NORTH CAROLINA
PUBLIC STAFF
UTILITIES COMMISSION

March 29, 2022

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

Re: Docket No. E-100, Sub 179
Duke Energy Progress, LLC and Duke Energy Carolinas, LLC
2022 Biennial Integrated Resource Plans and Carbon Plan

Dear Ms. Dunston:

Pursuant to ordering paragraph four of the Commission's November 19, 2021 Order Requiring Filing of Carbon Plan and Establishing Procedural Deadlines, the Public Staff hereby files its report on the March 22, 2022 stakeholder meeting held by Duke Energy Progress, LLC and Duke Energy Carolinas, LLC.

Please do not hesitate to contact me with any questions.

Sincerely,

Electronically submitted
s/ Nadia L. Luhr
Staff Attorney
nadia.luhr@psncuc.nc.gov

Attachments

Docket No. E-100, Sub 179

Public Staff Report
Duke Energy "Carolinas Carbon Plan"
Stakeholder Meeting 3 (March 22, 2022)
9:30 am – 4:30 pm

ATTACHMENTS

Attachment 1 – Participants
Attachment 2 – Agenda
Attachment 3 – Presentation Slides

GENERAL OVERVIEW

The third stakeholder meeting was moderated by third-party facilitator Great Plains Institute. After an introduction, Duke summarized the desired outcomes of the Carbon Plan process, as expressed by stakeholders in the previous two stakeholder meetings. Duke then presented on the Grid Edge and Customer Programs, and Carbon Plan Transmission Cost Estimates. Next, Rich Wodyka with the North Carolina Transmission Planning Collaborative (NCTPC) gave an overview of the NCTPC and its study process, and then, the Clean Power Suppliers Association and the Brattle Group gave a presentation on their initial Carbon Plan modeling. Lastly, Duke gave a presentation with an update on its modeling and the development of potential pathways for compliance. Throughout the stakeholder meeting, participants were able to ask questions and give feedback, and also used a chat box to ask questions and make comments.

Duke stated that while this was the last stakeholder meeting, there will be a significant amount of ongoing stakeholder engagement. In addition, rather than holding additional technical subgroup meetings, Duke stated that it had added some of the requested topics to the agenda for discussion in this third stakeholder meeting. Duke is also planning to schedule one additional meeting in April, focused on community impacts, environmental justice, and a just transition to reduced carbon emissions.

With regard to transparency, Duke stated that it plans to provide stakeholders with a subset of draft preliminary modeling assumptions by April 15, and the full set of final modeling assumptions, including the complete EnCompass data set in its native format, on May 16 when it files its proposed Carbon Plan (pursuant to executed NDAs where appropriate). Duke also noted that discovery on its proposed Carbon Plan would begin on May 16.

The stakeholder meeting covered the following information:

- <u>Introduction</u>

- <u>Duke Response to Stakeholder Desired Outcomes</u>
    - Desired outcomes that will be addressed in the development of the proposed Carbon Plan (engagement, modeling, analysis, and transparency)
    - Desired outcomes that will be addressed in the execution of the Carbon Plan (siting and community impacts and integrating other efforts)
    - Desired outcomes that are being addressed through other work streams (environmental impacts beyond CO_2, grid resilience and hardening, support favorable business environment, and affordability for all customers)

- <u>Discussion on Grid Edge and Customer Programs: Empowering Customers to Reduce Carbon Emissions</u>
    - DSM/EE Update
    - Potential enablers for delivering more DSM/EE in the Carolinas
    - Demand response and key enablers
    - Integrated Volt Var Control and Distributed System Demand Response
    - Rate design opportunities
    - Distributed energy technologies
    - Regulatory Sandbox concept

- <u>Transmission Impacts in Carbon Plan</u>
    - Factors impacting transmission needs and costs

- Network upgrade cost estimates
- Offshore wind transmission considerations
- PJM capacity purchase transmission considerations
- Risk assessment for off-system purchases

- Overview of the North Carolina Transmission Planning Collaborative
  - Purpose, goals, and organizational structure
  - Study process overview

- Clean Power Suppliers Association and Brattle Group Presentation of Carbon Plan Modeling
  - Preliminary results – Duke resource mix to meet the 70% GHG reduction by 2030 (modeling approach, assumptions, and study results)

- Duke Update on Modeling and Development of Potential Pathways for Compliance
  - Key base assumptions for selectable resources
  - Selectable resource options
  - Preliminary pathways to carbon neutrality by 2050
  - Potential portfolios
  - Execution risks

- Wrap Up

STAKEHOLDER QUESTIONS AND REQUESTS ON PROCESS

- Whether Duke will be taking or incorporating feedback from stakeholders on the draft assumptions between April 15 and May 16.
- Whether non-intervening parties will have access to detailed modeling assumptions if they execute an NDA.
- Whether those who choose not to sign a global NDA can make an agreement to receive specific information designated as confidential.
- Whether Duke will provide information showing where (and why) stakeholder input did not change Duke's proposed Carbon Plan.
- Requests for further engagement opportunities regarding EE and the Carbon Plan.
- Requests to see Duke's assumptions and methodology for its proposed cap on annual solar capacity additions and for collaboration on this issue.

ISSUES ON WHICH THERE IS CONSENSUS

- Following concerns regarding the counting of South Carolina emissions expressed by stakeholders in previous stakeholder meetings, Duke stated that it would count CO_2 emissions from any new carbon emitting resources in South Carolina as though they are sited in North Carolina.
- General support for the concept of a "regulatory sandbox."

ISSUES IN DISPUTE

The list below captures broad themes of questions and comments made during the stakeholder meeting. The issues below are not necessarily in dispute at this time, nor is this an exhaustive list of points raised. In addition, the items below are attributable to one or more participants and do not represent the views of the group as a whole. The Public Staff does not take a position on any of the issues listed below at this time.

Carbon Plan, Generally

- Concern regarding population growth and push for EVs, and whether there will be sufficient non-weather-dependent power to meet those needs.
- Questions regarding when siting decisions will be made.
- Comment that resilience can mean a greater emphasis on microgrids and programs that encourage installation of onsite solar and storage.
- Concerns that the proposed Carbon Plan filed by Duke will not achieve a 70% reduction by 2030.

Transmission

- Questions regarding how Duke will ensure that it will not have to upgrade its transmission upgrades at a later date.
- Whether Duke plans to use the results of the Transmission Cluster Study to inform the Carbon Plan on transmission cost adders, and how inputs from future DISIS cluster studies can be used in Carbon Plans.
- Transmission and distribution investments need to support residential solar.
- Whether Duke will model the effect on transmission costs of joining PJM or forming an RTO.
- Whether joining PJM could result in significant cost savings.
- Comment that PJM has requested a two-year pause on new interconnections, which could delay affected system studies triggered by projects in North Carolina.
- Comment that more solar projects in PJM could push more flow in DEP's direction, requiring fewer upgrades overall.
- Comment that the use of historical approval timelines for new and upgraded transmission ignores potential improvements to the process.
- Question regarding how the costs of transmission upgrades will be allocated among rate classes and DEC/DEP.
- Whether Duke is considering proactive transmission and distribution upgrades rather than reactive upgrades project-by-project.
- Questions regarding how the NC Transmission Planning Collaborative and Carbon Plan processes will interact. Will Duke submit a Public Policy Study scenario for its proposed Carbon Plan to the NCTPC? Could a study be completed in time to be considered before the Carbon Plan is approved in December 2022?

- Whether North Carolina's existing transmission planning processes are adequate to comply with the Carbon Plan requirements; whether a more active transmission planning process is needed.
- Duke should explore non-wires alternatives.
- Duke should begin building needed upgrades as soon as possible.

Environmental Justice and Communities

- Important to know how environmental justice, support of impacted communities, and siting decisions will be addressed.

Renewable and Carbon-Free Resources

- Should consider the purchase of Midwest wind energy to supplement solar and offshore wind resources.
- Duke's Market Potential Study is not aggressive, and Duke can achieve greater than 1% in annual EE savings; Duke should pursue higher annual energy savings.
- Whether Duke has modeled how performance-based ratemaking and decoupling might increase the potential for EE savings.
- Discussion around the cost-effectiveness of EE as avoided costs shift based on levels of renewables, prices of natural gas, consideration of non-energy benefits, etc.
- Encouraging Duke to consider: the benefit of third-party aggregators for demand response; solar hot water; heat pumps; and EVs as demand response.
- Question regarding how Duke will input potential DER values for purposes of developing a least cost plan without details of how DERs will be utilized in system planning to reduce actual costs.
- Duke should use ISOP to bolster a larger role for customer-sited DERs in a least cost plan; integrated distribution planning is key.
- Concern that Duke is relying on SMR/advanced nuclear in its modeling despite not knowing whether that technology will be available, instead of building more solar and wind sooner to make sure the carbon reduction goals are met.
- Comment that offshore wind could be available for selection before 2030.
- Question regarding whether the hydrogen is generated using carbon-free power.

Modeling and Inputs

- Whether the modeling assumptions will include natural gas forward prices at Transco Zone 5.
- Question regarding how Duke will deal with the natural gas constraints in the Carolinas on Transco Zone 5 if it doesn't build capacity out of state.
- Noting the importance of forecasting gas prices.
- Need to include imports and market purchases in the modeling in order to determine a least-cost resource mix.

- Grid improvements will be needed to support imports.
- Whether grid investments that enable DERs and were planned before HB 951 will be counted as “costs” in determining a least-cost plan, or whether they will be excluded as being pursued independent of the Carbon Plan.
- Whether Duke is considering significantly overbuilding wind and solar as a preferred option to building out storage.
- Whether Duke can model EE/DSM as a supply-side resource to incorporate load and carbon reductions for the specific load shapes and make them selectable when cost-effective.
- Customer-sited DERs should be modeled as supply-side resources.
- Should consider managed EV charging as a resource in the Carbon Plan.
- Whether Duke is including community solar in its modeling.
- Question regarding what the assumptions are for hydrogen fuel delivery costs.
- Duke should not force arbitrary limits on the construction of new CCs; should let the model show that new CC would not be least cost.
- Concern that the majority of pathways modeled by Duke are based on extending the compliance deadline past 2030.
- Whether Duke would consider ramping up rooftop solar and EE more than in its current forecast to buy time for longer-term options.

NEXT STEPS

- Information, feedback, and questions can be sent to DukeCarbonPlan@gpisd.net.
- Meeting materials will be posted on www.duke-energy.com/CarolinasCarbonPlan.

Docket No. E-100, Sub 179 **ATTACHMENT 1**

Public Staff Report
Duke Energy "Carolinas Carbon Plan"
Stakeholder Meeting 3 (March 22, 2022)
9:30 am – 4:30 pm

Participating Stakeholders

Members of the public
350 Charlotte
350 Triangle
AARP
AARP South Carolina
ABB Inc.
Advance Carolina
AES
Alder Energy Systems
Ameresco
APCO Worldwide
Apex Clean Energy
API SE Region
Appalachian Voices
Ardagh Group
Atrium Health
Audubon North Carolina
Avangrid Renewables
BAI/CIGFUR
Bailey & Dixon, LLP
Baldwin Consulting Group, LLC
Bank of America
BP
Brattle
Bright Blue Door LLC
BrightNight Power
Broad River Energy
Brooks Pierce
Carolina Utility Customers Association
Carolinas Clean Energy Business Association
CELI
Central Electric Power Cooperative, Inc.
ChargePoint
Chatham County
Chatham County Climate Change Advisory Committee
CIGFUR
Citizen's Climate Lobby
City of Asheville
City of Charlotte
City of Wilmington
Clean Energy Buyers Association

CleanAIRE NC
Clemson University
Climate Reality Project
Coastal Conservation League
Conservation Voters of South Carolina
Consultant, Energy and Environment
Continental Tires
Corning Incorporated
CRP
Cypress Creek Renewables
Dominion Energy
Draughon Farms, LLC
Duke University
Durham County Government
East Point Energy
Eckel & Vaughan
Ecoplexus Inc.
Ed Ablard Law Firm, Wilmington NC
Electric Cooperatives of South Carolina
ElectriCities of NC
Energy Savers Network
Environmental Defense Fund
EPRI
Fayetteville Public Works Commission
Fox Rothschild LLP
Gaia Herbs
GE
Geenex Solar LLC
Good Solar Organization
Google, LLC, Lenoir NC
Greensboro Earth Quakers
Guidehouse
Illuminate Power Analytics, LLC
Interfaith Creation Care of the Triangle
Invenergy
Keystone Tower Systems
Lockhart Power Company
Longroad Energy
McGuireWoods LLP
Mecklenburg County
Meridian Renewable Energy
Messer
Milliken & Company
Natural Resources Defense Council
NCUC - Public Staff
New Alpha CDC
New Belgium Brewing
New Energy Economics
North Carolina Alliance to Protect Our People and the Places We Live
North Carolina Climate Justice Collective
North Carolina Conservation Network

North Carolina Department of Commerce
North Carolina Department of Environmental Quality
North Carolina Department of Environmental Quality – Division of Air Quality
North Carolina Department of Justice - Attorney General
North Carolina Department of Transportation
North Carolina Electric Membership Cooperative
North Carolina Governor's Office
North Carolina Interfaith Power & Light
North Carolina Justice Center
North Carolina League of Conservation Voters
North Carolina Manufacturers Alliance
North Carolina Sustainable Energy Association
North Carolina Transmission Planning Collaborative
Nuclear Energy Institute
Nutrien
Orsted
PactivEvergreen
Palantir
Palladium Energy
Parker Poe
Person County ED
Pine Gate Renewables, LLC
Pitt County Board of Commissioners
PJM Interconnection LLC
Plus Power
Pterra Consulting
Renewable Energy Services
Research Triangle Cleantech Cluster
RMI
Robinson Consulting Group
Rutherford Electric Membership Corporation
RWE Renewables
Santee Cooper
Savion
Schonfeld Strategic Advisors, LLC
SEPA
Sierra Club
Soltage
South Carolina Department of Consumer Affairs
South Carolina Office of Regulatory Staff
South Carolina State Conference NAACP
Southeast Sustainability Directors Network
Southeastern Wind Coalition
Southern Alliance for Clean Energy
Southern Current LLC
Southern Environmental Law Center
Southern Renewable Energy Association
Spilman Thomas & Battle, PLLC
St Eugene Catholic Church - Care of Creation Team
Strata Clean Energy
Strategen Consulting

Sunnova
Sunrun Inc.
Synapse Energy Economics
The Glarus Group LLC
Thread Trail Enterprises
Tierra Resource Consultants
Town of Apex
Town of Cary
Town of Chapel Hill
UNC School of Law
UTILICOM
Vestas North Americas

Carolinas Carbon Plan Stakeholder Meeting 3

March 22, 2022 | 9:30am – 4:30pm ET

Agenda:

9:30am: **Introduction, Welcome, Housekeeping**

9:45am: **Duke Response to Stakeholder Desired Outcomes**

10:15am: **Break**

10:30am: **Discussion on Grid Edge and Customer Programs: Empowering Customers to Reduce Carbon Emissions**

- EE/DSM Collaborative update, demand response, IVVC/DSDR, rate design, DERs

12:00pm **Lunch Break**

1:00pm **Transmission Impacts in Carbon Plan: Overview of the methodology to develop transmission impact estimates to be used in Carbon Plan**

1:45pm **Overview of the North Carolina Transmission Planning Collaborative**

- Presenter: Rich Wodyka, NCTPC Administrator

2:30pm **Break**

2:45pm **Clean Power Suppliers Association and Brattle Group Presentation of Carbon Plan Modeling**

3:30pm **Duke Update on Modeling and Development of Potential Pathways**

4:15pm **Wrap Up, Adjourn**

Duke Energy Carolinas Carbon Plan Stakeholder Meeting 3

Virtual Meeting – March 22, 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.

