meeting, panelists should use the "Raise Hand" feature to indicate you would like to voice a question or comment. Observers are not able to use the "Raise Hand" feature.
- **Chatham House Rule**: Empower others to voice their perspective by respecting the "Chatham House Rule;" you are welcome to share information discussed, but not a participant's identity or affiliation (including unapproved recording of this session).

Solar Interconnection Forecast for Carbon Plan Modeling

Carolinas Carbon Plan Technical Subgroup Stakeholder Meeting

FEBRUARY 18, 2022

Introductions

Duke Presenters and Panelists:

- Bailey McGalliard
  - Lead Strategy & Analytics Consultant
- Sammy Roberts
  - General Manager, Transmission Planning and Operations
- Matt Kalemba
  - Director, Distributed Energy Technologies Planning and Forecasting
- Support Panelists:
  - Kerry Powell
    - VP Transmission and Fuels Strategy and Planning
  - Maura Farver
    - Director, Distributed Energy Technologies Strategy and Policy
  - Ken Jennings
    - General Manager, Renewable Integration and Operations

Stakeholder Panelists:

- Tyler Norris, Cypress Creek Renewables
- Jeff Thomas, NCUC Public Staff
- Dustin Metz, NCUC Public Staff
- Steve Levitas, Pinegate Renewables
- Kirsten Millar, Rocky Mountain Institute
- Maggie Shober, Southern Alliance for Clean Energy
- Tyler Fitch, Synapse Energy Economics
- Ed Burgess, Strategen Consulting
- Daniel Brookshire, North Carolina Sustainable Energy Association

Agenda and Level Set

- Goal: Discuss the model inputs to be used to forecast how much new solar Duke can safely interconnect each year.
  - A forecast is an **estimate** of future conditions, using **the best information available today**

- Topics to cover today:
  - ***Historic*** pace of interconnection and increasing complexity of interconnection on DEC/DEP systems → *how to translate this into future predictions*
  - Describe factors impacting ***future*** pace of interconnection:
    - Length of time from Interconnection Agreement to In-Service Date
    - Volume of transmission network upgrades that can be completed each year

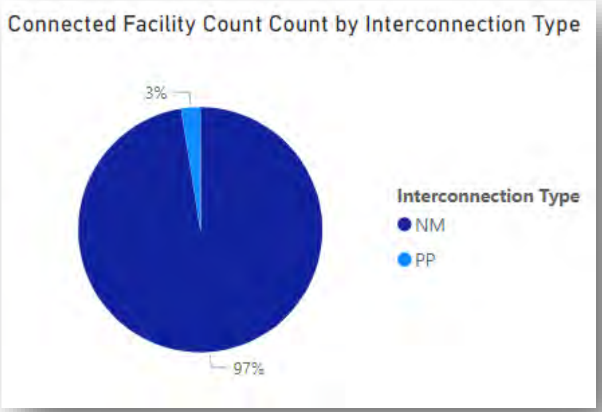
- Topics that are out of scope:
  - Policy debates as to the "merits" of solar as a resource
  - Cost or operational assumptions of solar included in the model (separate session on this)
  - Transmission investments that could be identified and evaluated through the FERC-jurisdictional local transmission planning process
  - Affected systems generator interconnection studies/policies

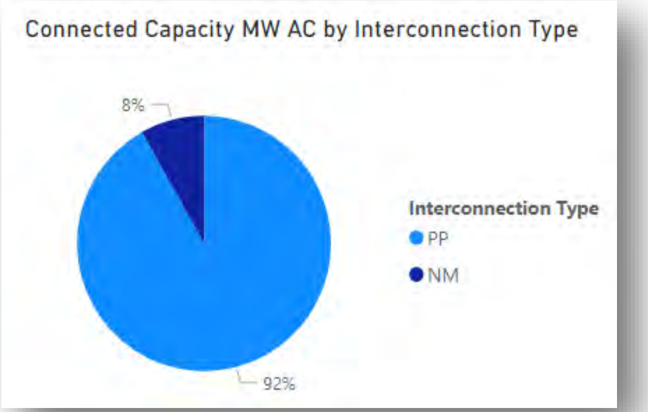
- ***Intent*** is to discuss appropriate modeling assumptions, not to solve the policy debates around transmission planning and generator interconnection

Defining Scope of this Historic Look

- Two most prominent configurations in our service territory can be categorized as follows:
  - **Net Metering** (customer offsets utility usage)
  - **Purchased Power** (customer sends generation to the grid)

- **Purchased Power** represents **3%** of the **count** of interconnections and **92%** of the **Installed Capacity** connected to our grid in the Carolinas through 2021.





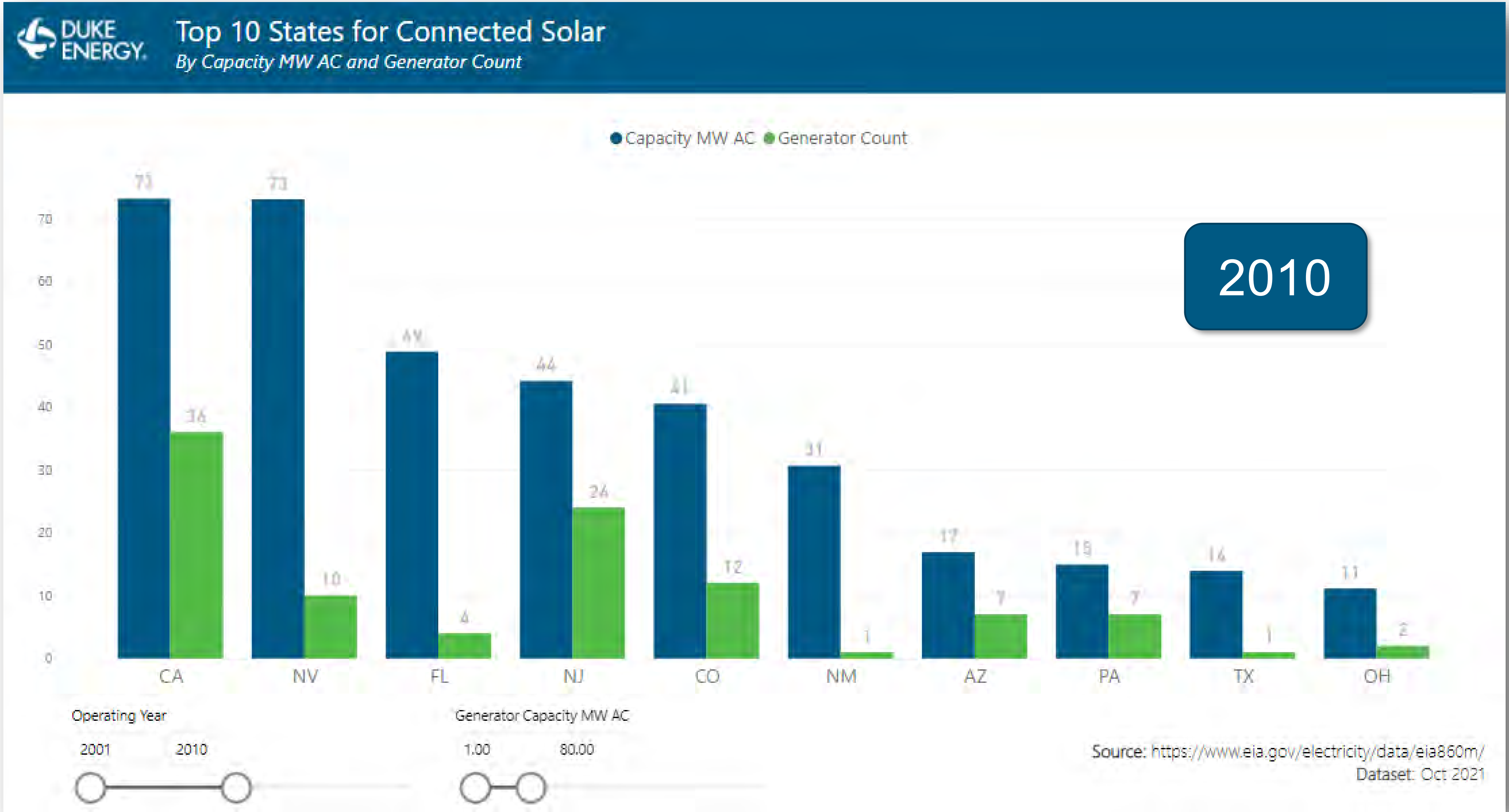
- For the purposes of this historical interconnection recap, we will focus on **Purchased Power** configured solar

A Quick Look at US Solar Interconnection Trends

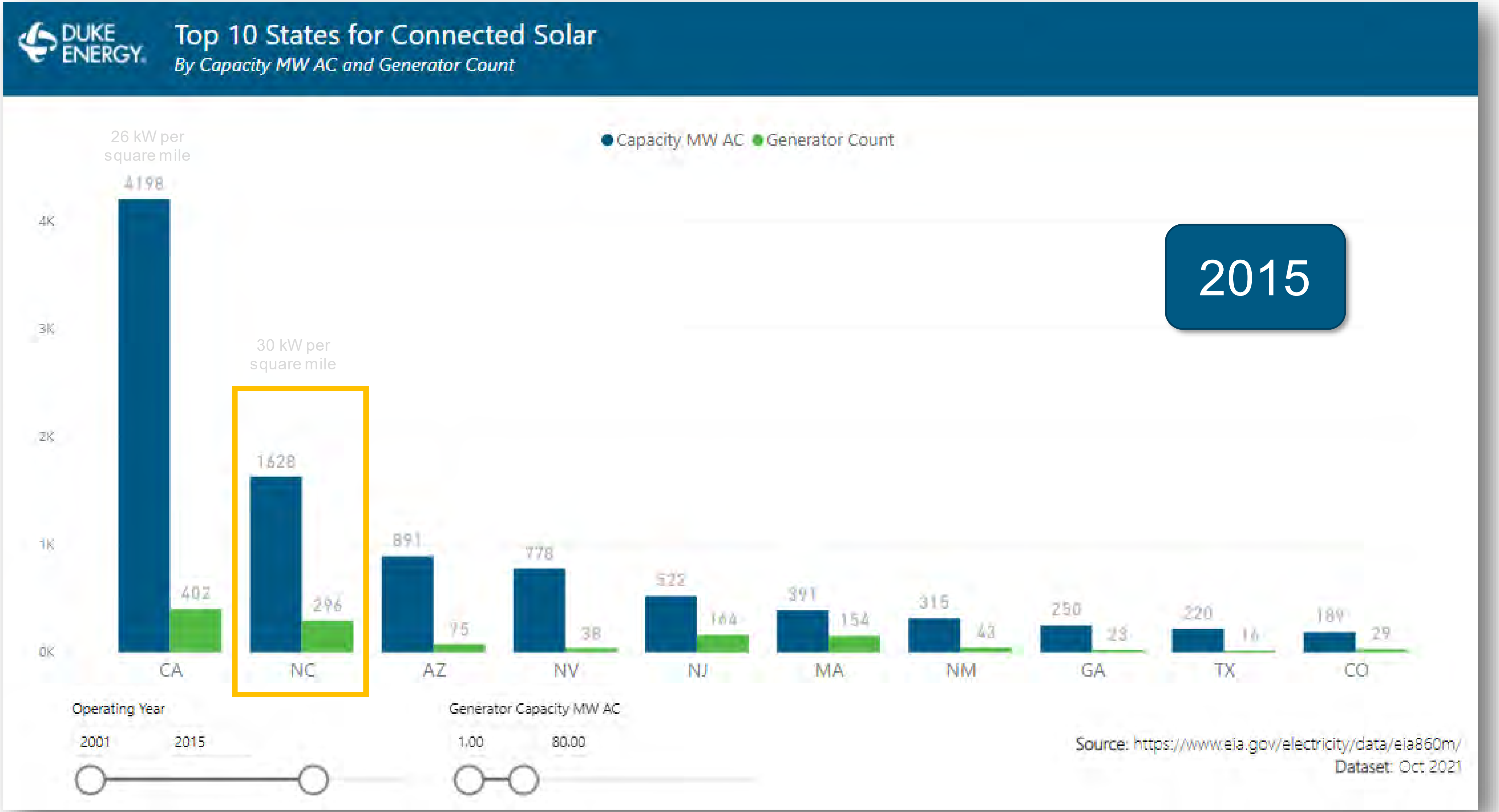
- Data Source: EIA 860 M, October 31
- Data Context: Qualified Facility generators (purchased power intent, 80 MW or less)

Top 10 States for Connected Solar

By Capacity MW AC and Generator Count



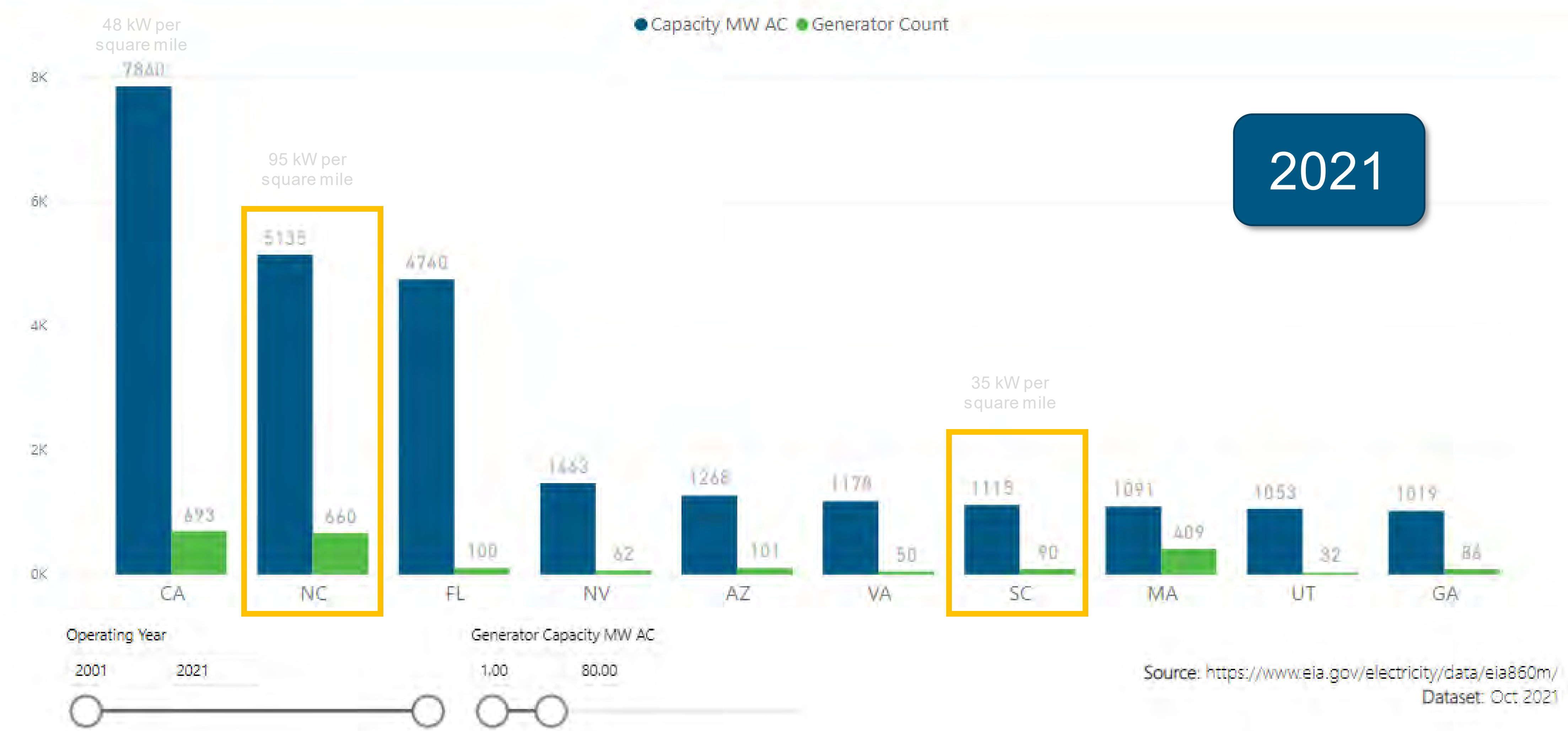
Source: https://www.eia.gov/electricity/data/eia860m/
Dataset: Oct 2021



DUKE ENERGY
Top 10 States for Connected Solar
By Capacity MW AC and Generator Count
Capacity MW AC
Generator Count
26 kW per square mile
30 kW per square mile
4198
402
1628
296
891
75
778
38
522
164
391
154
315
43
250
23
220
16
189
29
4K
3K
2K
1K
0K
CA
NC
AZ
NV
NJ
MA
NM
GA
TX
CO
2015
Operating Year
2001
2015
Generator Capacity MW AC
1.00
80.00
Source: https://www.eia.gov/electricity/data/eia860m/
Dataset: Oct 2021