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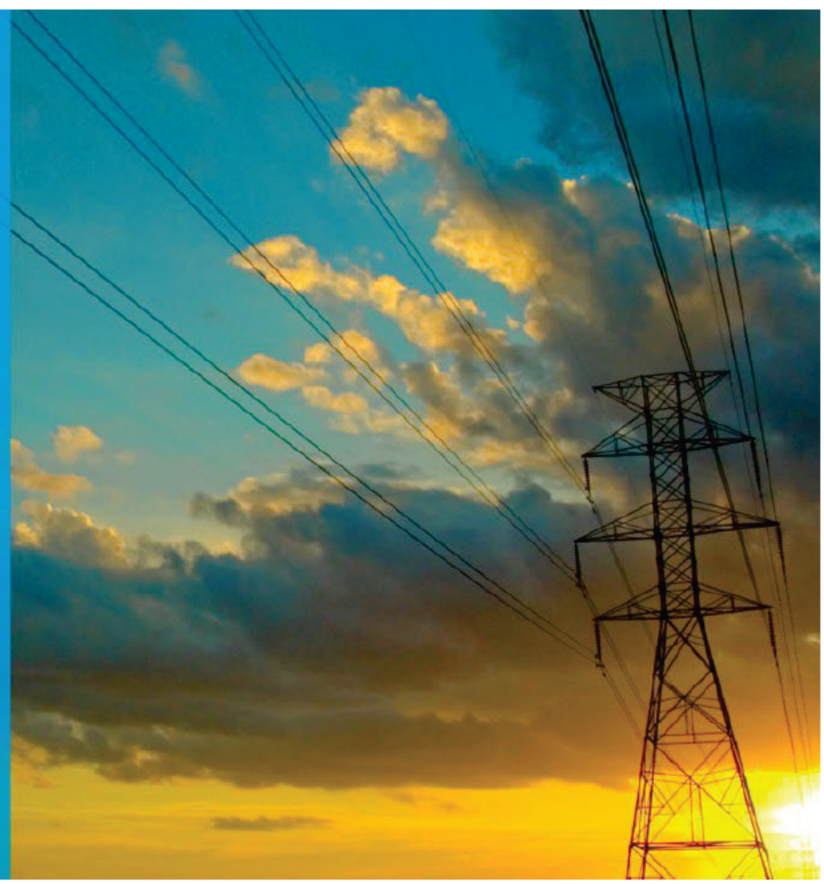

Today's Agenda

9:30am:	Introduction, Welcome, Housekeeping
9:45am:	Duke Response to Stakeholder Desired Outcomes
10:15am:	Discussion on Grid Edge and Customer Programs: Empowering Customers to Reduce Carbon Emissions
10:45am:	Break
11:00am:	Discussion on Grid Edge and Customer Programs: Empowering Customers to Reduce Carbon Emissions cont.
12:00pm:	LUNCH BREAK
1:00pm:	Transmission Impacts in Carbon Plan
1:45pm:	Overview of the North Carolina Transmission Planning Collaborative
2:30pm:	Break
2:45pm:	Clean Power Suppliers Association and Brattle Group Presentation on Carbon Plan Modeling
3:30pm:	Duke Update on Modeling and Development of Potential Pathways
4:30pm:	Wrap Up, Adjourn

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Duke Welcome

Swati Daji

Senior Vice President, Enterprise Strategy & Planning

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Meeting Ground Rules

- **<u>Respect each other</u>:** 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.

- **<u>Focus on values and outcomes</u>:** 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.

- **<u>Chatham House Rule</u>**: 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

- **<u>Respect the time</u>:** 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.

- **<u>Use the chat</u>:** 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.

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

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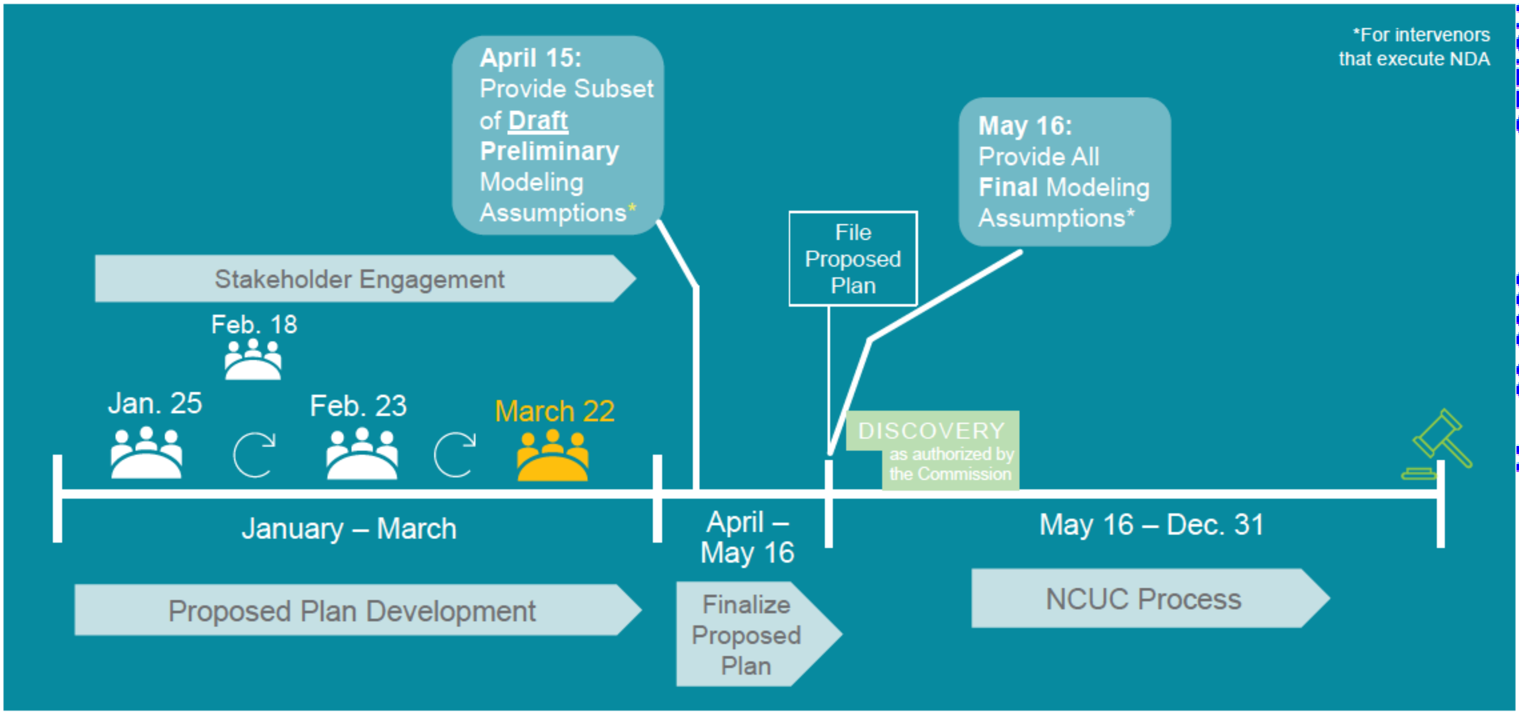
Carbon Plan Development Process



Stakeholder Desired Outcomes

Duke Energy Response

MARCH 22, 2022

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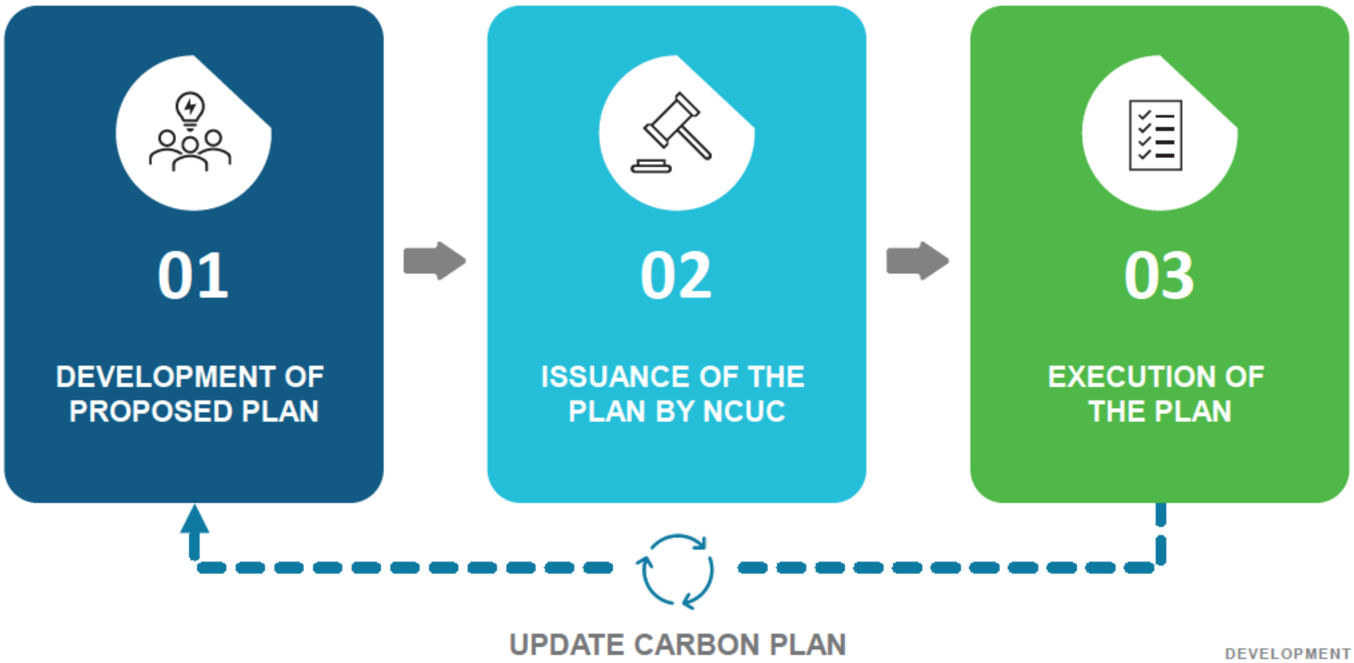
Phases of Carbon Plan Development and Execution



Stakeholder Desired Outcomes

The following desired outcomes will be addressed in the **development** of the proposed Carbon Plan:

Engagement

- Consider input from stakeholders and recognize where input changed assumptions, and what those changes were.
- Identify areas of consensus on as many issues as possible prior to filing.
- 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.

Modeling

- Consider new or expanded customer-facing programs for energy efficiency, DSM, and renewables.
- Consider a modeling approach that begins with a few alternative end states that meet the goal.

Analysis

- Maintain a long-term view towards achieving a net-zero system (keep the end goal in mind).
- Strive to achieve fair and affordable rates and total costs for all customers, including at-risk/low- and moderate-income households and communities.
- Enhance resilience and grid hardening through changes over time.

Stakeholder Desired Outcomes

The following desired outcomes will be addressed in the **development** of the proposed Carbon Plan:

Transparency

- 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.
- Transparently present metrics and principles being used to develop pathways and make modeling decisions.
- Transparently present the impacts of the plan, including costs.
- Clarify policy and regulatory interdependencies with the other components of HB 951.
- Clarify consideration of carbon costs and carbon policies in the selected scenarios.
- Clarify definition of net zero.
- Clarify the approach to siting facilities between North Carolina and South Carolina.

Stakeholder Desired Outcomes

The following desired outcomes will be addressed in the **execution** of the Carbon Plan:

Siting and Community Impacts

- Take a holistic and intentional approach to the siting of new facilities, avoiding areas already disproportionately impacted by energy generation or other industrial facilities.
- Provide support for coal plant host communities to address the economic and community impacts of plant retirements.
- Center environmental justice communities in the development of the carbon plan.

Integrate Other Efforts

- 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.

Stakeholder Desired Outcomes

The following desired outcomes are being addressed through other work streams:

Environmental Impacts Beyond CO_2

- Address all greenhouse gas emissions beyond carbon dioxide, including upstream methane leakage from natural gas being delivered to electric power plants.
- Consider life cycle assessment of all system resources, including but not limited to construction of infrastructure, etc., to get to net zero

Support Favorable Business Environment

- Support the ability of businesses and industries to operate competitively, preserve existing jobs, and/or to create new jobs.
- Consider the carbon reduction goals and plans of cities and businesses in Duke's service territories.

Grid Resilience/Hardening

- Enhance resilience and grid hardening through changes over time.

Affordability For All Customers

- Strive to achieve fair and affordable rates and total costs for all customers, including at-risk/low- and moderate-income households and communities.

Grid Edge and Customer Programs

EE/DSM Update

TIM DUFF
GENERAL MANAGER, RETAIL CUSTOMER AND REGULATORY STRATEGY

MARCH 22, 2022

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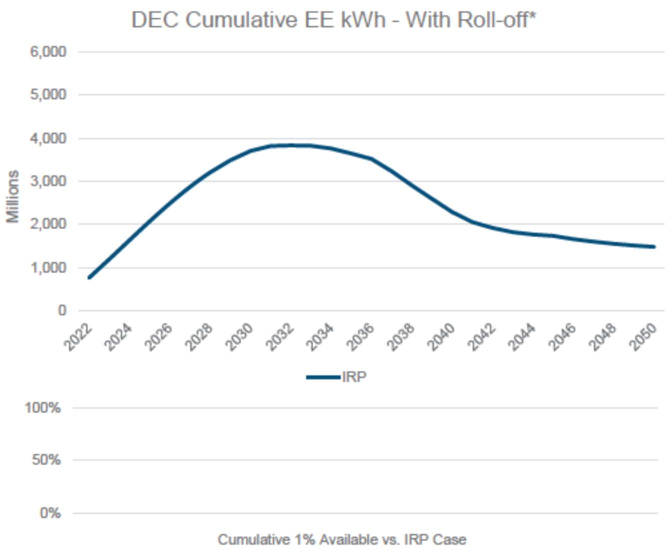
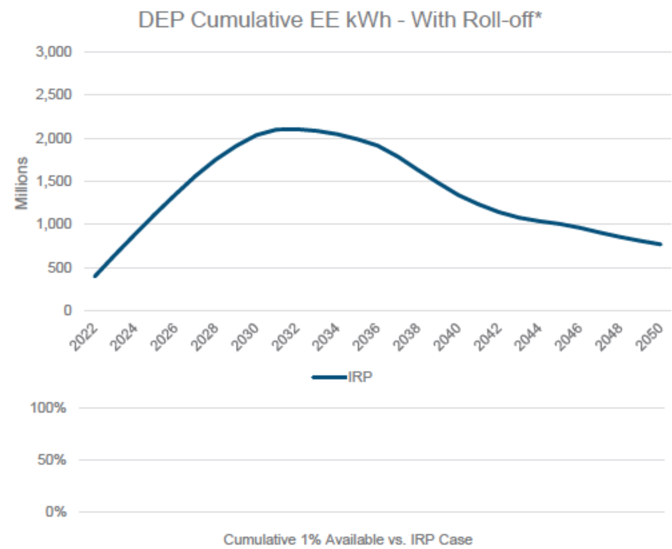
IRP Forecast – Budget + MPS blend





* Roll-off:

- Energy saving impacts no longer represented in our EE forecast as measures reach "end of life"
- Ongoing savings are accounted for in the load forecast.