Top 10 States for Connected Solar

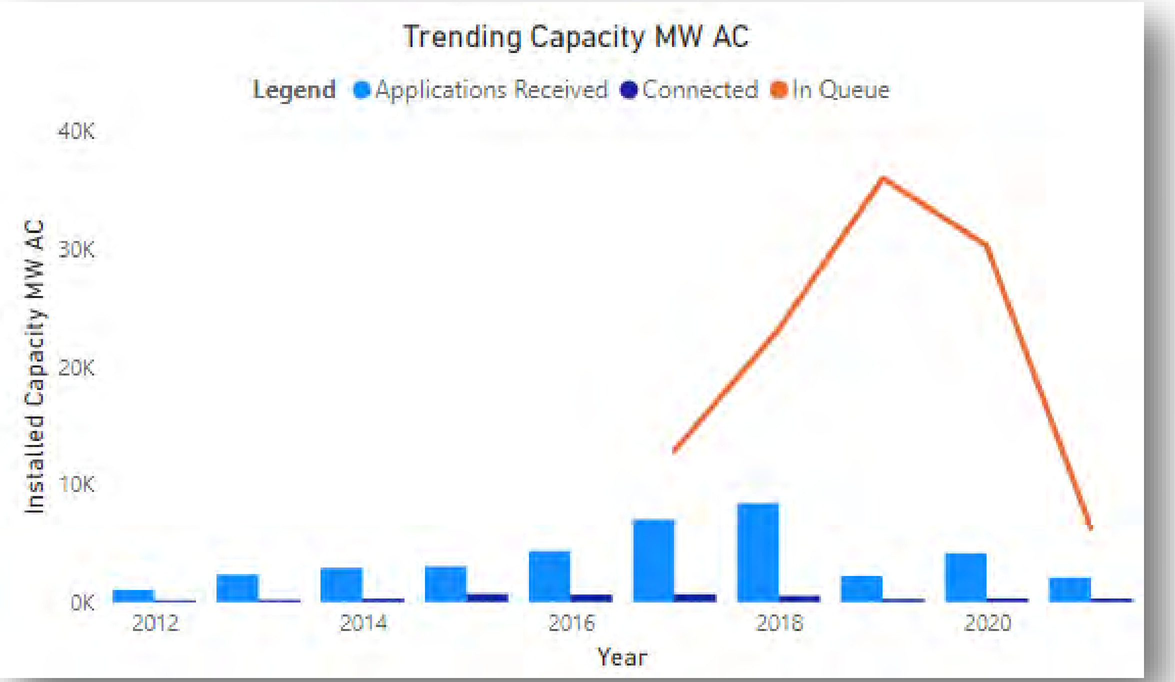
By Capacity MW AC and Generator Count

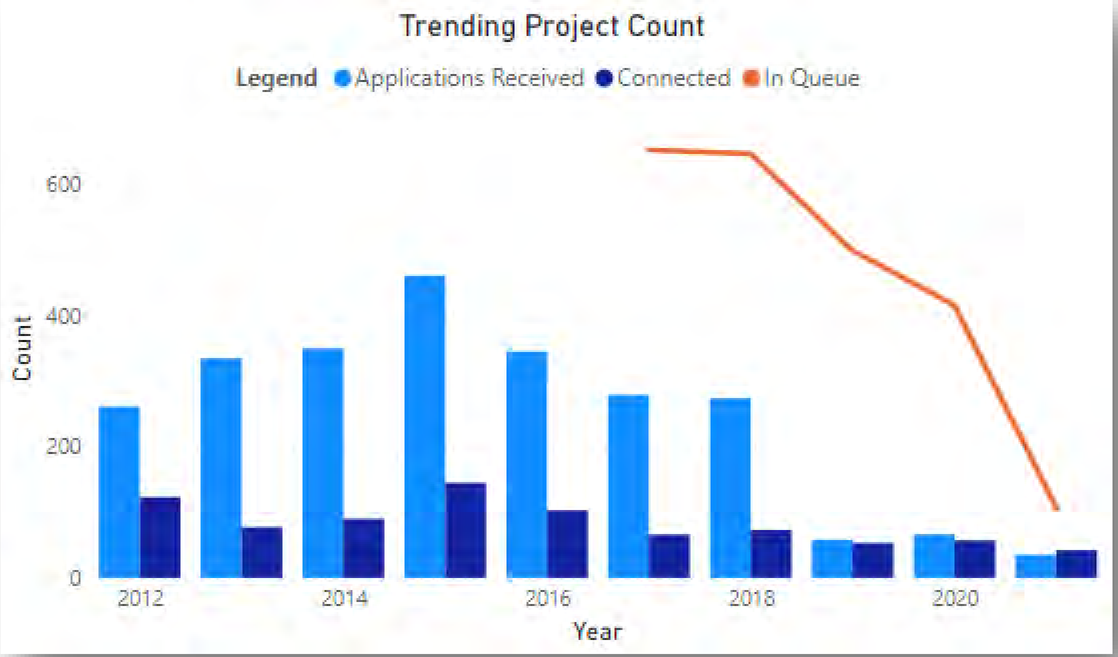


Source: https://www.eia.gov/electricity/data/eia860m/
Dataset: Oct 2021

Duke Energy Service Area

Duke Energy has cumulatively connected approximately **4,300** MW universal scale solar in the Carolinas to-date.





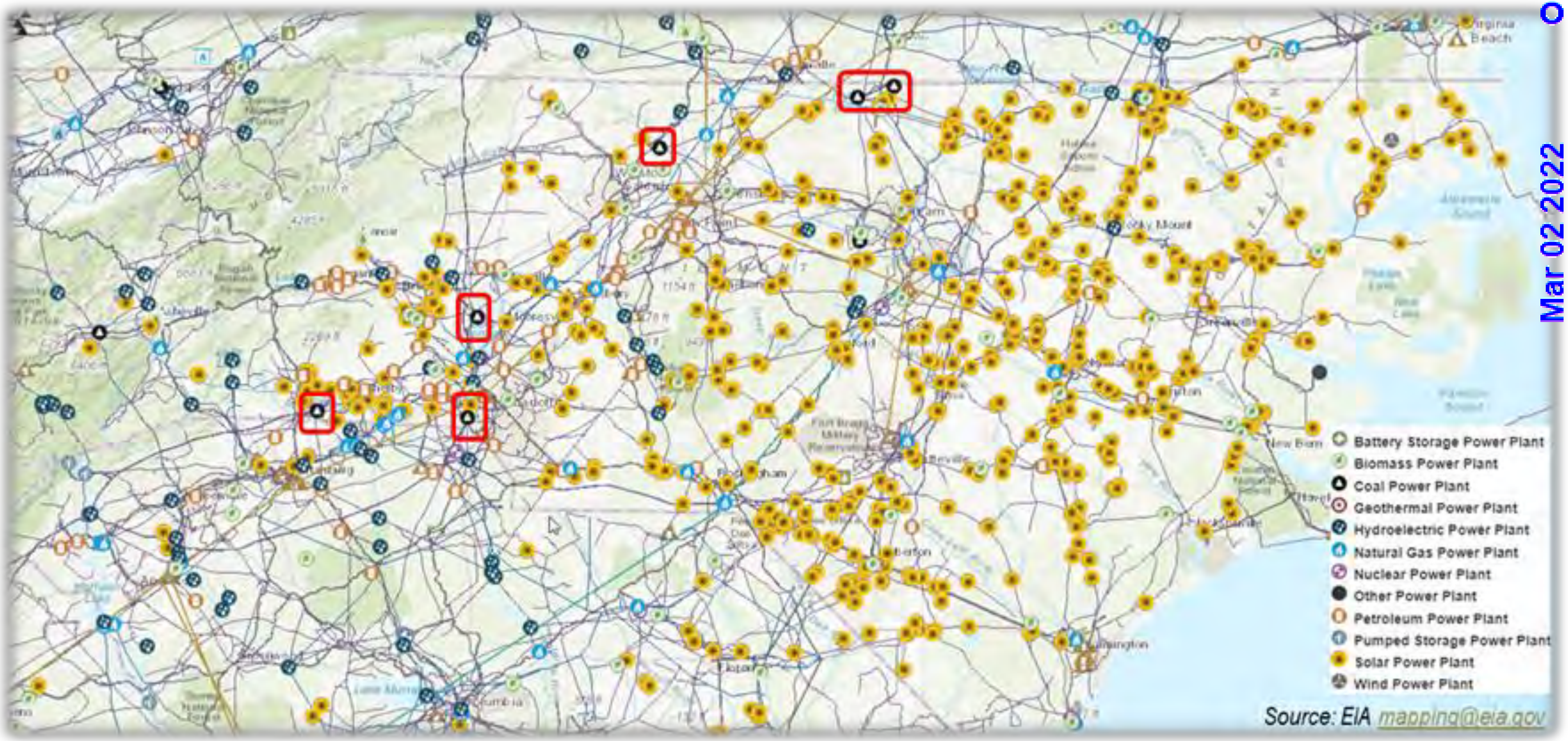
Two key takeaways:

1. Highlight movement of projects In Queue
2. Visible movement in the **application count and capacity**, while the **connected count and capacity remains relatively consistent**.

Let's discuss.

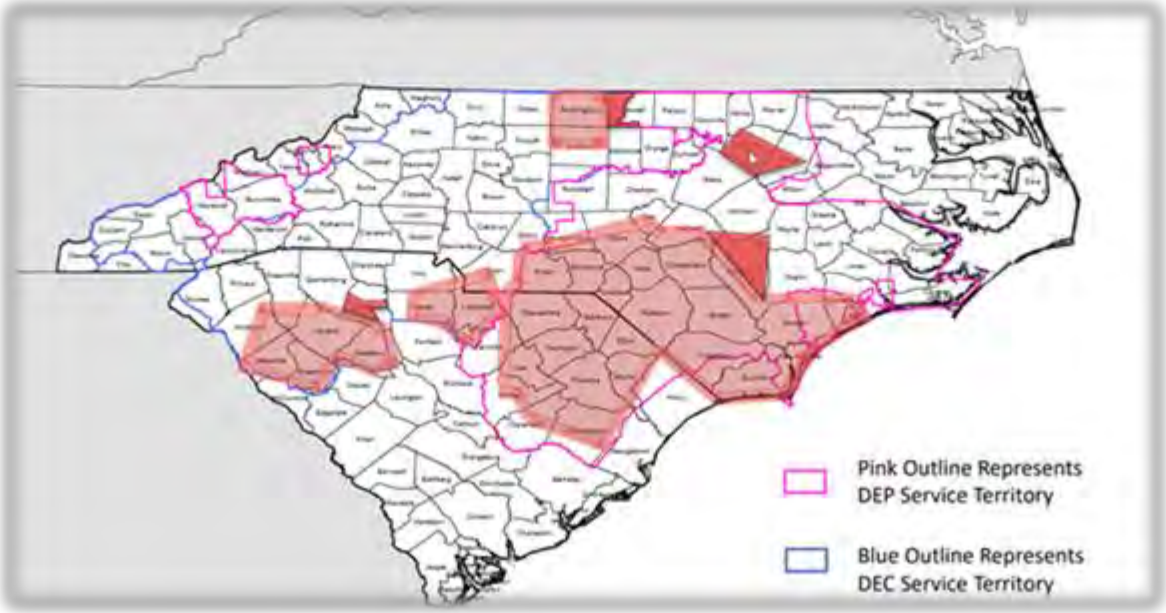
Distributed Generation and Transmission Transformation

- Distributed Generation is requiring a transformation of the grid
- Coal retirements could be impactful
- Pace of transformation will quicken
- Reliability will not be sacrificed

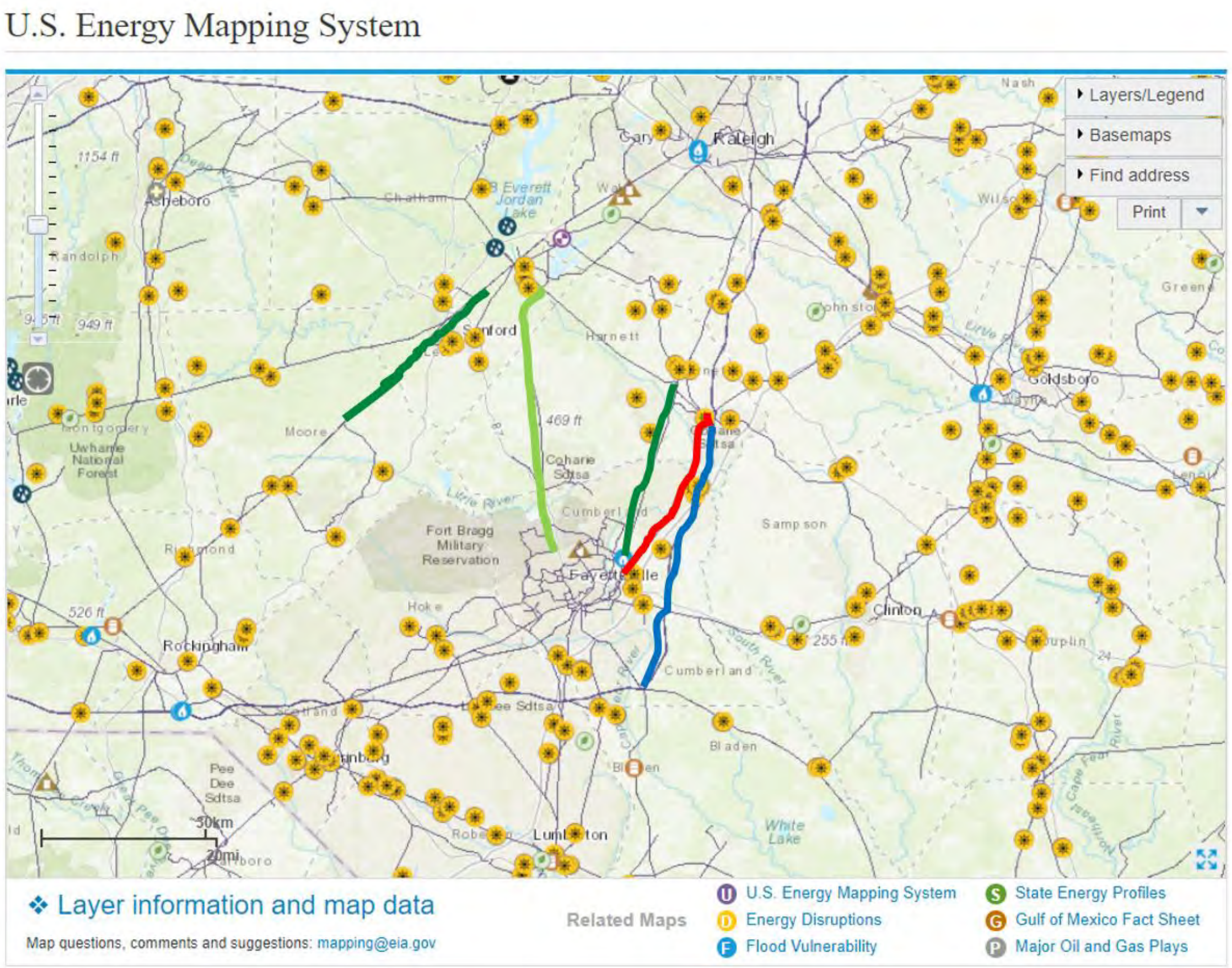


Unlocking the Red Zone

- Generator location in red zone areas will likely require significant upgrades
- Network upgrades required to unlock red zone areas
- Network upgrades require coordinating transmission outages
- Working to make process more efficient
- Reliability will not be sacrificed



Constructing Network Upgrades



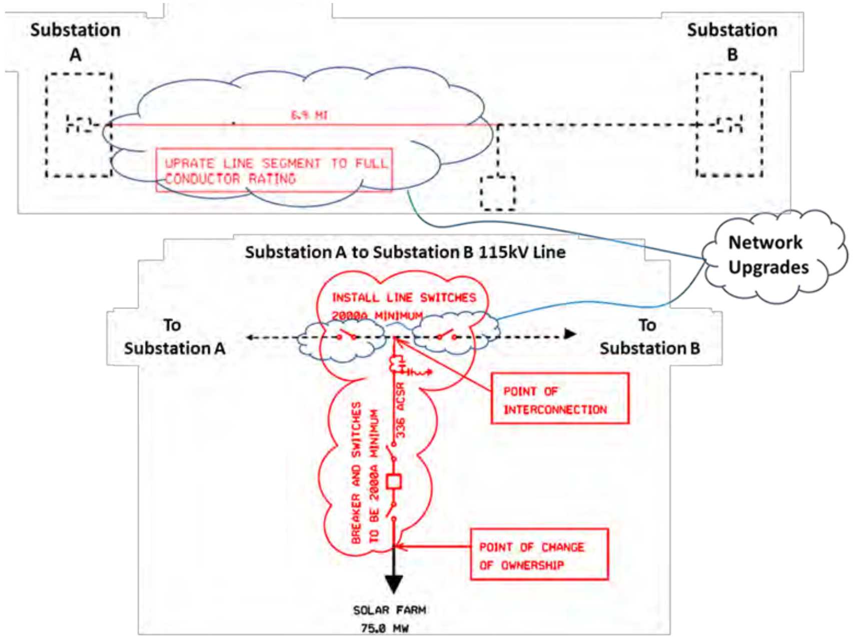
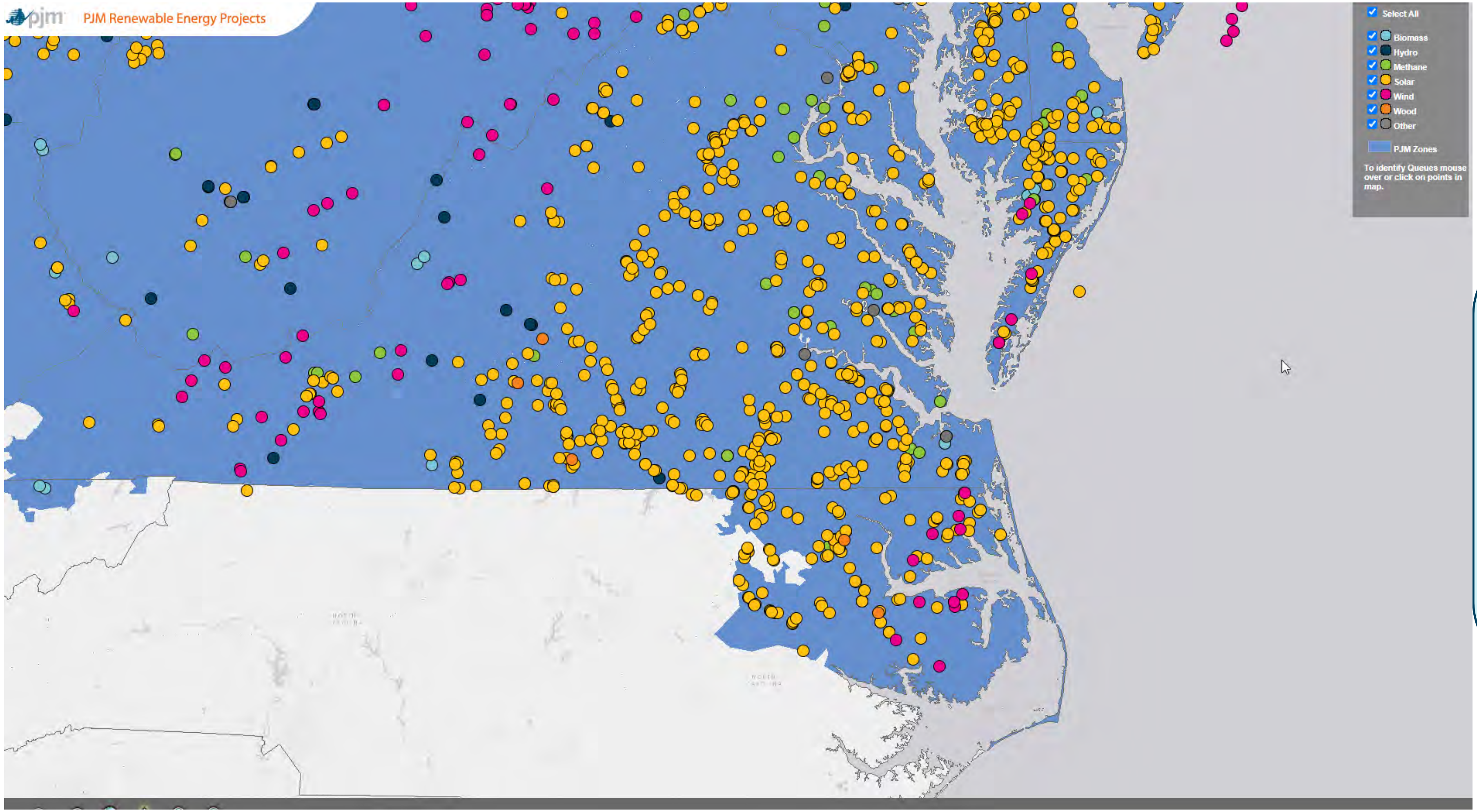