Energy Efficiency Update

MARCH 22, 2022

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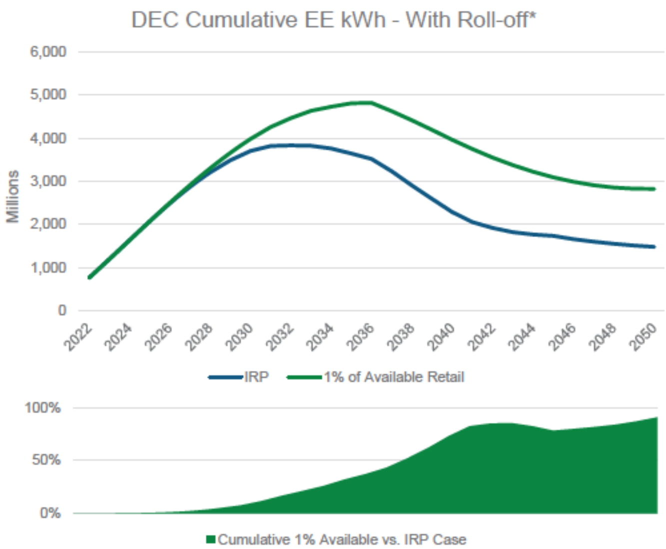
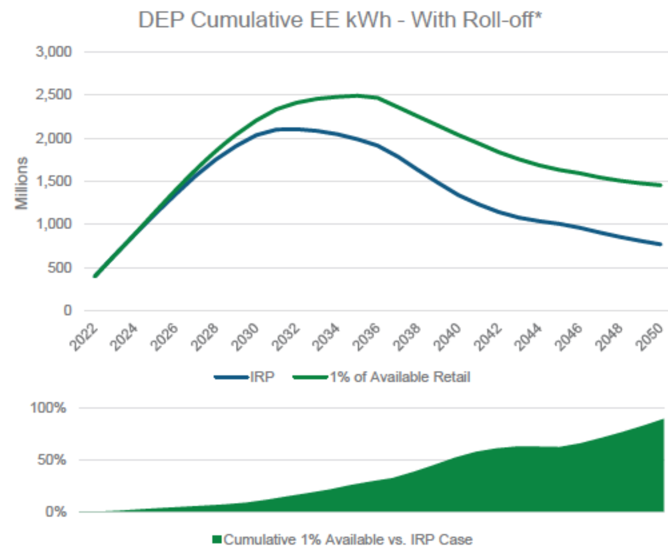
Base Forecast – 1% of Available Retail Load





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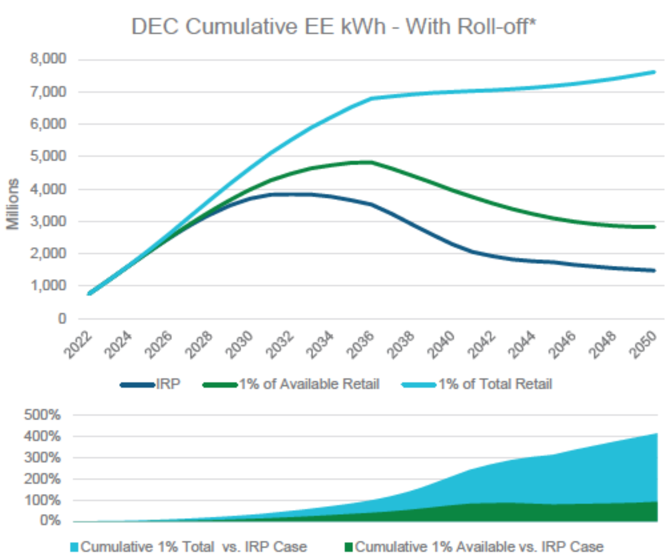
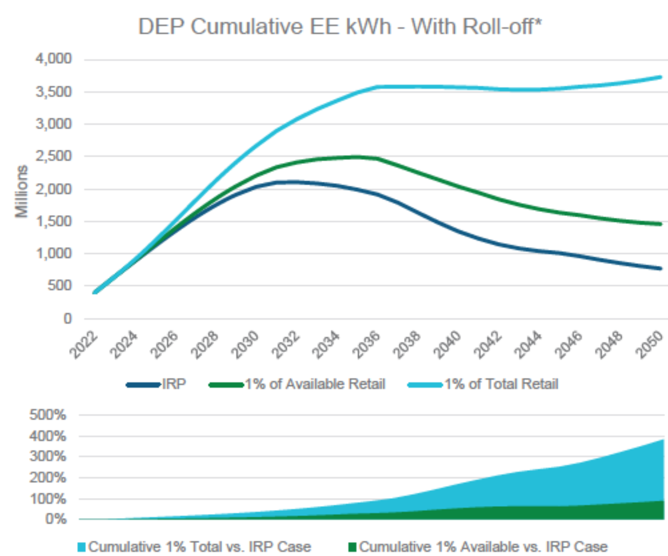
High Forecast – 1% of Total Retail Load





* Roll-off:
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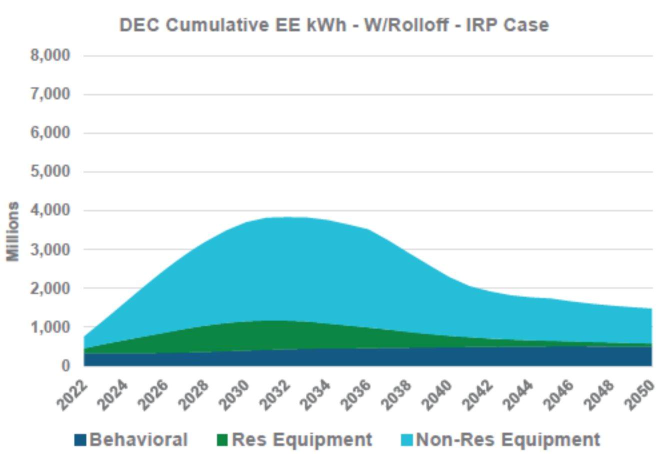
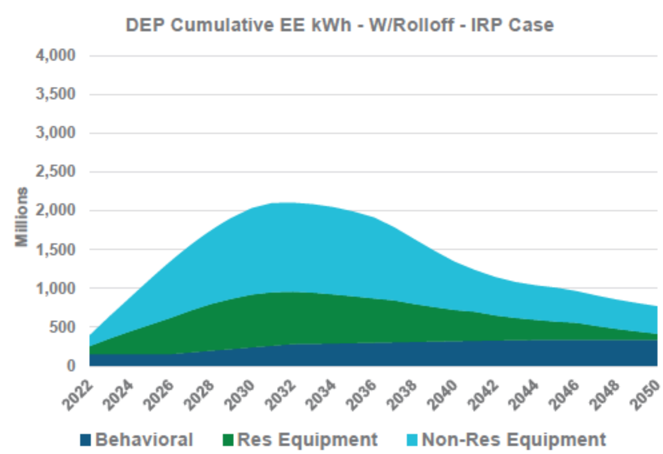
EE program Spending Comparison

Period	Percentage Cost Increase vs IRP	
	1% Eligible Sales	1% of Total Sales
2022-2030	6.7%	13.0%
2030-2050	52.6%	156.9%
2022-2050	32.7%	94.3%

IRP Forecast – Budget + MPS blend





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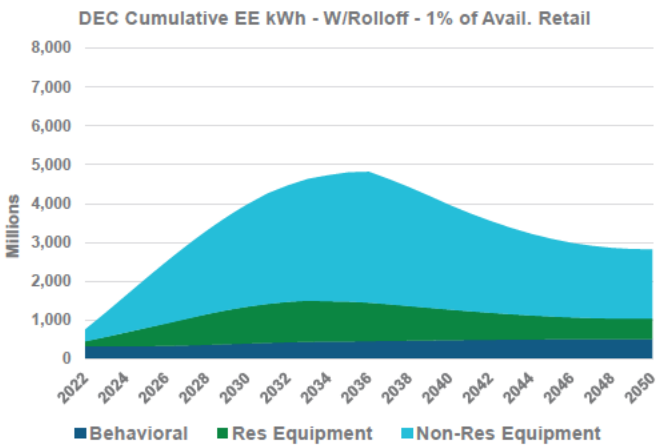
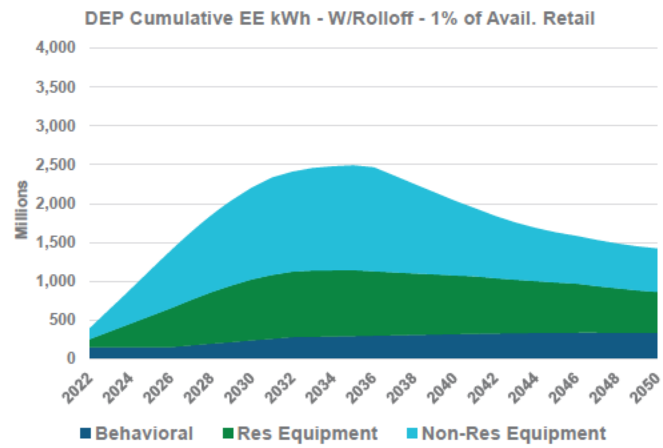
Base Forecast – 1% of Available Retail Load





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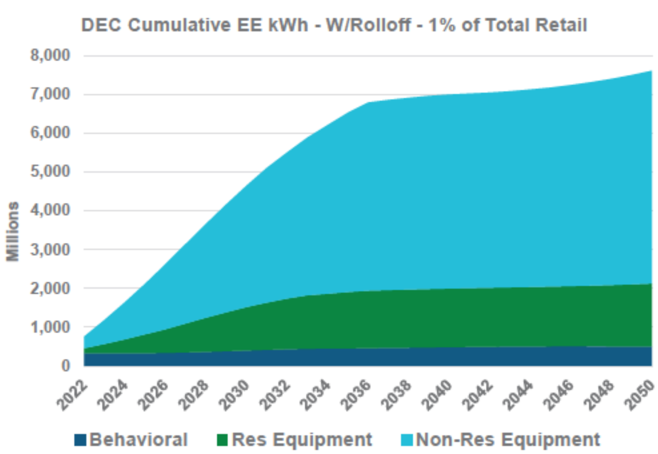
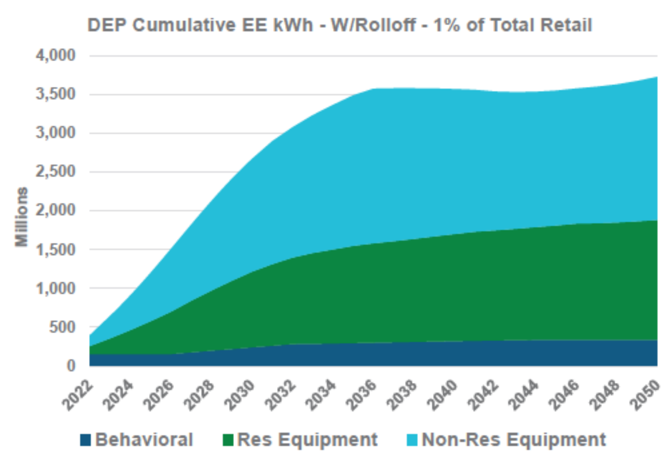
- Ongoing savings are accounted for in the load forecast.

High Forecast – 1% of Total Retail Load





* Roll-off:
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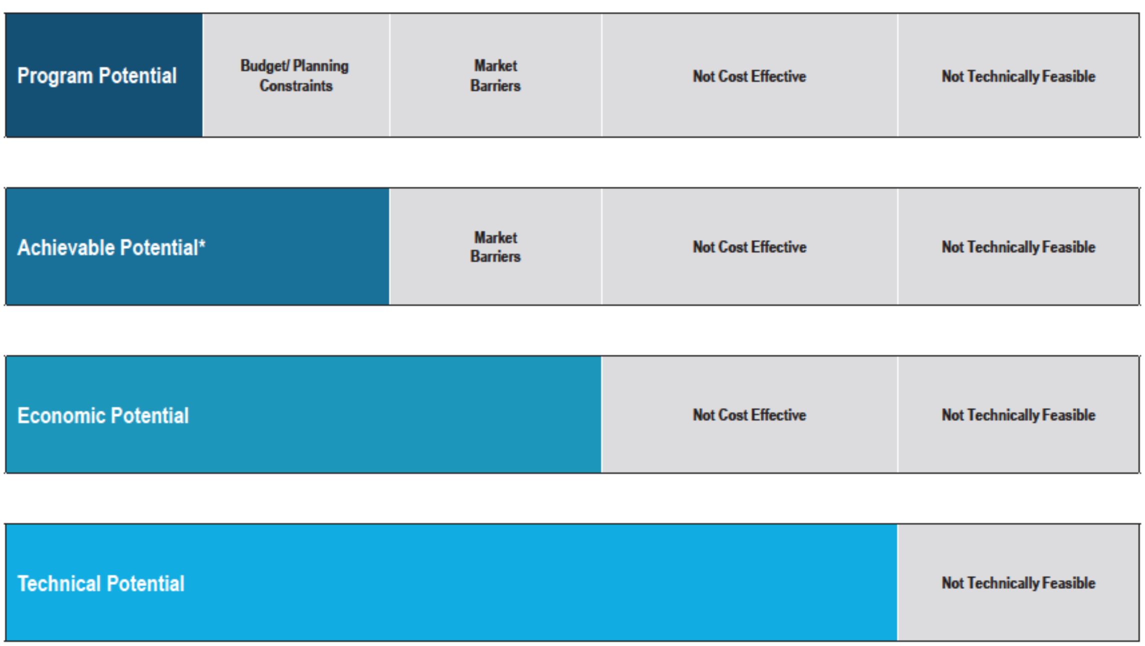
- Ongoing savings are accounted for in the load forecast.

Putting 1% of Retail Sales in Context

State	Average Residential Usage (KWH)	Average Residential Rate ($/KWH)	1% EE of Annual Retail Sales per Customer (KWH)	Equivalent Annual EE Savings Percentage for Duke Customer
Arkansas	12,720	0.126	127	0.98%
Massachusetts	7,224	0.243	72	1.73%
Oregon	10,992	0.112	110	1.14%
Colorado	8,532	0.135	85	1.46%
Iowa	10,380	0.116	104	1.20%
Vermont	6,804	0.196	68	1.84%
Illinois	8,652	0.135	87	1.44%
Duke Energy (NC & SC)	12,494	0.110	125	1.00%
California	6,864	0.232	69	1.82%
Rhode Island	7,128	0.251	71	1.75%
Minnesota	9,300	0.128	93	1.34%

Moving Beyond the Carolinas' Base EE/DSM Forecast



Program additions and modifications to optimize existing program portfolio impacts

Structural modifications and mechanisms that remove market barriers to program participation

Modifications that will enhance the cost effectiveness of new programs and enable program modifications

Modifications that will expand the number of potential measures and offers reducing consumption from the grid

Potential Enablers for Delivering More EE/DSM in the Carolinas

Structural modifications and mechanisms that remove market barriers to program participation	
On-Tariff Financing	Establishing an on-tariff financing program and the necessary recovery mechanism consistent with HB951 to reduce upfront capital costs and credit barriers to undertaking energy efficiency
Marketing enhancements	AMI and other customer data allows better target marketing of programs to customer with high energy savings potential from specific measures
Modifications enhancing the cost effectiveness of new programs and enabling program changes	
Recognition of the value of carbon	A financial value recognizing the value of avoided carbon emissions from energy efficiency programs in cost effectiveness evaluation (UCT).
As Found Energy Savings Recognition	Currently energy savings only recognize savings versus a device's efficiency standard despite the fact true carbon reduction is the energy reduction versus the actual device replace
Recognition of localized customer programs values	Identify overloaded circuits/substations and target localized customer programs to offset specific required high T&D spend
Modifications expanding the potential measures and offers reducing consumption from the grid	
Utility Codes and Standards Program	Currently advancement of building codes and appliance standards reduces potential savings. Creating opportunity for attribution associated with code advancement and compliance
Customer owned assets that reduce grid consumption	Opportunity to incentivize customers to adopt assets like rooftop solar that reduce energy consumption and carbon emissions from the utility grid.not currently shown as potential
Development of energy efficiency programs for new electrification loads	Currently electrification adds load to the forecast, but little to no energy efficiency opportunities associated with load that actually reduces non-utility carbon emissions
Modifications to Non-Residential Customer Opt Out	Currently energy and carbon savings associated with efficiency potential for industrial and customers using over 1,000,000 KWH not able to be achieved through utility programs
Expand EE Programs to wholesale customers	Opportunity to expand potential EE savings and carbon savings to include potential from customers that take generation from the Duke Carolinas' system.

Grid Edge and Customer Programs

Demand Response

STACY PHILLIPS
DIRECTOR, DEMAND SIDE MANAGEMENT

MARCH 22, 2022

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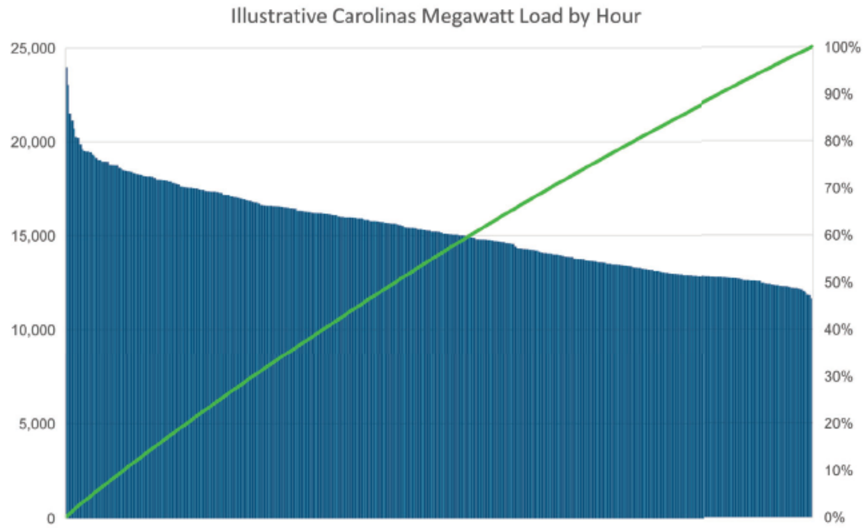
Demand Response Overview

Virtual Peaker Plant

- Duke compensates customers for the ability to curtail their usage during times of extreme load or temperatures.
- Load shed capability is included in IRP planning.