Figure 1 – Network Upgrades Associated with Interconnecting 75MW Solar Facility

Challenges are not unique to Duke

PJM recently proposed two-year delay on approximately 1,250 projects in the queue

- New projects not eligible for review until 4Q 2025



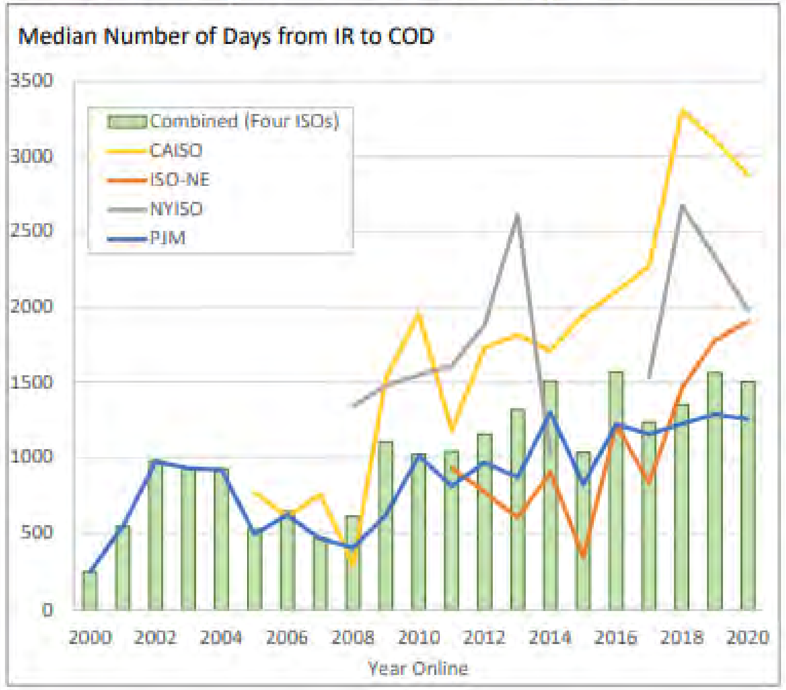
Federal Energy Regulatory Commission

"A piecemeal approach to expanding the transmission system is not going to get the job done. We must take steps today to build the transmission that tomorrow's new generation resources will require."
FERC Chairman Glick
(July 15, 2021)

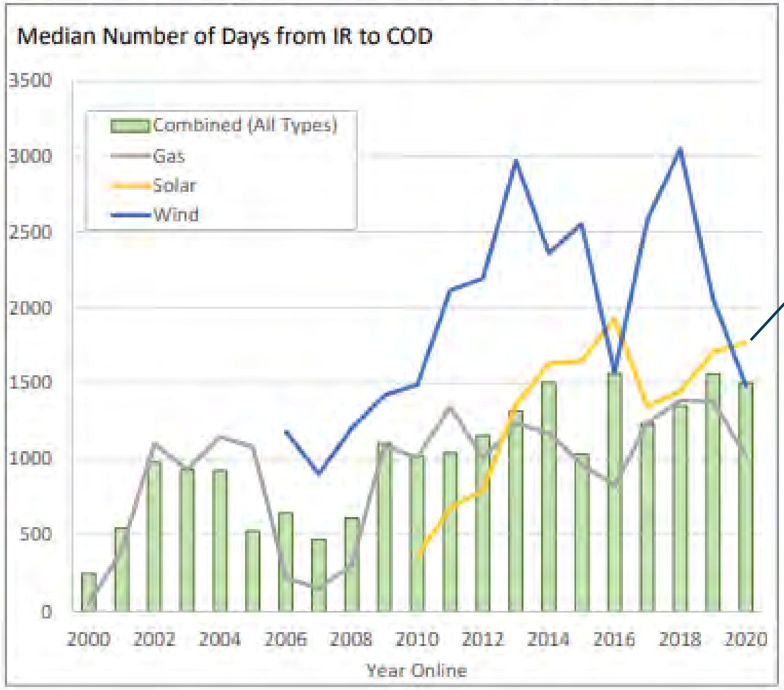
2021 LBNL Report Shows Lengthy Interconnection Timelines

The time from interconnection request (IR) date to commercial operations date (COD) is increasing for some regions and generator types; typically longer for CAISO and for wind

Completed Projects: Time in Queue, by ISO



Completed Projects: Time in Queue, by Resource



Year	Completed Projects
2000	10
2001	20
2002	27
2003	23
2004	28
2005	25
2006	37
2007	49
2008	69
2009	52
2010	60
2011	81
2012	76
2013	82
2014	72
2015	114
2016	134
2017	82
2018	88
2019	71
2020	73

2020 = ~1750 days
~4.8 years

Notes: (1) Data on completed projects were only collected for five ISOs, though only the four shown provided COD. (2) Data are only shown where sample size is >3 for each year. (3) "Time in queues" is calculated as the number of days from the queue entry date to the commercial operations date

6

Lawrence Berkeley National Laboratory, May 2021 Report, https://emp.lbl.gov/publications/queued-characteristics-power-plants

Solutions to Explore

- Revised interconnection process ✓
  - Cluster studies with cost sharing mechanism for network upgrades

- Create efficiencies to reduce timeframe from Interconnection Agreement to COD

- Follow local transmission planning process to explore and facilitate transmission upgrades for public policy needs

OATT Attachment N-1 – Local Transmission Planning

- FERC has exclusive federal jurisdiction over transmission planning
- Follow the FERC approved Orders 890 and 1000 Local Transmission Planning process in the OATT
  - North Carolina Transmission Planning Collaborative covers DEC and DEP transmission systems in NC and SC
    - OSC – Oversight Steering Committee
    - PWG – Planning Working Group
    - TAG – Transmission Advisory Group
  - Process must consider all transmission customer stakeholders that wish to provide input
  - Annual Local Transmission Planning cycle
  - Considers Reliability Projects, Economic Projects, and Public Policy Need

Current Carolinas Interconnection Timeline
Signed IA through Construction

Current timeline for construction from Interconnection Agreement approaches 3 years

- Interconnection facilities only - additional time if network upgrades are required

IR

IA

24-36 months <u>without</u> Transmission System Upgrades

Project Online

Site Specifics for Connections

Pad Grading with Easement Info

Interconnection Equipment Construction

Fiber Comms Connection

Reliability Sys Ops Engineer Readiness assessment

Minimal effort without transmission upgrades

Outage Coordination Assessment for Real time connect

1-2 weeks pre online date

Permission to Operate Checklist

2-3 months

Solar Site Testing

1 month

Network Upgrades, depending on complexity and ROW acquisition needs, can range between 3-6 years from project start through completed construction

Typical Network Upgrade Tasks	Months
Siting	10
CPCN	7
Line Design	24
Prepare Permits	6
Obtain Permits/Construction Planning	12
Construction per mile per crew	2

Solar Interconnections in Model

- The Carbon Plan must be an executable plan that achieves the Carbon reductions under HB951 and that maintains or enhances reliability

- The timing and ability to interconnect resources should be reflected in the model

- Solar is unique
  - One of the few carbon free resources readily available pre-2030
  - Most optimal areas for solar development are in the most transmission constrained areas
  - Timing to interconnect solar will primarily be driven by timing of transmission system upgrades

- The timing, number, and volume of solar interconnections, and the costs required to increase the pace of solar deployment on the system should be modeled
  - Model solves based on capacity (i.e. MW), but limitation is a combination of number of projects and capacity

Annual Solar Interconnection Capability – Model Sensitivities

Range of Interconnection Capability Sensitivities

Nameplate MW	2026	2027	2028	2029	2030	Potential Connected Solar by 2030*
Progressive	*About* 10 projects @ 75 MW Average = 750 MW	750	750	750	750	~10,250
Enhanced Transmission Policy (Base)	About 10 projects @ 75 MW Average = 750 MW	1,000	1,360	1,360	1,360	~12,300

- *Progressive* – Land availability less constraining than expected, cluster study process leads to more efficient interconnections as upgrade costs are shared among more participants, and / or shift to larger solar facilities leads to steady solar interconnections at historically high levels
- *Enhanced Transmission Policy* – Proactive strategic transmission investments lead to more efficient solar interconnections and increased possibility of larger solar projects

**Assumes 6,500 MW connected by 2025 including CPRE Tr3 and NC GSA*

Transmission Cost Adder

(Illustrative DRAFT)

Incremental Solar MW	Transmission Cost Adder, $/kw
< 2,000	$X
2,000 – 3,000	$X+
3,001 – 5,000	$X++

Stakeholder Questions and Discussion

Questions
Feedback
Comments

Next Steps:

- Meeting materials will be uploaded to the website:

  www.duke-energy.com/CarolinasCarbonPlan

- Information/feedback can be sent to:

  DukeCarbonPlan@gpisd.net

- The next stakeholder meeting is next Wednesday, February 23rd. Please send an email if you need the registration link for this meeting.

Break

Subgroup 2 will begin at 1:00pm

GREAT PLAINS INSTITUTE | Better Energy. Better World.

Participant Roles:

- **Observers:**
  - Not able to participate in meeting discussions
  - Can submit questions/comments to panelists using the chat function
  - Invited to send feedback via email (DukeCarbonPlan@gpisd.net) after the meeting

- **Panelists:**
  - Able to participate in meeting discussions
  - Can submit questions/answers using the chat function
  - Invited to send feedback via email (DukeCarbonPlan@gpisd.net) after the meeting

Today's Approach

- ~~Subgroup 1:~~
  ~~Solar Interconnection Forecast~~
  ~~(10:00am-12:00pm)~~
- Subgroup 2:
  Solar/Wind Technology Operational/Cost Assumptions
  (1:00pm-3:00pm)
- Subgroup 3:
  Storage Operational/Cost Assumptions and System Configurations
  (3:30pm-5:00pm)

Meeting Ground Rules

- **Respect each other:** Help us to collectively uphold respect for each other's experiences and opinions, even in difficult conversations. We need everyone’s wisdom to achieve better understanding and develop robust solutions.
- **Use the chat:** Panelists and observers can submit comments and questions in the chat. GPI staff will monitor the chat to pull out questions for Q&A portions. Please be respectful and focus on issues, not people.
- **Raise your hand:** During dedicated Q&A portions of the meeting, panelists should use the “Raise Hand” feature to indicate you would like to voice a question or comment. Observers are not able to use the “Raise Hand” feature.
- **Chatham House Rule**: Empower others to voice their perspective by respecting the “Chatham House Rule;” you are welcome to share information discussed, but not a participant's identity or affiliation (including unapproved recording of this session).

GREAT PLAINS INSTITUTE

Better Energy. Better World.

Solar and Wind Technology and Cost Assumptions

Carolinas Carbon Plan Technical Subgroup Stakeholder Meeting

FEBRUARY 18, 2022

Introductions

Duke Energy Presenters and Panelists:

- Matt Kalemba
  - Director, Distributed Energy Technologies Planning and Forecasting
- Adam Reichenbach
  - Lead Engineer, Generation Technology
- Clift Pompée
  - Managing Director, Generation Technology
- Support:
  - Glen Snider
    - Managing Director, Carolinas Integrated Resource Planning

Stakeholder Panelists:

- Mark Johnson, Clemson University
- Zander Bischof, Cypress Creek Renewables
- Neil Kern, Electric Power Research Institute
- John Lemire, NC Electric Membership Corporation
- Jeff Thomas, NCUC Public Staff
- Dustin Metz, NCUC Public Staff
- Amanda Levin, National Resource Defense Council
- Steve Levitas, Pinegate Renewables
- Kirsten Millar, Rocky Mountain Institute
- Katharine Kollins, Southeast Wind Coalition
- Tyler Fitch, Synapse Energy Economics
- Ed Burgess, Strategen Consulting
- Moji Abiola, Apex Clean Energy

Agenda and Level-Setting

Agenda Overview:

- Utility Scale Solar Profile Development, Operational Assumptions
- Utility Scale Solar Cost Development Process
- Onshore Wind Profile Development; Operational Assumptions
- Onshore Wind Cost Development Process
- Offshore Wind Operational Assumptions
- Offshore Wind Cost Development Process

Out of Scope:

- Confidential specific cost information

INTENT

Provide information and allow for discussion regarding how Duke builds cost and operational assumptions for the generic solar and wind generators included in the model

We may see many different technology configurations and costs in real life.

In Carbon Plan modeling, we include a specific generation/unit type that is representative of future installations on the system

Modeled Solar vs Selected Solar

- As of Jan. 1, 2022, there were approximately 4,300 MW of utility scale solar on the DEC and DEP systems
- An additional 2,200 MW of utility scale solar is expected to connect by 2025 based on existing contracts and interconnection agreements for projects that have not yet reached operation along with completion of CPRE Tranche 3
- The Carbon Plan will include these facilities as "modeled" solar*
- Additional solar will be available as "selected solar" beginning in 2026
- ***Today's discussion will focus on the characteristics of "selected solar"***
- ***There is a difference between "selected solar" in the model and optimal solar configurations at the execution phase of the plan. Solar configurations used in the model are best estimates of representative solar facilities that are likely to be available at the time of connection***

** An additional 325 MW of solar will be input into the model from 2026 – 2030 which represents NC GSA solar that has yet to be contracted*

Utility Scale Profile Development

Historical Irradiance

- 20 years of historic data
- 22 representative locations across the Carolinas

Best Fit Year

- Mimics a TMY ("Typical Meteorological Year")
- Identify best fit year for each month that most closely matches the average historical irradiance for that month

Generate Best Fit Profiles

- PVSyst used to model solar configurations based on DC/AC ratios and Tracking capability
- Creates hourly profiles using only Best Fit Year irradiance

Load Match Profiles

- Match historical load and solar production to future load forecasts
- Combine best fit and load match data to create final hourly profiles

Solar Technology Key Variables

- Panel mount
  - Fixed Tilt – Arrays of solar panels placed at fixed angle which is usually the optimum tilt
  - Single Axis Tracking – Arrays of solar panels mounted with trackers that move along one axis (usually east-west direction)
    - Over 90% of connected facilities are fixed tilt configuration
    - Majority of facilities connecting over next 3 years are single axis tracking
- DC / AC Ratio or "Overpaneling"
  - The ratio of PV power to inverter power
  - In most cases, targeting high ratio with minimal clipping losses
- Panel type
  - Monofacial – One side of solar cells collecting light
  - Bifacial – Two sides of solar cells collecting light

Solar PV Technology Assumptions

- **Standalone Solar**
  - 75 MW facility
  - Single-Axis Tracking
  - 1.4 DC/AC panel ratio
  - Monofacial modules
  - Carolina's region
  - 26-28% capacity factor
- **Solar Plus Storage**
  - 75 MW facility
  - Single-Axis Tracking
  - 1.6 DC/AC panel ratio
  - Monofacial modules
  - Carolina's region
  - 30-32% capacity factor

Adjustable Parameters	*Unit*	Input
Size (MW-AC)	*MW-AC*	75
Case Overbuild Ratio[b]	%	1.4
Forecast Basis	*n/a*	Carolinas
Tilt Orientation	*n/a*	Single Axis Tracker
Module Face	*n/a*	Monofacial
Region	*n/a*	Southeast

Solar PV Data Sources and Process

Data Sources

- Capital cost data from Guidehouse modeling tools
  - Updated Fall 2021
- O&M cost data from solar development team's internal model
  - Updated January 2022
- Additional data sources considered:
  - Internal solar development team and supply chain department
  - Burns & McDonnell engineering study
  - EPRI annual solar cost and performance data
  - NREL ATB 2021
  - Lazard Levelized Cost of Energy 2021
  - EIA AEO 2021

Process

Cost reports based on market data for solar installations in US

↓

Information is tailored to account for specific NC and SC cost adjustment factors at generic location

↓

EPC estimate generated from input data

↓

Duke-specific owner's cost adder and transmission adder included with cost (this is the "overnight" cost)

↓

Overnight cost information is converted to "all-in" cost including financing, inflation, and disposal/recycling

Stakeholder Questions and Discussion

Alignment with stakeholders' experiences and industry norms?

Questions
Feedback
Comments

Other cost or data sources Duke should be considering?

Onshore Wind Resource

- As of 1/1/2022, no utility scale wind resources in DEP and DEC territories
- Wind viewed as a complimentary resource at high solar build outs
- Carolinas onshore wind assumed to be available as a selected resource beginning in 2028
- Considering including wheeled wind from PJM or other neighbors as a potential resource to meet goal
- ***Today's discussion will primarily focus on the characteristics of onshore Carolinas wind as a resource***
- ***There is a difference between "selected wind" in the model and optimal wind configurations at the execution phase of the plan. Wind configurations used in the model are best estimates of representative wind facilities that may be available at the time of connection***

Utility Scale Onshore Wind Profile Development

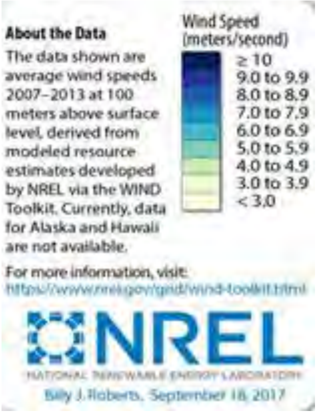
Historical Wind Speeds
- 20 years of historic data
- 6 representative locations across eastern NC

Best Fit Year
- Mimics a typical year of wind speed using historical data
- Identify best fit year, month, and location that closely matches the average historical wind speed for that month

Generate Best Fit Profile
- From the best fit year a single 8760 wind speed profile is created
- Using wind turbine power curves and heights, a best fit capacity factor profile is created

Forecast
- Best Fit Profile is used to develop a 30-year forecast

Locations for Modeled Wind



- When evaluating options for wind resource, mainly followed NREL's exclusions
  - Urban areas
  - Bodies of water
  - Protected lands
  - Distance from structures
  - Ridgetop lands (above 4,000 ft)
  - Military bases and radar line-of-site

Onshore Wind Technology Assumptions

- 150 MW facility
- 4 MW turbines
- 100-meter hub height
    - Evaluating higher hub heights, but insufficient data exists to include in modeling
- Carolina's region
- 20-30% capacity factor

Onshore Wind Data Sources and Process

Data Sources

- Capital cost data from Burns & McDonnell engineering study
  - Updated January 2022
- O&M cost data from Burns & McDonnell engineering study
- Additional data sources considered:
  - EPRI annual wind cost and performance data
  - NREL ATB 2021
  - Lazard Levelized Cost of Energy 2021
  - EIA AEO 2021