Everyone Wins

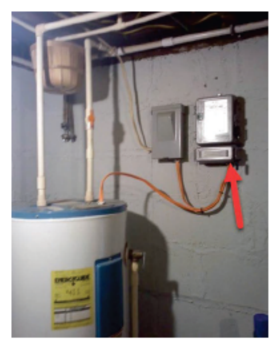
- Utility does not build a little used plant, mitigating rate increases
- Customers earn bill credits
- Improves reliability



Carolinas Demand Response Portfolio

Duke Energy Carolinas

		Summer – 897 MW	Winter – 412 MW
Res	Power Manager Switch	419 MW	0 MW
Res	Bring Your Own Thermostat	41 MW	9 MW
Non - Residential	PowerShare	363 MW	318 MW
Non - Residential	Interruptible Service	61 MW	81 MW
Non - Residential	EnergyWise Business	11 MW	2 MW
Non - Residential	Standby Generation	2 MW	2 MW



Duke Energy Progress

		Summer – 707 MW	Winter – 276 MW
Res	Power Manager Switch	406 MW	14 MW
Res	Bring Your Own Thermostat	20 MW	8 MW
Non - Residential	Demand Response Automation	35 MW	22 MW
Non - Residential	Large Load Curtailable	242 MW	232 MW
Non - Residential	EnergyWise Business	4 MW	0.2 MW

Almost 500,000 residential customers participate across the Carolinas.

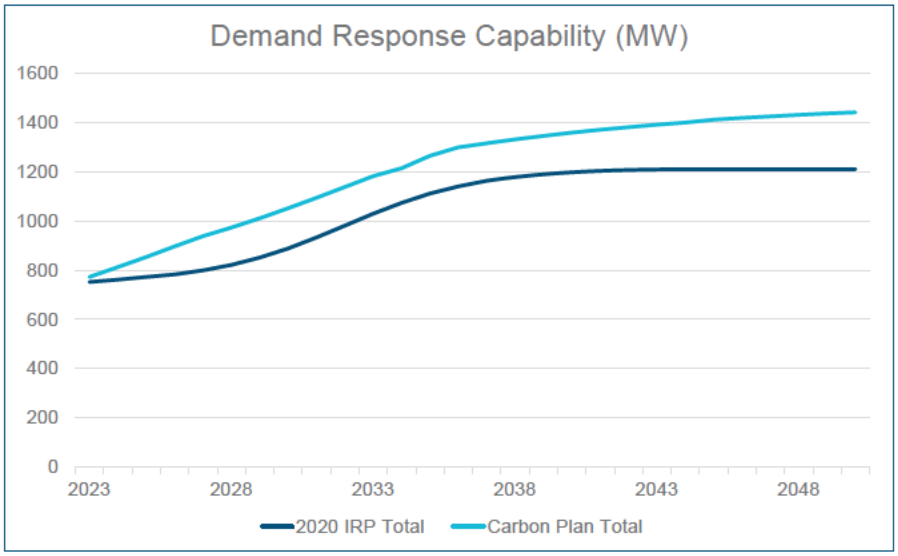
Winter Capability Growth

Virtual Peaker Plant

- Currently modeling approximately 1050 MW of winter capability in 2030.
- 18% increase over the previous IRP
- Minimal winter capability before 2021

Initiatives

- Focusing on residential heat load, growing Bring Your Own Thermostat
- Small / Medium Business program enhancements
- Auto DR capability
- Programs outside of the Winter Peak Study



Demand Response Industry Evolution

DR 1.0 Demand Response

- Largely manual control
- One way paging, can't confirm load shed
- Commercial / industrial interruptible tariffs
- Used for capacity and planning

1970's – 2000's

DR 2.0 Auto Demand Response

- Smart thermostats
- Increased automation and precision
- Two way communications with devices – aware of device status
- Near real-time visibility

2000's – 2010's

DR 3.0 Demand Flexibility

- DR is just one of many DERs used to manage the grid
- Rate enabled devices and appliances
- Provide multiple grid / ancillary services
- Building controls to continuously optimize load
- Distribution and transmission investment deferral or avoidance

2020's & Beyond

Duke Energy Demand Response Plans

You May Know DR For…	In the Future We Will Also Be…
Peak Shaving and Emergencies	Load Shaping and Economic Shaving
System Level	Distribution Level
Generation Avoidance	T&D Investment Avoidance / Deferral
Occasional Usage	Frequent Usage
Summer Afternoons	Winter Mornings, Afternoons Year Round

Key Enablers

Low Friction Measures

- Customers are more willing to participate in programs that they don't notice in operation
- Examples include smart home device adoption, especially thermostats, water heaters, storage, energy management systems

Building Codes

- Requiring Demand Response ready water heaters and other appliances when commercially available
- Examples include wi-Fi enabled water heaters, smart panels, smart inverters

Pathway for Greater Non-Residential Participation

- The cost of the Demand Response rider is only offset by full load program participation. More customers may participate with smaller, less critical loads.

Greater System Value

- With lower friction measures, the system can be used more, creating more system value and increased customer incentives
- Changes to inputs used in valuing Demand Response in cost effectiveness tests

New Summer Thermostat Use Cases

- When viewed as a Flexible Demand Management, instead of emergency capability, thermostats can help balance intermittent renewable generation
- NCUC approval for the need to acquire customers for summer capability
- May help avoid transmission or distribution investment as many circuits are still summer peaking.

Break

Please return at 11:05AM.

Questions?

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Grid Edge and Customer Programs

Integrated Volt Var Control (IVVC)

Distribution System Demand Response (DSDR)

JAY OLIVER
MANAGING DIRECTOR, GRID SYSTEMS INTEGRATION

MARCH 22, 2022

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INTEGRATED VOLT VAR CONTROL (IVVC)

- Distribution System Demand Response (**DSDR**) supports peak shaving and MW (demand) reduction
- Conservation Voltage Reduction (**CVR**) supports energy (MWH) reduction on a year-round basis

<table>
<tr><th></th><th>DSDR to CVR [DEP]</th><th>CVR [DEC]</th></tr>
<tr><td>Objective:</td><td>Move DEP from a predominant DSDR (peak shaving) operational strategy to a CVR operational strategy, targeting an estimated 2% voltage reduction.</td><td>Deploy an IVVC program in DEC that would primarily operate in CVR year-round, targeting an estimated 2% voltage reduction.</td></tr>
<tr><td>Scope:</td><td>• Scale up over 2-3 years
• Enable all eligible circuits by 2025
• Run CVR ~ 90% of the time 2025 and beyond
• Operate DSDR less than 10% of the time</td><td><table>
<tr><th colspan="2">Phase 1</th></tr>
<tr><td>% Eligible Circuits</td><td>72%</td></tr>
<tr><td>Approx. % of base load</td><td>70%</td></tr>
<tr><td>Year Enabled</td><td>2025</td></tr>
<tr><th colspan="2">Phase 2</th></tr>
<tr><td>% Eligible Circuits</td><td>17%</td></tr>
<tr><td>Approx. % of base load</td><td>10%</td></tr>
<tr><td>Year Enabled</td><td>TBD</td></tr>
<tr><td>TOTAL % Eligible circuits</td><td>89%</td></tr>
<tr><td>TOTAL % of base load</td><td>80%</td></tr>
</table></td></tr>
<tr><td rowspan="2">Benefits:</td><td>• Reduce load by approx. 1.4% on enabled circuits
• $119M avoided generation fuel costs
• Approximately 186,000 Tons of CO_2 benefit
• Benefits to Cost Ratio (BCR): 23.9</td><td>• Reduce load by approx. 1.4% on enabled circuits
• $369M avoided generation fuel costs
• Approximately 548,000 Tons of CO_2 benefit
• Benefits to Cost Ratio (BCR): 1.2</td></tr>
<tr><td colspan="2">• Less peak load on the grid reduces the need to build additional peaking generation
• Fuel savings passed directly to customers
• Optimized control of Volt/VAR devices improves the grid's ability to respond to intermittency
• Enable integration of distributed energy resources (i.e.- rooftop solar) and electric vehicles (ev)</td></tr>
</table>

Grid Edge and Customer Programs

Rate Design Opportunities & Distributed Energy Technologies

LELAND SNOOK
MANAGING DIRECTOR, RATE DESIGN AND REGULATORY SOLUTIONS

MARCH 22, 2022

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Rate Design Opportunities

Time of Use and Dynamic Pricing

Intersection with Demand Response

System Beneficial Electrification

Rate Design – More Options and Control

Dynamic & TOU Pricing

- Time periods based on system dynamics
- Critical peak prices or response rewards
- Shift use to lower cost times if possible
- Enable distributed energy technologies (DETs)
- Optional subscription management of DETs

Hourly Pricing

- Should drive price responsive behavior
- New structures needed to enable more broad and diverse participation
- Can apply to existing load if price responsive

Intersection with Demand Response

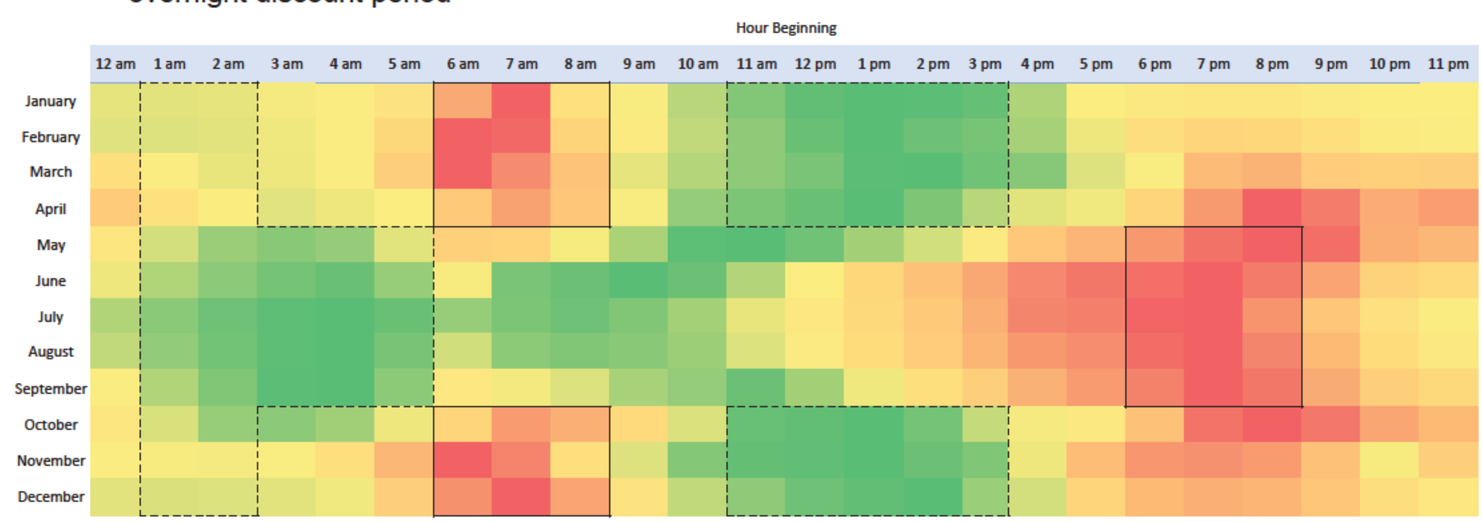
- Behavioral demand response
- Peak time rebates (PTR)
- Optional subscription management
- Bring your own battery (BYOB)
- Smart device control

System Beneficial Electrification

- Customer adoption of Electric Vehicles
- System benefits unlocked with TOU/dynamic pricing and smart device bundles
- On tariff financing
- Vehicle to home or grid (future state)

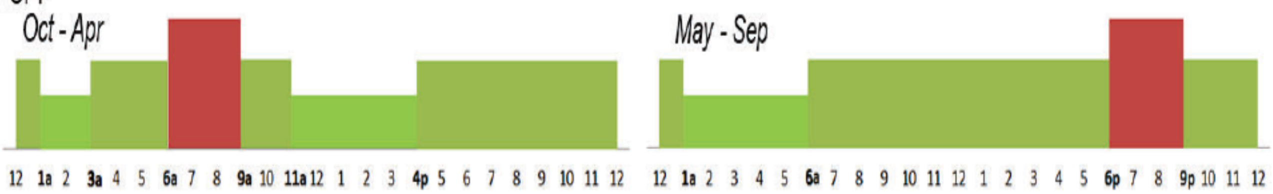
System Driven Time of Use Periods – Cost Duration Model 2030

- Summer peak aligns with proposed peak period beyond 2025
- Mid-day costs in winter continue to drop in later years due to solar, but costs remain low for overnight discount period



System Driven Time of Use Periods

R-TOU-CPP
SGS-TOU-CPP



- On-Peak 6-9 am in Winter, 6-9 pm in Summer
- Discount periods 1-3 am and 11 am – 4 pm in Winter and 1-6 am in Summer

Distributed Energy Technologies (DETs)

Distributed Solar

- Solar Choice– TOU CPP rate (future state)
- TOU monthly netting for energy export (future state)
- Smart Saver Solar EE Program (future state)

Storage Technology

- Batteries
- Bring your own battery (BYOB)
- Subscription with battery management

Smart Thermostats

- Residential load management through TOU & CPP
- Bring your own thermostat (BYOT)
- Subscription with T-stat management

Electric Vehicles

- Beneficial Charging
- Vehicle to Home
- Vehicle to Grid
- Fleet Electrification
- Hourly Pricing for flexible loads

What is a Regulatory Sandbox?

- Creating space for innovation
- A concept developed to address regulatory uncertainty
- Innovation requires testing new potentially unproven concepts and technologies
- Sandbox concept provides leeway from normal regulations and requirements for a limited period of time
- Allows new products and services to be rolled out in a limited environment to gain clarity

QUESTIONS?

Lunch Break

Please return at 1:00PM.

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Carbon Plan Transmission Cost Estimates

SAMMY ROBERTS
GENERAL MANAGER, TRANSMISSION PLANNING AND OPERATIONS

MARCH 22, 2022

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Transmission Cost Estimates in Carbon Plan

INTENT → Estimate transmission costs of various pathways/portfolio.

Similar to Integrated Resource Planning, transmission costs in the Carbon Plan **serve as a proxy** for actual costs that will be developed during the execution phase.

Development of Carbon Plan

Specific location of new generation are **unknown**

Transmission costs are **estimated**

Execution of Carbon Plan

Specific location of new generation are **known**

Actual transmission costs developed

Carbon Plan Associated Transmission Considerations

- Factors Impacting Transmission Needs and Cost Determinants
  - Generation Size
  - Location
    - For example:
      - Constrained vs. unconstrained area
      - Greenfield site vs. Brownfield site
    - At best, we know mere generalities about some resource types (i.e., Offshore wind or PJM Capacity Purchase)
  - Sequence of Resource Interconnection
  - Generating Resource Retirements
  - Load projection
  - Long-term Transmission Planning Considerations

NCUC 2020 IRP Order

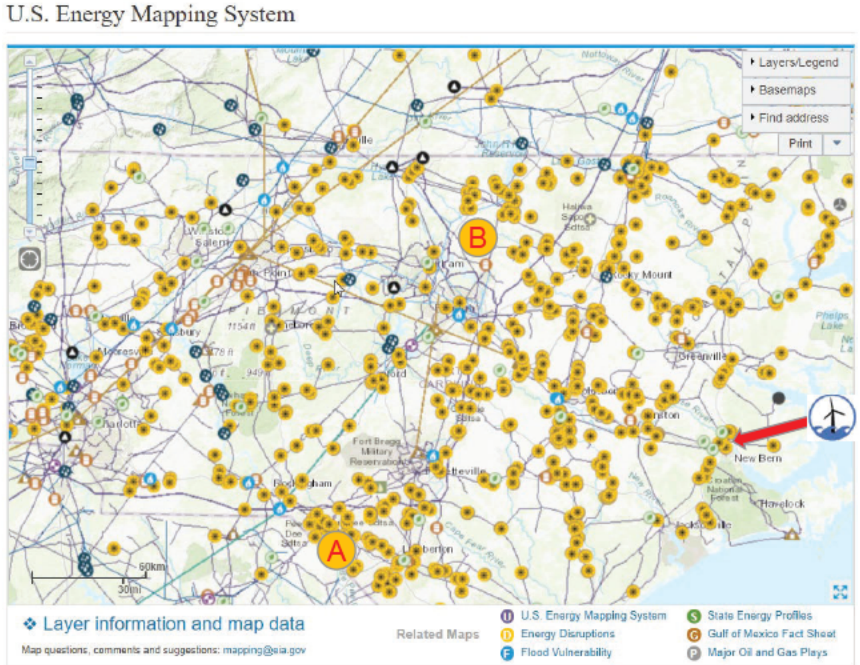
The Commission concludes that in developing their Carbon Plan for 2022 and for future IRPs DEC and DEP should:

1. Continue to follow the directive contained in the Commission's August 27, 2019, Order in Docket No. E-100 sub 157 that the IRPs contain an analysis of anticipated or likely grid impacts associated with each alternative resource portfolio modeled in the IRPs and continue to refine transmission network upgrade cost estimates for incremental resources to take into account the most recent system impact study results;
2. Determine the feasibility of providing a timeline for necessary critical transmission network upgrades required to enable interconnection of incremental resources identified in each alternative resource portfolio modeled in the IRPs;
3. Incorporate the results of the North Carolina Transmission Planning Cooperative (NCTPC) offshore wind study results and associated cost estimates;
4. Incorporate applicable results from the 2021 NCTPC Future Resource Scenario Study, as was referred to and discussed at the Second Technical Conference;
5. Refine import capability studies specifically for capacity purchase from PJM; and
6. Continue to assess costs, risks, and reliability aspects of potential off-system purchases.