Process

Costs are based on current EPC estimates to construct on onshore wind facility in Duke Carolinas territory

↓

EPC and Owner's cost estimates prepared by Burns & McDonnell for generic site

↓

Duke-specific transmission adder included with cost (this is the "overnight" cost)

↓

Overnight cost information is converted to "all-in" cost including financing, inflation, and disposal/recycling

Offshore Wind Technology Assumptions

- 1600 MW of wind generation
- 12/15 MW turbines
- Carolina's region
- 40-45% capacity factor

Cost Forecast Parameters

Parameter	Units
Region	
Region Cost Scenario	
Regional Cost Multiplier	
OPEX Guidehouse scaling factor	
CAPEX Guidehouse Scaling Factor	
Regional Onshore Spure Line Cost	*$/MW-mile*
Technology Cost Development Scenario	
Grid Feature Cost	*$/kW*
Techno Resource Group (TRG)	
Commercial Date of Operation (COD)	*year*
Forecast period start	*year*

Offshore Wind Data Sources and Process

Data Sources

- Capital cost data from Guidehouse modeling tools
  - Updated Fall 2021
- O&M cost data from Guidehouse modeling tools
- Additional data sources considered:
  - Burns & McDonnell engineering study
  - EPRI annual wind cost and performance data
  - NREL ATB 2021
  - Lazard Levelized Cost of Energy 2021
  - EIA AEO 2021

Process

1. Cost reports based on market data for offshore wind installations in US and globally
2. Information is tailored to account for specific NC and SC cost adjustment factors
3. EPC estimate generated from input data
4. Duke-specific owner's cost adder and onshore transmission adder included with cost (this is the "overnight" cost)
5. Overnight cost information is converted to "all-in" cost including financing, inflation, and disposal/recycling

Stakeholder Questions and Discussion

Alignment with stakeholders' experiences and industry norms?

Questions
Feedback
Comments

Other cost or data sources Duke should be considering?

Next Steps:

- Meeting materials will be uploaded to the website:

  www.duke-energy.com/CarolinasCarbonPlan

- Information/feedback can be sent to:

  DukeCarbonPlan@gpisd.net

- The next stakeholder meeting is next Wednesday, February 23rd. Please send an email if you need the registration link for this meeting.

Break

Subgroup 3 will begin at 3:30pm

Participant Roles:

- **Observers:**
  - Not able to participate in meeting discussions
  - Can submit questions/comments to panelists using the chat function
  - Invited to send feedback via email (DukeCarbonPlan@gpisd.net) after the meeting

- **Panelists:**
  - Able to participate in meeting discussions
  - Can submit questions/answers using the chat function
  - Invited to send feedback via email (DukeCarbonPlan@gpisd.net) after the meeting

GREAT PLAINS INSTITUTE | Better Energy. Better World.

Today's Approach

- ~~Subgroup 1:~~
  ~~Solar Interconnection Forecast~~
  ~~(10:00am-12:00pm)~~
- ~~Subgroup 2:~~
  ~~Solar/Wind Technology Operational/Cost Assumptions~~
  ~~(1:00pm-3:00pm)~~
- Subgroup 3:
  Storage Operational/Cost Assumptions and System Configurations
  (3:30pm-5:00pm)

Meeting Ground Rules

- **Respect each other:** Help us to collectively uphold respect for each other's experiences and opinions, even in difficult conversations. We need everyone's wisdom to achieve better understanding and develop robust solutions.
- **Use the chat:** Panelists and observers can submit comments and questions in the chat. GPI staff will monitor the chat to pull out questions for Q&A portions. Please be respectful and focus on issues, not people.
- **Raise your hand:** During dedicated Q&A portions of the meeting, panelists should use the "Raise Hand" feature to indicate you would like to voice a question or comment. Observers are not able to use the "Raise Hand" feature.
- **Chatham House Rule**: Empower others to voice their perspective by respecting the "Chatham House Rule;" you are welcome to share information discussed, but not a participant's identity or affiliation (including unapproved recording of this session).

Storage Technology in Carbon Plan Model

Carolinas Carbon Plan Technical Subgroup Stakeholder Meeting

FEBRUARY 18, 2022

Introductions

Duke Energy Presenters and Panelists:

- Matt Kalemba
  - Director, Distributed Energy Technologies Planning and Forecasting
- Adam Reichenbach
  - Lead Engineer, Generation Technology
- Sherif Abdelrazek
  - Director, Renewable Engineering
- Support:
  - Glen Snider
    - Managing Director, Carolinas Integrated Resource Planning
  - Laurel Meeks
    - Director, Renewable Business Development
  - Mike Rib
    - Director, Integrated Optimization

Stakeholder Panelists:

- Mark Johnson, Clemson University
- Neil Kern, Electric Power Research Institute
- Nathan Adams, Longroad Energy
- Brad Slocum, East Point Energy
- Jeff Thomas, NCUC Public Staff
- Dustin Metz, NCUC Public Staff
- Raafe Khan, Pinegate Renewables
- Kirsten Millar, Rocky Mountain Institute
- Ron DiFelice, Southern Current
- Tyler Fitch, Synapse Energy Economics
- Ed Burgess, Strategen Consulting

Storage in the Carbon Plan

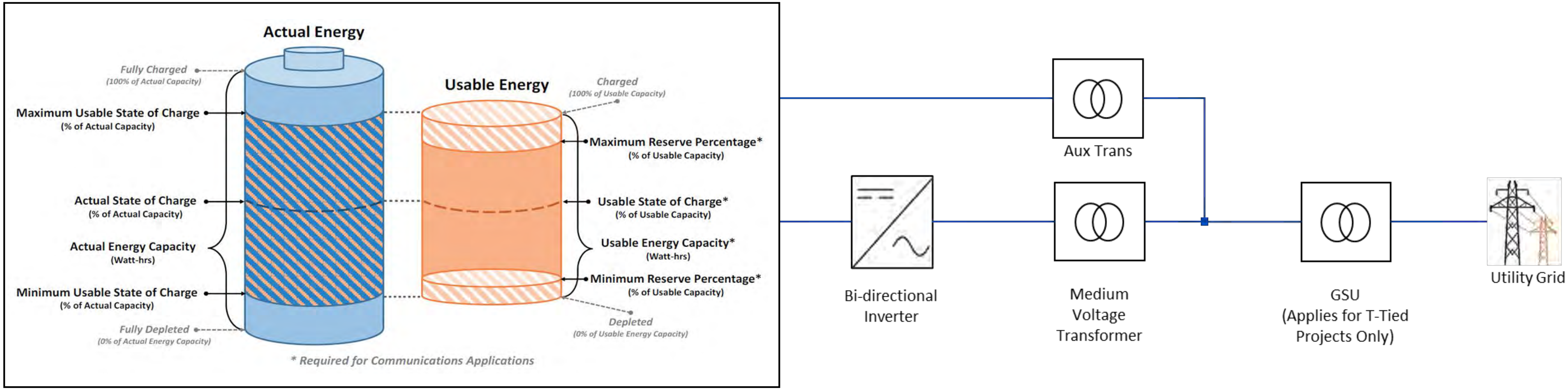
- Energy storage is expected to be an important resource in the Carbon Plan
- Energy storage use cases in Carbon Plan modeling may differ from energy storage use cases at implementation
- Discreet storage technology assumptions are required for modeling purposes; these assumptions will likely differ from storage that is actually constructed on the Duke system
- ***Today's discussion will focus on the characteristics of storage that will be allowed to be selected by the model in the Carbon Plan development***

Storage Use Cases for Carbon Plan Modeling

Use Case	Notes
Capacity	Based on ELCC study
Energy Arbitrage	Energy time shift
Ancillary Services	Regulation (including load following, AGC response), balancing and contingency reserves

- Some use cases may be complementary while others may be mutually exclusive
- Grid reliability use cases are also being considered in ISOP and grid planning, including grid reliability improvement, grid project deferrals, voltage support and black start.
- Grid use cases involve site specific requirements and benefits and don't lend well to generic capacity expansion planning