Examples of Why Size, Location, and Sequence Matter

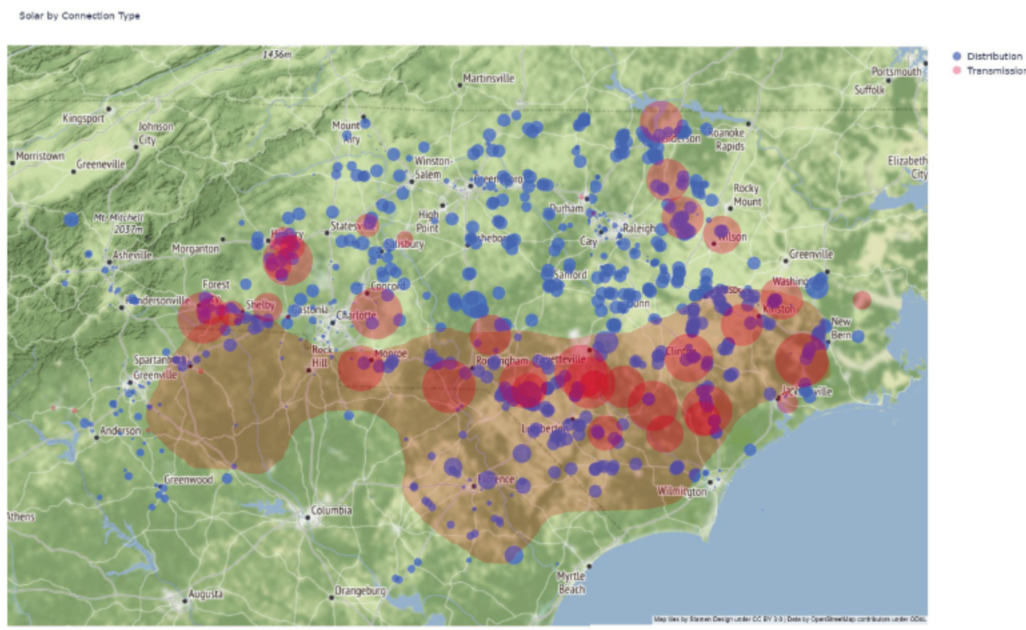
- **Location** - for interconnecting a 200 MW solar facility
  - A – several significant network upgrades needed
  - B – small network upgrades needed
- **Size** - for injecting offshore wind into New Bern
  - 800 MW – likely no new 500kV line network upgrade needed
  - 1600 MW – a new 500kV line network upgrade is needed and additional 230kV line upgrades needed
- **Sequence** – likely to interconnect significant amounts of solar prior to any offshore wind

U.S. Energy Mapping System



Current and Future Carolinas Solar

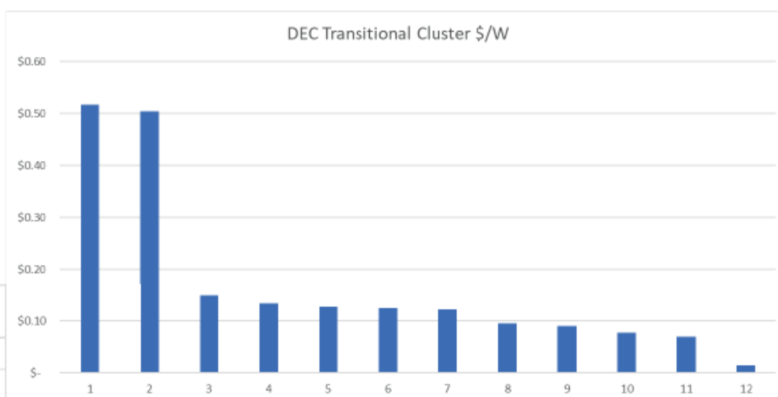
- Map represents over 4.5GW of connected solar (>20kW)
  - Red – Transmission
  - Blue - Distribution
- Does not reflect 270MW additional solar connected to Wholesale within DEC and DEP
- Shaded region provides an example of solar-preferred siting based on past queue information, land availability and lease prices

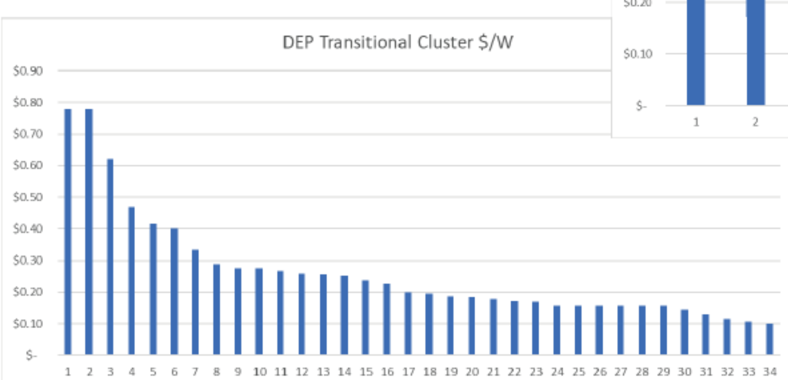


Network Upgrade Cost Estimates

Example for Solar (DEC/DEP average)

Reference	$/W
2020 IRP	0.1672
2021 SC Modified IRP	0.1913
2022 Carbon Plan	0.2110





Offshore Wind Transmission Considerations

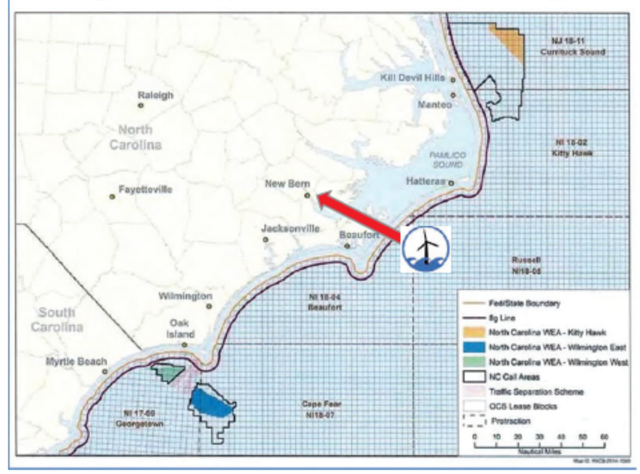
2020 NCTPC Offshore Wind Study Report

- New Bern would be one of the better sites to inject up to 3.2 GW of offshore wind.
- A formal generation interconnection study will be needed to assess the upgrades and estimated cost to interconnect offshore wind.

Schedule for Transmission

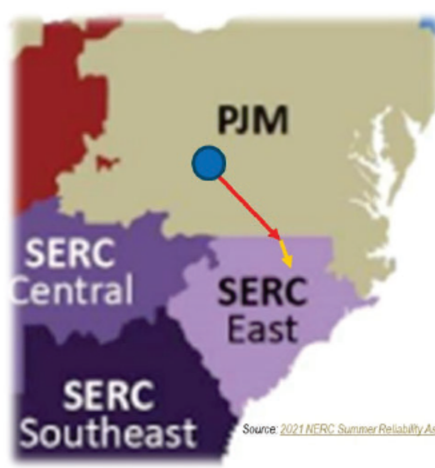
- Leverage existing ROW as much as possible
- New ROW, Public Engagement, Scoping, Routing, Permitting, CPCN processes, Construction
  - 800MW – estimated 7 to 8 years
  - 1600MW – 2400MW - estimated 9 to 11 years

NC Wind Energy Areas (WEAS) (Developed in Joint Venture by Duke Energy and NREL)



PJM Capacity Purchase Transmission Considerations

- Cost of Transmission Reservation for Firm Capacity Purchase – PJM Border Rate is currently $67,625/ MW-yr and has increased 21.5% since 2020.
  - A transmission reservation for a 1500 MW purchase from PJM would cost $100M/yr
- For example: 300MW PJM Transmission Service Reservation request was submitted by DEC in 2019.
  - Allocated $411M in upgrade costs
  - 84 months estimate to get upgrades in-service
- Duke Energy's Assessment
  - Reveals significant upgrades needed – schedule and cost concerns
  - Concerned with potential impacts from PJM Queue Reform
- Validation of cost and schedule through TSR request



Source: 2021 NERC Summer Reliability Assessment

Risk Assessment for Off-system Purchases

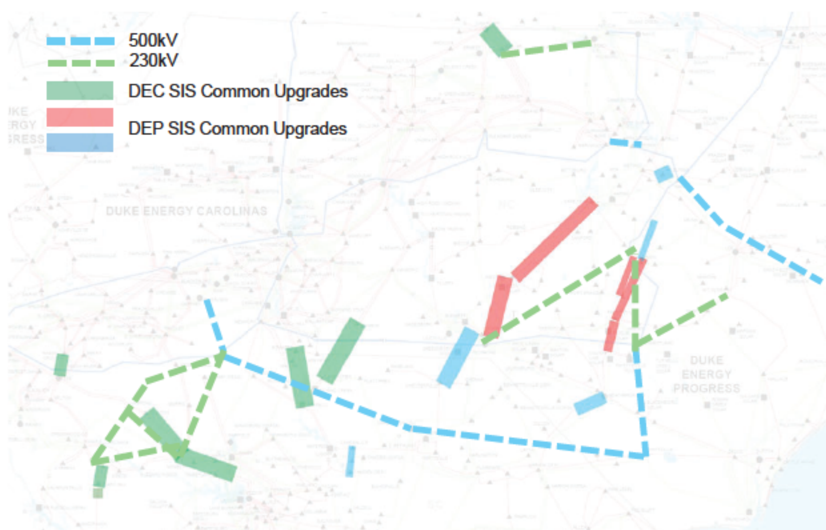
System risks with relying on significant off-system capacity purchases for Carbon Plan resource needs include, but are not limited to:

- **Delay in resource availability** – delays in transmission network upgrades on the DEC/DEP transmission systems or neighboring transmission systems due to sitting, permitting, or construction issues
- **Impact on system ancillary needs** – Voltage/Reactive Support, Inertia/Frequency Response, AGC/Regulation for balancing renewable output
- **Vulnerability to neighboring system congestion issues** – TLR curtailment due to transmission constraints in neighboring areas
- **Transmission system stability** – stability concerns due to added distance between the capacity resource and load.

Long-term Transmission Expansion Planning - Example

Moving toward net-zero (2050)

- Hypothetical example of significant greenfield transmission (represented by the dashed lines) that will be needed as we go beyond 2030 toward net zero CO2 emissions
- Most likely over $7B of greenfield and SIS identified common upgrades transmission represented on the map needed for interconnecting Carbon Plan resources
- Greenfield transmission project schedules are up to 10 – 15 years



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North Carolina Transmission Planning Collaborative

Carbon Plan Meeting
March 22, 2022

NCTPC Process Overview
Rich Wodyka

Prior to Establishment of NCTPC

- Transmission plans were developed independently by each IOU for their own control areas
- Limited involvement from municipally owned electric utilities, electric cooperatives, and other transmission-dependent utilities
- Emphasis on reliability

Fundamental Purpose of the NCTPC

- Improve and continue to improve transmission planning in North Carolina in collaborative process with increased involvement by all stakeholders
- The NCTPC is the local transmission planning process included in the Duke OATT that covers the DEC and DEP transmission systems

NCTPC Participation Agreement

Agreement executed on May 20, 2005 by:

- **Duke Power**
- **Progress Energy**
- **ElectriCities of NC – representing municipally owned electric utilities**
- **North Carolina Electric Membership Corporation (NCEMC) – representing NC electric cooperatives**

NCTPC Goals

- **Provide Participants and other stakeholders the opportunity to participate in the NC Transmission Planning Collaborative (NCTPC) process**
- **Preserve integrity of the current reliability and least cost planning process**
- **Provide analysis of increased access to resources inside and outside Progress and Duke control areas**
- **Develop a single Collaborative Transmission Plan that includes reliability and local enhanced access solutions while appropriately balancing costs, benefits and risks**

NCTPC Organizational Structure

- **Oversight / Steering Committee (OSC)**
  - Reviews and approves the Reliability and Local Economic Planning criteria, critical assumptions and scenarios to be used by the PWG
  - Oversee the study process and approves the final Coordinated Transmission Plan
- **Planning Working Group (PWG)**
  - Provides expertise in model development, running the transmission models, problem identification, solution development and overall plan development
  - Performs study analysis and reports results to the OSC
- **Transmission Advisory Group (TAG)**
  - Provides advice and recommendations to the OSC which will aid in the development of a Coordinated Transmission Plan
  - Membership open to all stakeholders
- **Independent Third Party (ITP)**
  - Independent advisor to the OSC and PWG and will vote to break a tie in the OSC
  - Facilitates the TAG activities and advises on the entire NCTPC process

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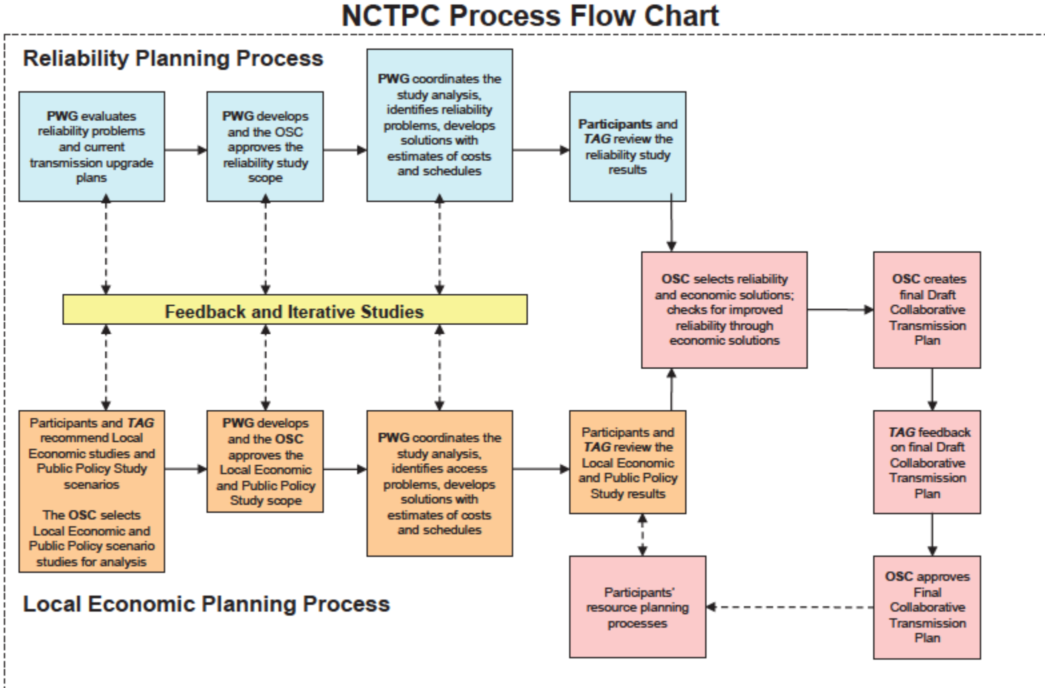
NCTPC Process Flow Chart



Annual Local Economic and Public Policy Study Requests

- Participants and TAG can propose local economic hypothetical scenarios to be studied
- Requests can include in, out and through transmission service
- Participants and TAG can propose study scenarios related to public policies that are driving the need for local transmission
- TAG request is distributed annually in January

Annual Study Scope of Work

- **Reliability Planning Process**
  - Analyze forecasted transmission system conditions out in the next 5 and 10 years
  - Identify transmission problems and develop solutions
- **Local Economic Study Process**
  - TAG, as well as Participants, provide input on proposed Local Economic Study scenarios and interfaces for study
  - TAG, as well as Participants, provide input in identifying any public policies that are driving the need for local transmission
- **Development of Annual Study Scope**
  - PWG prepares a proposed annual study scope of work for both the Reliability and Local Economic Study Process
  - TAG has an opportunity to review and comment on the proposed study scope of work
  - OSC approves the final Annual Study Scope of Work

Past and Current Local Economic Study Scenarios

- Hypothetical Imports/Exports re-evaluated every other year (last performed in 2019)
  - 1000 MW transfers
- Hypothetical NC Generation
  - Fossil Fuel
  - Wind Energy – On-shore and Off-shore
    NCTPC only and NCTPC-PJM Joint Study
- Retirement of Coal Units
- 2022 - 4 Requests being considered

Past and Current Public Policy Study Scenarios

- 2020 - Study of Possible Offshore Wind Interconnection Points
- 2021 - High Renewables Study (1 scenario)
  - Preliminary results March 28th TAG meeting
- 2022 - 2 Requests being considered

NCTPC Overview Schedule

Reliability Planning Process

- Evaluate current reliability problems and transmission upgrade plans
- Perform analysis, identify problems, and develop solutions
- Review Reliability Study Results

Local Economic Planning Process

- Propose and select Local Economic Studies and Public Policy Study scenarios
- Perform analysis, identify problems, and develop solutions
- Review Local Economic Study and Public Policy Results

Coordinated Plan Development

- Combine Reliability and Local Economic Study and Public Policy Results
- OSC publishes DRAFT Plan
- TAG review and comment
- OSC publishes FINAL Plan

TAG Meetings

1st Quarter | 2nd Quarter | 3rd Quarter | 4th Quarter

NCTPC Study Process Overview

1. Assumptions Selected
2. Study Criteria Established
3. Study Methodologies Selected
4. Models and Cases Developed
5. Technical Analysis Performed
6. Problems Identified and Solutions Developed
7. Collaborative Plan Projects Selected
8. Study Report Prepared

Study Assumptions Selected

- Study Year's for Reliability analyses:
  - Near-term: 5 years from current year
    - Analyze both summer and winter cases
  - Longer-term: 10 years from current year
    - Alternately analyzed summer and winter cases
- Study Year's Local Economic Study analyses:
  - Longer-term: 10 years from current year
    - Use same cases as Reliability analysis
- LSEs provide:
  - Input for load forecasts and resource supply assumptions
  - Dispatch order for their resources
- Adjustments may be made based on additional coordination with neighboring systems

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Study Criteria Established

- NERC Reliability Standards
  - Current standards for base study screening
  - Current SERC and NERC Requirements
- Individual company transmission criteria

Study Methodologies Selected

- Thermal Power Flow Analysis
- Each system (DEC and DEP) will be tested for impact of other system's contingencies

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Models and Cases Developed

- Start with latest series of NERC MMWG cases
- Latest updates to detailed models for DEC and DEP systems will be included
- Planned transmission additions from latest updated Transmission Plan included in models

Technical Analysis

- Conduct thermal screenings and analysis of the cases based on approved study criteria and methodologies

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Problems Identified and Solutions Developed

- Identify limitations and develop potential alternative solutions for further testing and evaluation
- Estimate project costs and schedule

Collaborative Plan Projects Selected

- Compare all alternatives and select preferred transmission solutions

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Transmission Plan Report Prepared, Reviewed & Published

- Prepare Draft report and distribute to TAG for review and comment
- TAG provided OSC feedback on Draft report
- OSC incorporates any TAG feedback received, if applicable
- OSC publishes Final Collaborative Transmission Plan Report

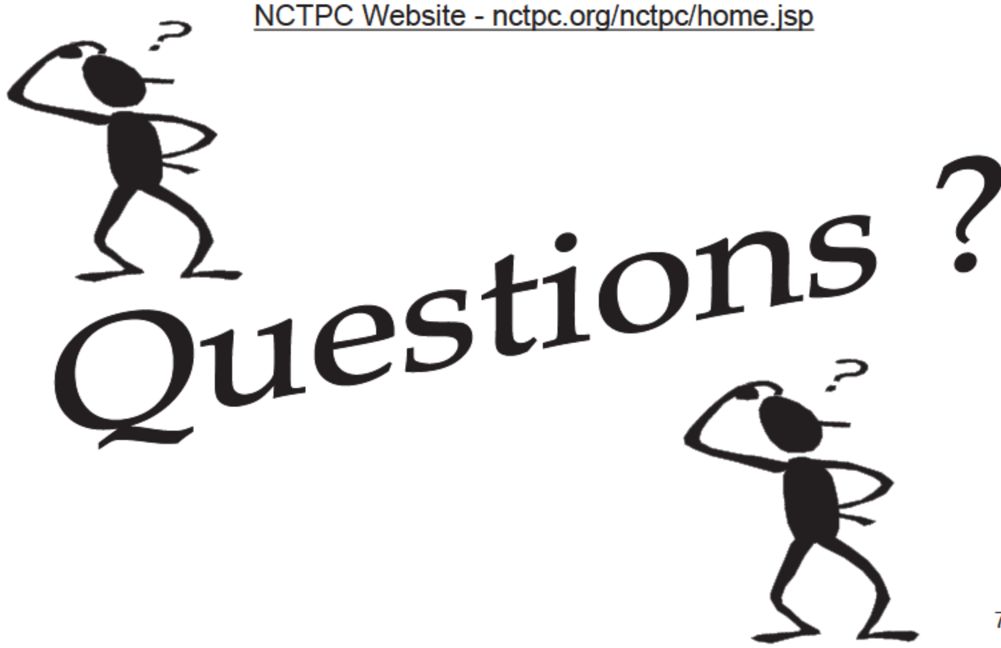
NCTPC Process Results

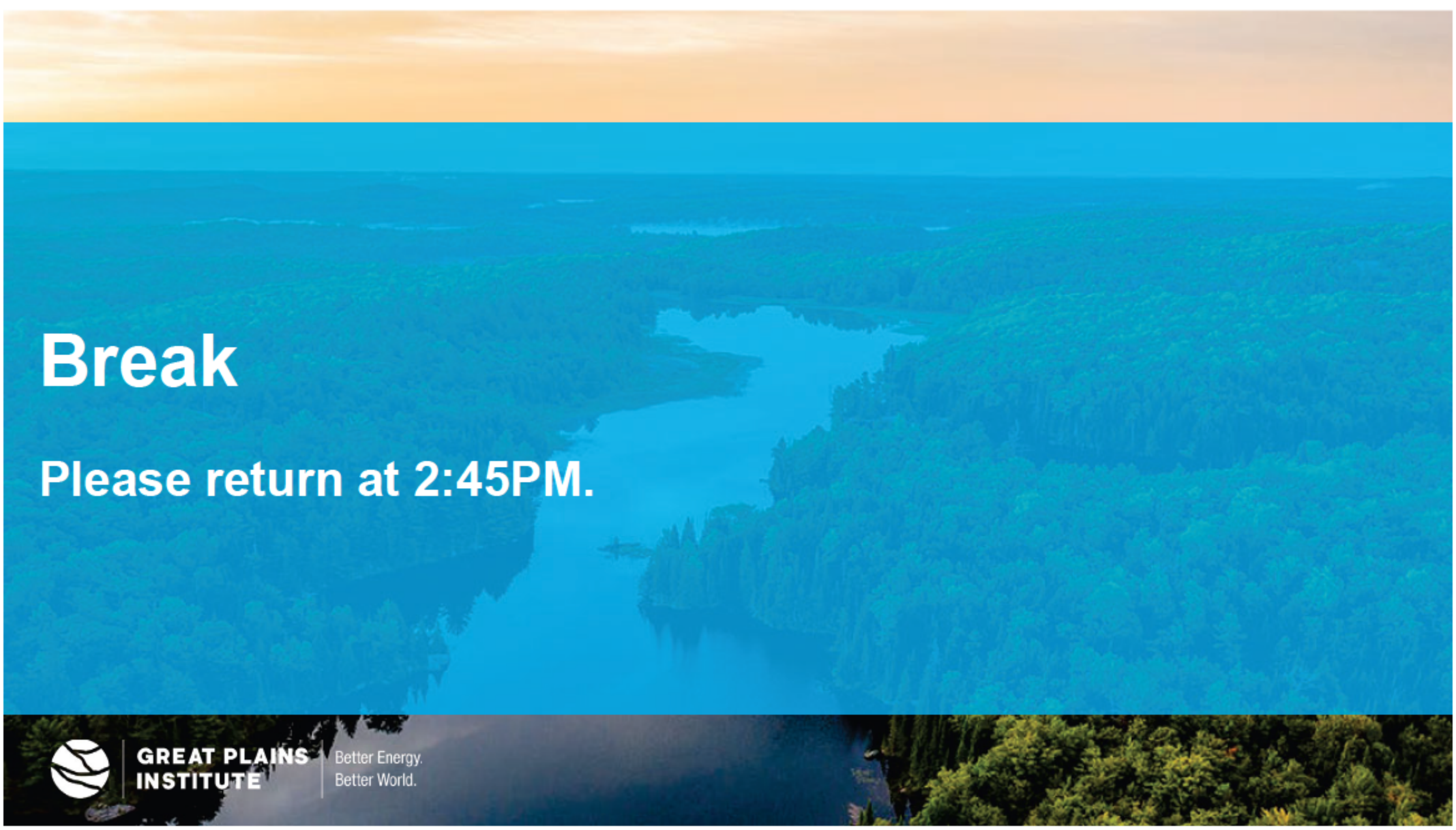
Since NCTPC inception in 2005

- Transmission projects totaling more than ***$2.123 billion*** have been identified in the NCTPC plans
- More than ***$1.13 billion*** in projects have been placed in service through the end of 2021
- ***$664 million*** are still in the planning stage
- Another ***$329 million*** were deferred until after 2031 or cancelled as a result of changing transmission system requirements
- Collaborative Transmission Plan is updated annually

North Carolina Transmission Planning Collaborative

NCTPC Website - nctpc.org/nctpc/home.jsp





Duke Energy Resource Mix to Meet 70% GHG Reduction by 2030 in NC

PRELIMINARY RESULTS

PREPARED BY
MICHAEL HAGERTY
METIN CELEBI
MATT WITKIN
JULIA OLSZEWSKI
FREDERICK CORPUZ

MARCH 22, 2022

PREPARED FOR
CLEAN POWER SUPPLIERS ASSOCIATION

Brattle

Disclaimer

PLEASE NOTE

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- The report reflects the analyses and opinions of the authors and does not necessarily reflect those of The Brattle Group's clients or other consultants. We thank Tyler Norris and Zander Bischof of Cypress Creek Renewables, LLC, Steve Levitas of Pinegate Renewables, LLC, and Hamilton Davis of Southern Current, LLC for their valuable contributions to our analysis.
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APPROACH

Introduction

Objective: Analyze least-cost future resource mix that achieves 70% reduction in emissions from Duke Energy's North Carolina power generation plants by 2030

Scope: Model Duke Energy system in North Carolina and South Carolina using updated assumptions through 2035

Approach:

- Update internal GridSIM model of Duke Energy system to incorporate GHG limits, new resource costs, and current natural gas prices
- Identify the least-cost resource mix to meet 2030 GHG goals
- Estimate annual resource additions from 2026 to 2030 to achieve the GHG goals

APPROACH

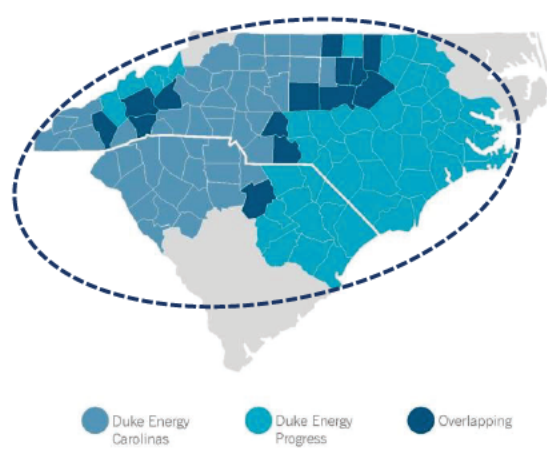
Modeling Approach

Analyzed the combined Duke Energy system using Brattle's internal capacity expansion model GridSIM

- Simulates dispatch of generation and storage resources to meet demand and cost-effective resource expansion
- Captures chronological dynamics of a future power system that relies more heavily on renewable resources by analyzing 49 representative days (4 days in each month plus the peak demand day)

Modeled the Duke service territory as an island with limited transactions with neighboring markets, similar to the approach in Duke 2020 IRP

Duke Service Territory Modeled



Source: https://www.hannonlaw.com/wp-content/uploads/2017/12/Duke-Energy-Carolinas-Territory-Map-768x768.jpg

STUDY ASSUMPTIONS

GridSIM Overview

INPUTS

Supply
- Existing resources
- Planned builds and retirements
- Fuel prices
- Investment/fixed costs
- Variable costs (inc. emissions costs)

Demand
- Representative day hourly demand
- Forecasts of annual and peak demand
- Planning reserve margins

Transmission
- Zonal limits
- Intertie limits

Regulations and Policies
- State energy policies and procurement mandates

GridSIM OPTIMIZATION ENGINE

Objective Function
- Minimize NPV of Investment & Operational Costs

gridSIM

Constraints
- Planning Reserve Margin
- Hourly Energy Balance
- Regulatory & Policy Constraints
- Resource Operational Constraints
- Transmission Constraints
- GHG Emissions Constraints

OUTPUTS

Builds/Retirements

Carbon Emissions

Market Prices (Energy, Capacity, REC)

Total Resource Costs

Customer Costs

Generator Revenues

STUDY ASSUMPTIONS

GridSIM vs EnCompass

Similar to GridSIM, EnCompass identifies the least-cost portfolio of resources to maintain system reliability, meet 2030 GHG limits, and meet hourly demand

- Encompass uses a different modeling approach that optimizes unit commitment decisions and also simulates dispatch of resources chronologically throughout the year

	GridSIM	EnCompass
Network Representation	Zonal	Zonal
Optimized Capacity Expansion and Retirement	Yes	Yes
Resource Adequacy Requirements	Yes	Yes
GHG Emissions Limit	Yes	Yes
Production Cost Simulation	Hourly, 49 representative days	Hourly, possibly on 8760 basis
Optimized Unit Commitment	No	Yes

Differences in modeling framework may result in slightly different 2030 resource mix, but the models themselves are likely to be less consequential than the input assumptions that go into them

Key Input Assumptions

Legend:
Data that Duke has made publicly available
Data that Duke may make publicly available but hasn't yet
Data that Duke will not make publicly available

Assumption	Brattle	Duke (understanding based on discussions to date)
Generation Capital Costs	- NREL 2021 ATB Conservative Case: solar, storage, onshore wind (Class 9), and offshore wind (Class 5), Gas CC - 2022 PJM CONE Study: Gas CT	- Guidehouse: solar, offshore wind, storage - Burns & McDonnell: onshore wind - Unknown for other resources
Transmission Cost Adder	- NC Transmission Planning Collaborative: Offshore wind - Internal experience: Other technologies	- Unknown for all resources
O&M Costs	- NREL 2021 ATB Conservative Case: solar, storage, onshore wind (Class 9), and offshore wind (Class 5), Gas CC - 2022 PJM CONE Study: Gas CT	- Duke internal: solar - Guidehouse: storage & offshore wind - Burns & McDonnell: onshore wind
Natural Gas and Coal Prices	- Natural gas prices: near-term forwards blended with average of EIA and Woodmac - Coal prices: delivered prices escalated based on AEO2021	- Natural gas prices: near-term forwards blended with average of EIA, EVA, IHS, and Woodmac - Coal prices: unknown
Fossil Heat Rates	- Existing resources: Historical heat rates of Duke resources - New resources: AEO assumptions	- Unknown
Renewable Capacity Factors	- Solar: 28% - Onshore Wind: 30% - Offshore Wind: 42%	- Solar: 26%-28% - Onshore Wind: 20%-30% - Offshore Wind: 40%-45%
Capacity Credit/ELCCs	- Duke 2020 IRP: 1% solar; 33% onshore wind; 45% offshore wind; 100% storage; 100% gas CC and CT	- New ELCC Study
Generation Ownership	- Solar: 45% IPP/55% Duke - All Other Resources: 100% Duke	- All Resources: 100% Duke