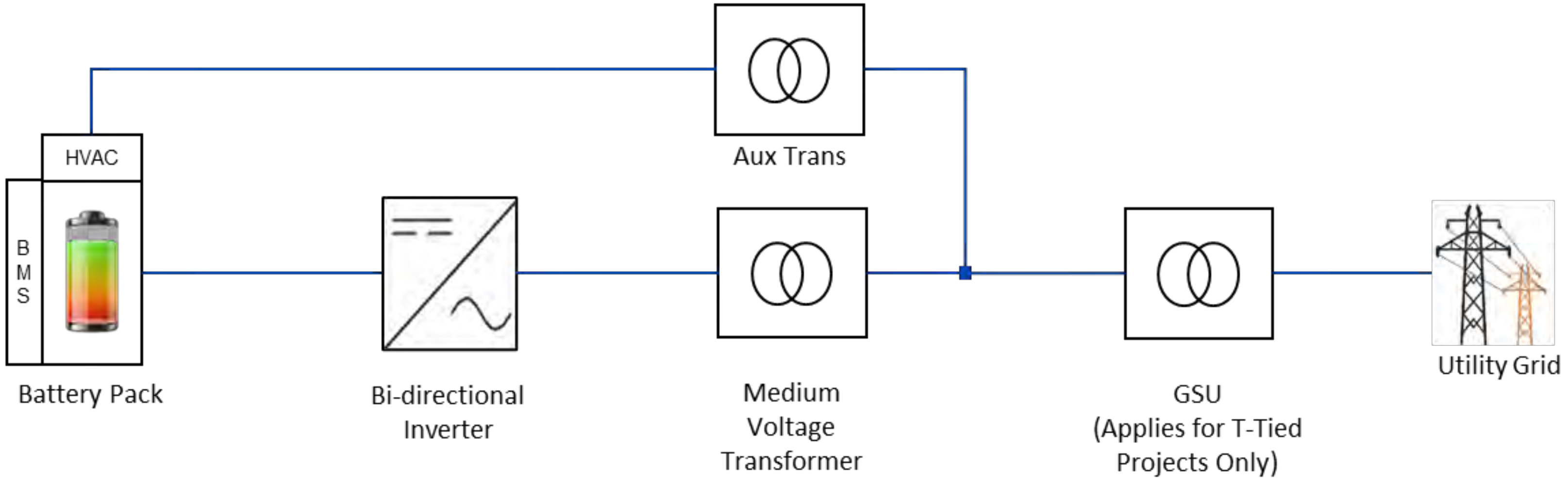
Storage Technology Key Terms



- **Duration** – Duration of time a battery system can discharge at its rated power capacity
- **Roundtrip Efficiency** – Measured as a percentage, is a ratio of the energy charged to the battery to the energy discharged from the battery. Duke uses A/C – A/C efficiency as the production cost models only consider the charging/discharging at the point of interconnect to the power system
- **Depth of Discharge** – The amount of energy that must remain, unused, in the battery to satisfy the warranty of the battery and/or allow the battery to complete the expected number of cycles over the life of the asset
- **Degradation** – The loss of energy capacity of a battery storage system over time
  - Augmentation – Replacing or adding battery cells on a regular, or semi-regular, basis to maintain the usable energy of the battery storage system
  - Overbuild – Refers to an increase in the nameplate energy capacity to account for expected degradation

Energy Storage Systems Configurations

Stand-Alone Energy Storage



Battery Pack

- Battery Packs: Battery packs consists of racks/strings. Each string consists of modules in series, each module consists of cells in series and parallel

Inverters

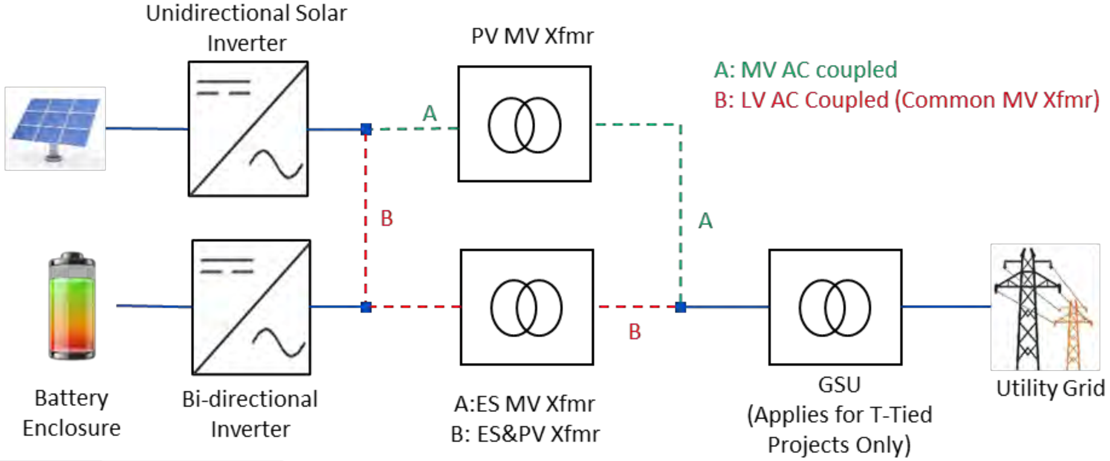
- Convert DC voltage to AC voltage and vice versa
- Battery inverters are bidirectional and can provide near instantaneous responses (ramp-rate) to operator control commands
- Output is low voltage (300V-700V)
- Consist of DC bus, IGBT stacks and output filters

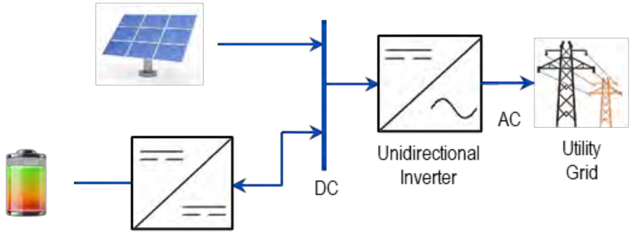
Energy Storage Systems Configurations

Solar Plus Storage

AC Coupled

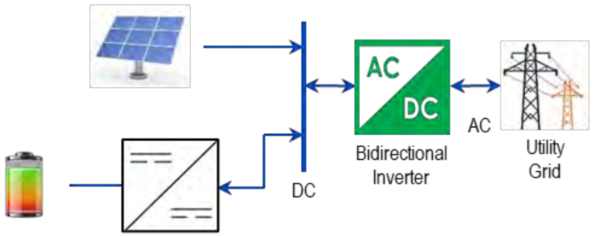
- Solar and storage are completely decoupled and can operate independently of each other.
- Separate bidirectional ES inverter included
- Charging the storage system from solar is less efficient than DC coupled systems
- Technology is mature for both solar and storage inverters





- Inverter is Unidirectional
- This topology mostly results from retrofitting solar plants with high DC/AC ratios to harvest clipped energy.
- ES discharge is limited by inverter capacity and solar production time.
- ES can only be charged through solar power.
- An ES DC/DC converter between battery and solar inverter DC input.
- ESS charge from solar is more efficient than AC coupled systems

Sole Solar Charging - DC Coupled



- Inverter is bidirectional
- ES discharge is limited by inverter capacity and solar production time.
- ES can be charged from both the solar facility and the grid.
- An ES DC/DC converter included between battery and common inverter DC input.
- ESS charge from solar is more efficient than AC coupled systems
- Example: Lake Placid Solar Plus Storage Facility

Flexible Charging - DC Coupled

Lithium Ion Battery Technology Assumptions

- **Common Parameters**
  - 90% depth of discharge limit – 10% overbuild for DOD
  - 85% round trip efficiency
  - LFP-quality chemistry
  - Annual replenishment – no overbuild for degradation
  - Carolinas region
- **Standalone Storage**
  - 50 and 100 MW facilities
  - 4, 6, and 8 hour durations
- **Solar Plus Storage**
  - 20 MW
  - 4 hour duration
  - 1 mid-life rebuild

Cost Parameters	*Unit*	Input value
Use Case	-	Capacity + Bulk Power Services
Power Capacity	*kW*	50,000
Usable Energy[a]	*kWh*	200,000
Overbuild Ratio[b]	-	1.00
Lithium Ion or Flow		Lithium_Ion
Battery Technology/Scenario	-	Base (LFP)
PCS Performance	-	Base Quality
Software and Controls	-	Complex: Real-Time Optimization
Balance of Plant	-	High/Custom
Systems Integration	-	Base
Site Installation	-	Base
Project Development	-	Base
Annual O&M[c]	-	Base
Replenishment	-	Yes

Battery Storage Data Sources and Process

Data Sources

- Capital cost data from Guidehouse modeling tools
  - Updated Fall 2021
- O&M cost data from Guidehouse modeling tools
- Additional data sources considered:
  - Internal battery development team and supply chain department
  - Burns & McDonnell engineering study
  - EPRI annual wind cost and performance data
  - NREL ATB 2021
  - Lazard Levelized Cost of Energy 2021
  - EIA AEO 2021

Process

1. Cost reports based on market data for Li-Ion battery storage installations in US
2. Information is tailored to account for specific NC and SC cost adjustment factors
3. EPC estimate generated from input data
4. Duke-specific owner's cost adder and transmission adder included with cost (this is the "overnight" cost)
5. Overnight cost information is converted to "all-in" cost including financing, inflation, and disposal/recycling

Other Storage Options Modeled

- Li-Ion can likely meet system need through Carbon Plan planning period (2030)
- Flow Battery
  - 20 MW, 8-hour duration
  - Costs from Guidehouse and Burns & McDonnell
- Advanced Compressed Air Energy
  - 300 MW, 10-hour duration
  - Costs from Burns &McDonnell referencing Hydrostor
- Pumped Hydro
  - 750 MW, 10-hour duration
  - Costs from Burns & McDonnell
  - Siting concerns for new pumped hydro
- Evaluating many long duration technologies through Emerging Technology Assessment Team (battery and non-battery)

Advanced Compressed Air Energy Storage
Flow Batteries
Flywheel Energy Storage
Gravitational Energy Storage
Hydrogen Storage
Li-Ion Batteries
Liquid Air Energy Storage
Metal-Air Batteries
Sodium-Based Batteries
Solid-State Batteries
Subterranean Pumped Storage
Thermal Energy Storage
Traditional Pumped Storage
Underground Compressed Air Energy Storage
Zinc Aqueous Batteries

Stakeholder Questions and Discussion

Questions

Feedback

Comments

Next Steps:

- Meeting materials will be uploaded to the website:

  www.duke-energy.com/CarolinasCarbonPlan

- Information/feedback can be sent to:

  DukeCarbonPlan@gpisd.net

- The next stakeholder meeting is next Wednesday, February 23rd. Please send an email if you need the registration link for this meeting.

GREAT PLAINS INSTITUTE

Better Energy.
Better World.

THANK YOU