Key inputs for the dispatch of existing resources and selection of new resources

Key Input Assumptions (2)

Legend:
Data that Duke has made publicly available
Data that Duke may make publicly available but hasn't yet
Data that Duke will not make publicly available

Assumption	Brattle	Duke (understanding based on discussions to date)
Renewable Capacity Addition Constraints	- Solar: uncapped (sensitivity based on Duke cap) - Onshore wind: 300 MW/yr, 2028-2030 - Offshore wind: 2,250 MW (Wilmington West/East WEA capacity) - Imports: No renewable imports	- Solar: 750 MW in 2026; 1,000 MW in 2027; 1,360 MW in 2028-2030 = 4,470 MW by start-2030 - Onshore wind: 300 MW/yr, 2028-2030 - Offshore wind: 1,400 MW - Imports: Unknown
Modeling GHG Limits	- NC emissions constrained in 2030 at 70% of 2005 - SC emissions constrained based on historical levels (2019-2021 avg.), increased for exp. load growth	- Set carbon price for both SC & NC units that achieves NC target with no constraint on SC emissions

Constrains Duke's tools for meeting targets

Determine Duke's ability to export GHG emissions outside of NC

STUDY ASSUMPTIONS

NC and SC GHG Emissions Caps

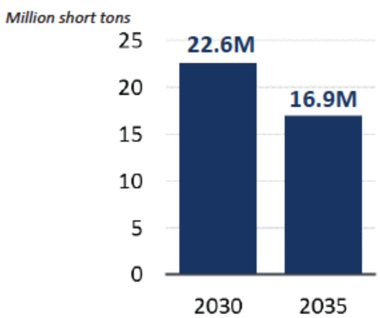
Duke North Carolina 2030 emissions cap of 22.6 million short tons is calculated as a 70% reduction from 2005 emissions levels (75.4 million short tons)

- Interpolate emissions linearly between 2030 and 2050 assuming NC reaches net zero emissions by 2050.
- Results in a 2035 emissions limit for Duke NC plants of 16.9 million short tons.

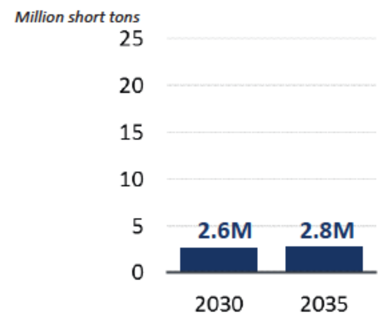
To limit GHG emissions leakage into SC, we limited Duke South Carolina emissions based on the average 2019-2021 emissions from existing plants

- We scale this value in each year according to the projected load growth by 2030 and 2035
- Historical emissions data sourced from EV data hub; load growth forecast sourced from Duke 2020 IRP.

Duke NC GHG Emissions Cap



Duke SC GHG Emissions Cap



STUDY ASSUMPTIONS

Coal Plant Retirement and Conversion Date Assumptions

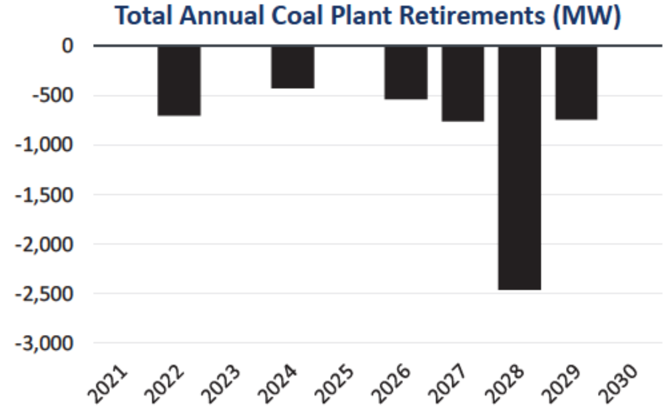
We assume that coal plants retire based on timing proposed during development of H951 legislation with retirement occurring 3 years after filing of replacement plans

- Belews Creek 1-2 and Cliffside 6 are converted to operate on natural gas

Coal Plant Retirement/Conversion Dates

Plant	Owner	Carbon Policy Case	Modeled Retirement
Allen 2-4	DEC	2022	2022
Allen 1-5	DEC	2024	2024
Cliffside 5	DEC	2026	2026
Marshall 1-2	**DEC**	**2035**	**2027**
Roxboro 1-2	**DEP**	**2029**	**2028**
Roxboro 3-4	DEP	2028	2028
Mayo 1	DEP	2029	2029
Marshall 3-4	DEC	2035	2035
Belews Creek 1-2	**DEC**	**2038**	**Gas-Only in 2030**
Cliffside 6	**DEC**	**2048**	**Gas-Only in 2030**

Total Annual Coal Plant Retirements (MW)



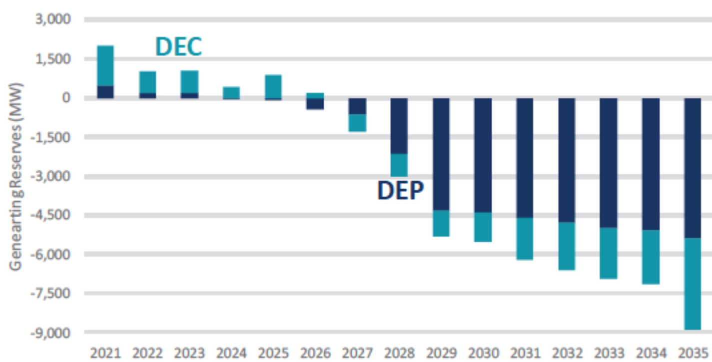
STUDY ASSUMPTIONS

Resource Adequacy

Estimated capacity shortfall for both DEC and DEP to meet their 17% reserve margin

- Started with 2020 IRP winter capacity balance and adjusted reserve margin based on alternative assumptions for coal plant retirements and new resource additions (only added mandated solar capacity under H589)
- Assumed ELCC of solar (1%), wind (33%), and 4-hour battery storage (100%) based on Duke 2020 IRP, and 45% for offshore wind based on average output during winter mornings

Projected Capacity Shortfall in the Updated Policy Case
(prior to identifying economic new resources)



STUDY ASSUMPTIONS

Available New Generation and Storage Resources

In addition to 6.4 GW of solar required under H589, GridSIM identifies new resource additions necessary to meet capacity & energy demand and GHG targets at least cost to ratepayers

Resource Type	Capacity Factor	RA Credit (% ICAP)	2035 Capacity Limit	Assumed Life
Gas CC	n.a.	100%	n.a.	20 years
Gas CT	n.a.	100%	n.a.	25 years
Solar	28%	1%	n.a.	30 years
Onshore Wind	30%	33%	900 MW	30 years
Offshore Wind	42%	45%	2,250 MW	30 years
4-Hour BESS	n.a.	100%	n.a.	15 years

Note: Due to time constraints, we did not model a separate solar+BESS hybrid resource, but do see both solar and storage entering when modeled as standalone resources.

We did not consider Gas CC with CCS or Nuclear SMR due to the limited feasibility of these resources being built by 2030

Note: We assume 6.4 GW of new baseline solar additions given that plans to utilize the remaining customer program capacity (about 400 MW) included in H589 remain uncertain.

Capital Costs for New Resources

Capital cost assumptions based on 2021 ATB Conservative case

- Based on feedback from Duke, we adopted lower capital costs for Gas CT using recent PJM Cost of New Entry (CONE) study
- For new Gas CC, we added $125/kW for the costs of new gas lateral based on EPA analysis of NC plants

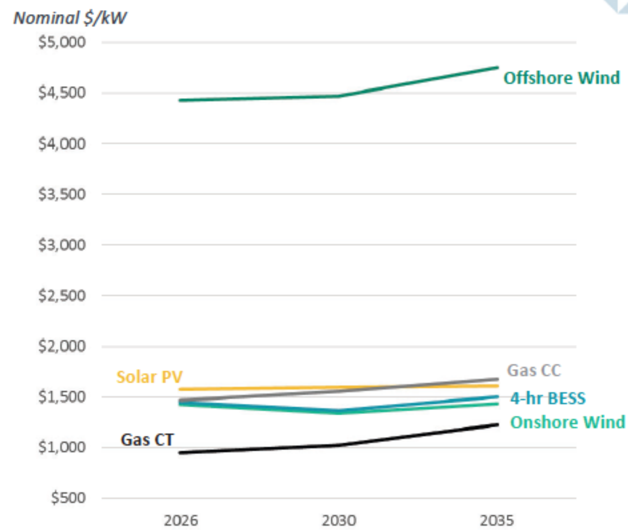
We added estimated transmission upgrades for each resource:

- Offshore wind: $441/kW in 2030 based on NCTPC study
- All other resources: $100/kW

Assume ITC and PTC phase out:

- 30% ITC for solar & storage online by Jan 1, 2024; phased down to 10% for projects online by Jan 1, 2027
- 30% ITC for offshore wind commencing construction by Jan 1, 2026 with ten years to complete (available for 2030 and 2035)
- PTC phases out for onshore wind resources entering after 2025

Overnight Capital Cost Projections



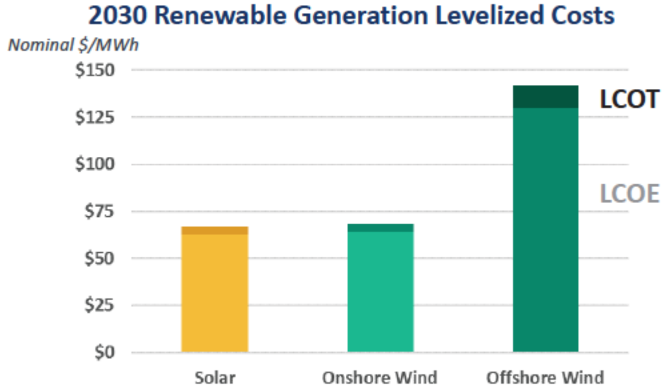
Note: Renewable capital costs are based on the NREL ATB conservative case. Offshore wind is based on Class 5 resources and onshore wind is based on Class 9 resources.

Comparison of Levelized Costs

The estimated 2030 LCOE for solar and onshore wind are similar ($65-70/MWh), while offshore wind is more than 2x higher ($140/MWh)

- We estimated the LCOE assuming the levelized costs remain constant in nominal terms over its economic life and assuming Duke's most recent cost of capital of about 6.5% ATWACC
- LCOE values shown here are higher than ATB due to use of nominal 2030 dollars (instead of real 2019 dollars), assumption that levelized costs are constant in nominal terms (instead of real terms), and higher cost of capital

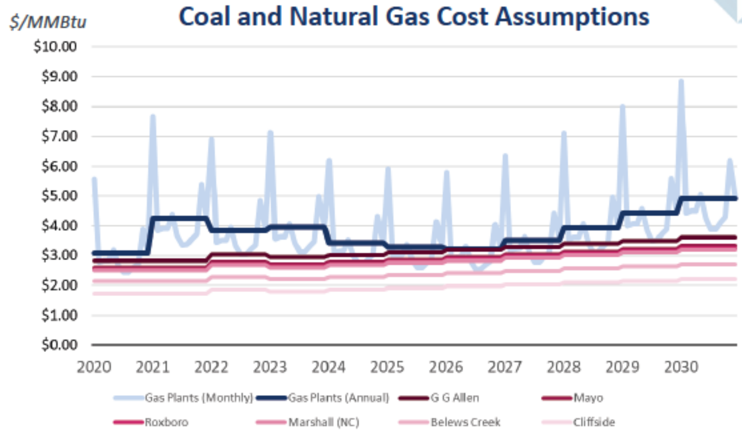
2030 Renewable Generation Levelized Costs



STUDY ASSUMPTIONS

Delivered Fuel Price Projections

- Delivered gas price forecast from recent forwards (first 5 years), then blend for 3 years with fundamentals-based forecasts (average of AEO2021 SERC and WoodMac TranscoZ6), then 100% fundamentals-based forecasts
  - Monthly shapes based on average historical shape from 2018-2020 to account for commodity price and variable delivery charges
- Coal price by plant based on delivered coal prices in 2020 and escalated based on AEO2021 forecast for delivered cost of coal into SRCA region



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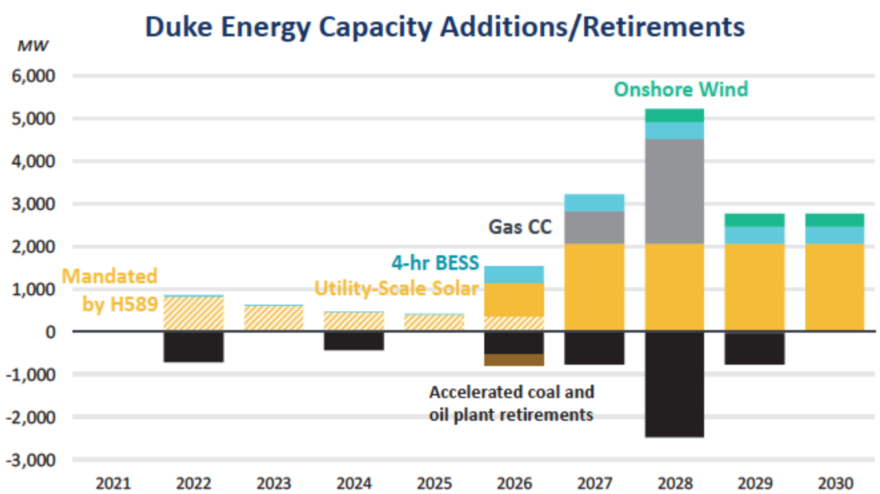
STUDY RESULTS

Projected 2030 Generation and Storage Resource Mix



Total New Resources by 2030

Utility-Scale Solar: +11,690 MW

- 2,690 MW due to H589 by 2026
- Additional 9,000 MW by 2030

Onshore Wind: +900 MW

4-Hour BESS: +2,000 MW

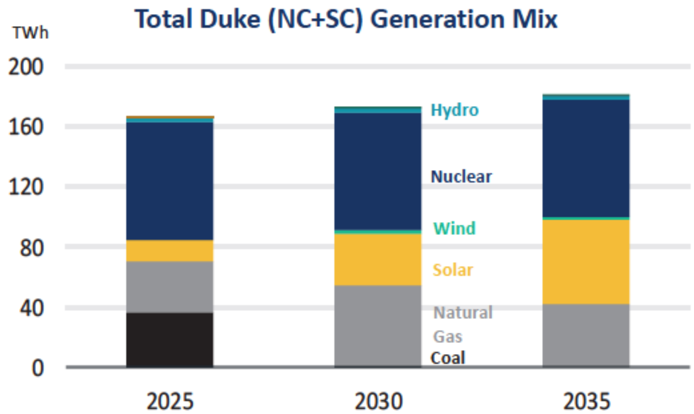
Gas CC: +3,200 MW

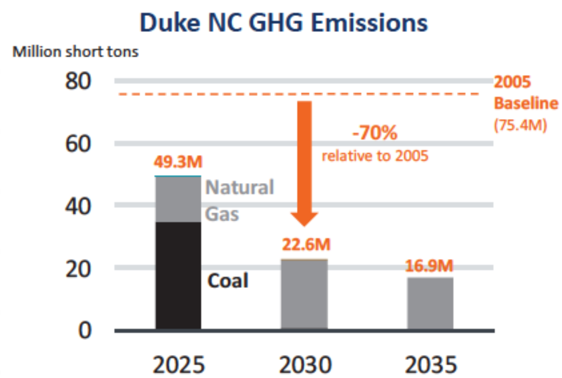
Offshore wind generation selected if solar capacity additions limited based on Duke Energy's proposed limits

Duke Energy Generation Mix and GHG Emissions

Solar and wind generation increase from 9% of total generation in 2025 to 22% in 2030

- Non-emitting resources (i.e., solar, wind, hydro and nuclear) account for 69% of total 2030 generation
- Coal generation decreases to nearly zero
- Natural gas generation increases in 2030 due to new Gas CC additions





Gas CC Entry Likely Overestimated

1. Modeling timeframe only extends to 2035, which does not consider that the value of generation from Gas CC will decrease after 2035 to achieve deeper GHG reductions
2. Assumed solar ELCC of 1% increases demand for other resources to meet reserve margin requirements
3. Normalized hourly demand and renewable generation conditions does not capture value of fast-start Gas CT and BESS to serve unexpected, sub-hourly market conditions

STUDY RESULTS

Impacts of Limiting Solar Additions by 2030

Limiting solar additions from 2026 to 2030 to the capacity Duke identified in its Enhanced Transmission Policy Case will result in the following:

- Require alternative clean sources of generation to meet the 2030 GHG goal
- One approach: add about 5,300 GWh of wind generation (1.4 GW offshore or 2.0 GW onshore)
- Increases 2030 costs by about $400 million

STUDY RESULTS

Key Resource Dynamics

- **Gas vs BESS costs:**
  - Currently selecting a mix of Gas CC and BESS resources such that shifts in costs will have a significant impact on capacity additions of each resource type by 2030
  - Modeling only to 2035 limits the long-term considerations of GHG limits and will tend to build more gas capacity
- **Solar vs Offshore wind costs:**
  - Solar costs are sufficiently low to be selected with 4-hour BESS instead of higher cost offshore wind
  - Even at 25% lower offshore wind costs, no offshore wind is built
- **Slower coal plant retirements will increase need for solar/wind additions**
  - With a GHG limit, the amount of combined gas/coal generation will depend on the average emissions rates from those resources
  - Earlier coal plant retirements will decrease the average emissions rate, increase gas/coal MWhs, and decrease need for wind/solar

SUMMARY

Key Takeaways

Based on our analysis of Duke Energy's options to achieve 70% reduction in GHG emissions, at least 8 GW of additional solar capacity (beyond the HB589 baseline) is necessary to meet the 2030 target, even under conservative solar cost assumptions

This will be the case unless one or more of the following occurs:

- Emissions leakage is allowed via imported gas generation (from SC or beyond Duke's system)
- Higher cost offshore wind is selected by Duke
- Large-scale renewable imports occur via Midwest wind or other resources

Duke's proposed limits on annual solar installations is likely to increase compliance costs of H951 or prevent achieving the 2030 target

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Appendix:
Study Assumptions

STUDY ASSUMPTIONS

Projected Energy Demand

DEP Projected Demand

YEAR	SUMMER (MW)	WINTER (MW)	ENERGY (GWH)
2021	12,885	14,161	63,731
2022	12,909	14,221	64,117
2023	12,913	14,240	64,525
2024	13,063	14,431	65,097
2025	13,207	14,566	65,600
2026	13,381	14,670	66,192
2027	13,461	14,867	66,824
2028	13,589	14,998	67,538
2029	13,833	15,248	68,159
2030	13,917	15,310	68,781
2031	14,075	15,506	69,412
2032	14,241	15,672	70,070
2033	14,361	15,792	70,655
2034	14,499	15,920	71,276
2035	14,757	16,210	71,925
Avg. Annual Growth Rate	1.0%	1.0%	0.9%

Source: DEP IRP (2020), Table C-11.

DEC Projected Demand

YEAR	SUMMER (MW)	WINTER (MW)	ENERGY (GWH)
2021	18,198	17,795	91,609
2022	18,284	17,933	92,162
2023	18,498	18,042	92,863
2024	18,670	18,195	93,622
2025	18,787	18,334	94,022
2026	18,976	18,493	94,702
2027	19,181	18,607	95,411
2028	19,358	18,790	96,167
2029	19,501	18,933	96,872
2030	19,738	19,074	97,533
2031	19,907	19,226	98,236
2032	20,124	19,393	98,869
2033	20,237	19,502	99,370
2034	20,420	19,605	99,875
2035	20,533	19,752	100,409
Avg. Annual Growth Rate	0.9%	0.7%	0.7%

Source: DEC IRP (2020), Table C-11.

Generation and Storage Operating Characteristics

Generation and Storage Resource Attributes

	Heat Rate (MMBtu/MWh)	Variable O&M ($/MWh)	Fixed O&M ($/ICAP MW-yr)
Existing			
Coal (Range)	8 87 - 10.61	$1.38 - $4.11	$21,337 - $33,673
Gas CC	7 07	$0.71	$16,249
Gas CT	11 26	$0.59	$7,573
Nuclear	10.43	$3.35	$86,083
Hydro	0 00	$1.55	$20,359
Pumped Hydro	0 00	$1.58	$6,816
Solar	0 00	$0.61	$6,906
New			
Gas CC	6.60	$1.39	$13,383
Gas CT	9 88	$4.50	$11,855
Solar	0 00	$0.00	$16,328
Wind Onshore	0 00	$0.00	$43,421
Storage	0 00	$5.00	$31,279
CHP	7 59	$1.39	$13,383

Notes: We assume $5/MWh for storage VOM based on assumed round-trip efficiency losses of ~15% on average energy prices of $35/MWh.

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- Electricity Litigation & Regulatory Disputes
- Electricity Wholesale Markets & Planning
- Environment & Natural Resources
- Financial Institutions
- Healthcare & Life Sciences
- Infrastructure
- Intellectual Property
- International Arbitration
- M&A Litigation
- Oil & Gas
- Regulatory Economics, Finance & Rates
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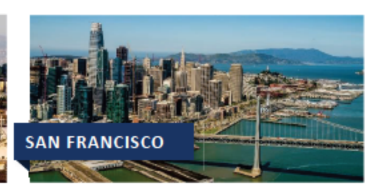
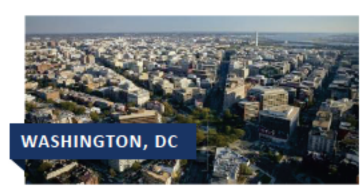
- Securities Class Actions
- Tax Controversy & Transfer Pricing
- Technology
- Telecommunications, Internet, Media & Entertainment
- White Collar Investigations & Litigation

Our Offices





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Brattle

Modeling Update and Preliminary Portfolio Development

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DUKE ENERGY.
BUILDING A SMARTER ENERGY FUTURE®

MARCH 22, 2022

Key Base Assumptions for Selectable Resources

Blue text indicates resource assumptions needed to achieve 70% reduction target

EE/DR

- EE **1% of eligible retail** sales
- IVVC growing to 90% of DEC circuits
- DR programs and critical peak pricing

Solar

- Solar interconnection potential increases to **1,350**MW/yr. by start of 2029 (> 2.5X 2020 IRP)
  - **1,800**MW/yr. sensitivity
- Bifacial panels
- Additional solar + storage config
- Costs ~1% lower than moderate NREL costs

Storage

- Up to **3,000**MW standalone batteries per year
- Costs within 1% of moderate NREL costs
- Bad Creek II – long duration storage

New nuclear

- SMR – 600MW (**300**MW blocks) available 2033-2034
- Advanced reactors or additional SMR available after 2036

Wind

- Onshore wind at 30% capacity factor – **300** MW/year starting 2029 up to 1,800MW total
- Offshore wind – Two **800**MW blocks (1/1/2030, 1/1/2032)
- Additional OSW available after 2040

Gas

- Plan will count emissions as if located in NC
- Earlier and shorter transition from market-based to fundamentals-based natural gas commodity prices
- Multiple views:
  - Constrained App. gas supply (up to ~2400 MW of New CC)
  - Constrained w/ No App. gas supply (up to ~800MW of New CC)

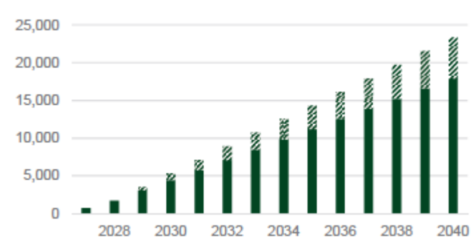
Hydrogen

- Assume H2 blending 2035+
- Incorporate H2 turbine conversion costs for existing gas and upcharge for 100% H2 capable new gas

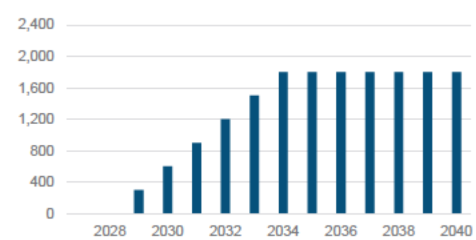
Selectable Resource Options (cumulative based on max annual potential)

CUMULATIVE LIMITS ON POTENTIAL NEW RESOURCES (MW)

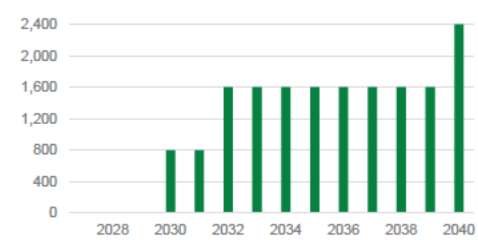
SOLAR



ONSHORE WIND



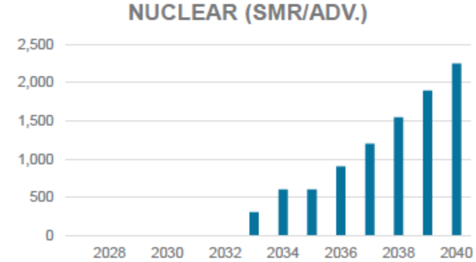
OFFSHORE WIND



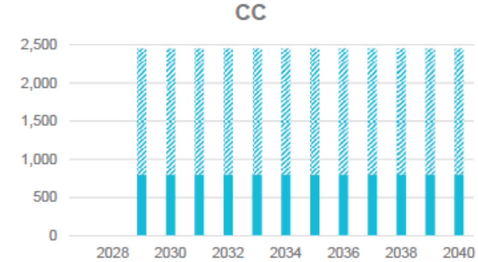
BATTERY/PEAKER

- Batteries and simple cycle CTs will enable integration of new renewable resources shown above.
- New peakers installed 2040 or beyond will be 100% hydrogen

NUCLEAR (SMR/ADV.)

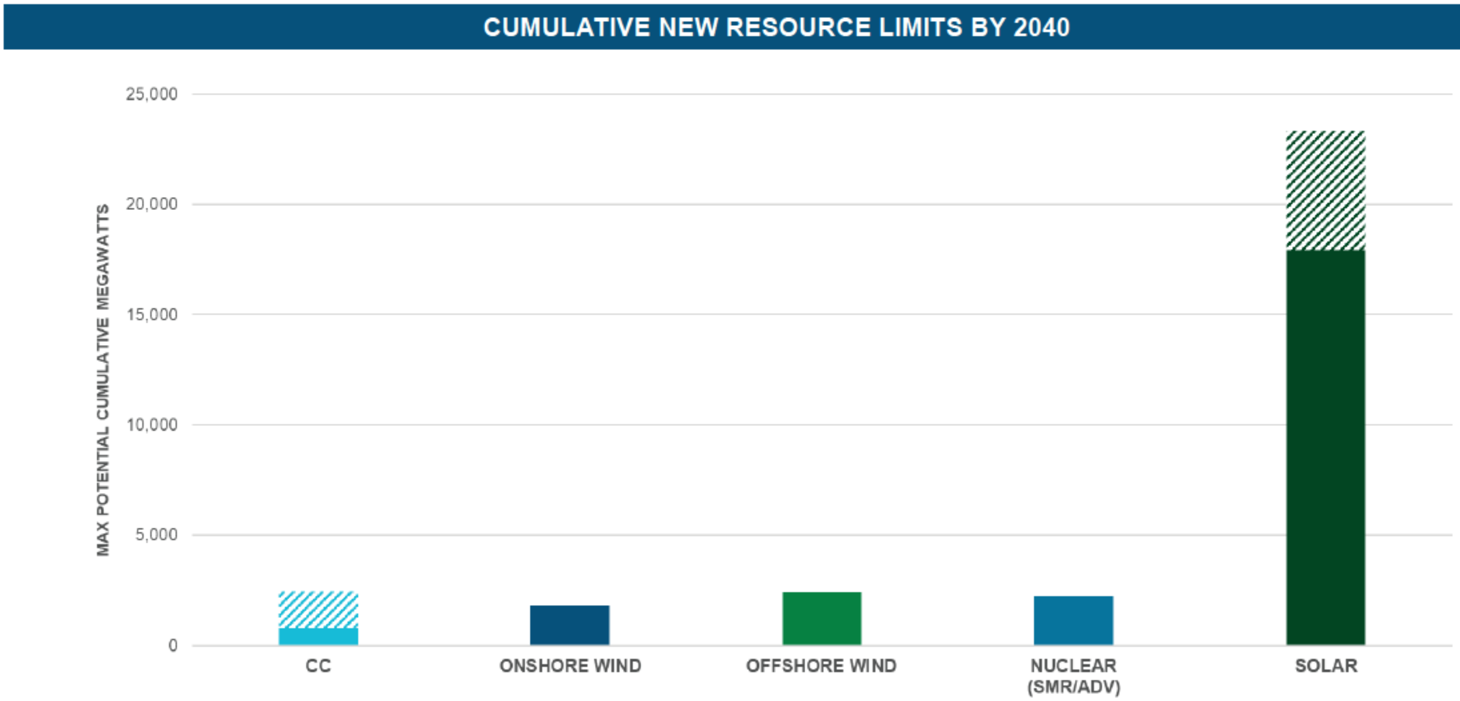


CC



Note: Dashed lines represent upper range of resource limits

Selectable Resource Options (cumulative based on max annual potential)

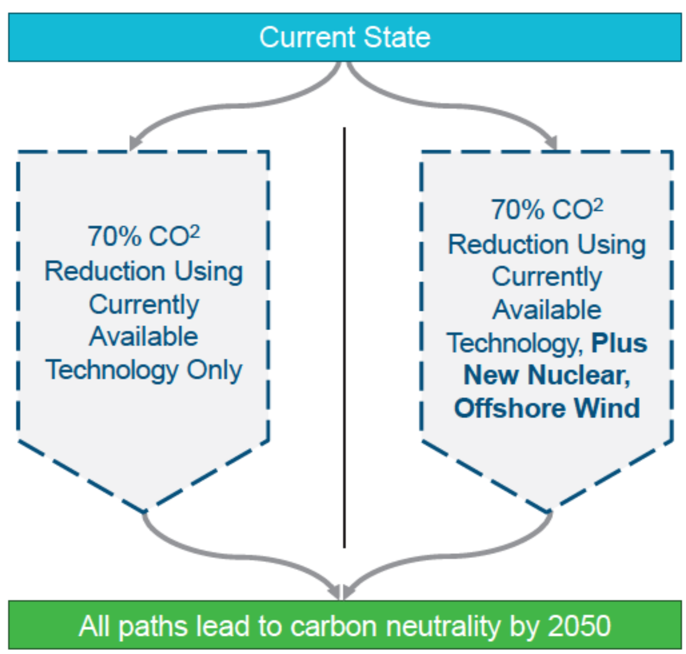


Note: Dashed lines represent upper range of resource limits

Paths on the Way to Carbon Neutrality

HB951

- "Retain discretion to determine optimal timing and generation and resource-mix to achieve the least cost path to compliance with the authorized carbon reduction goals, including discretion in achieving the authorized carbon reduction goals by the dates specified in order to allow for implementation of solutions that would have a more significant and material impact on carbon reduction; 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 for completion due to technical, legal, logistical, or other factors beyond the control of the electric public utility, or in the event necessary to maintain the adequacy and reliability of the existing grid. In making such determinations, the Utilities Commission shall receive and consider stakeholder input."



Snapshot: Potential Carbon Plan Portfolios in Year 70% is Achieved

PRELIMINARY DRAFT – MODELING ONGOING AND SUBJECT TO CHANGE

PRELIMINARY PATHWAYS	Grid Edge	Coal Ret.	New CC	Total Solar	Battery & Peaker	On. Wind	Off. Wind	New Pumped Storage	New Nuclear
70% by 2030 *with constrained App. gas*	EE 1% of eligible retail sales IVVC growing to 90% circuits Winter DR & CPP	Subcritical Coal Retired by 2030	2,400 MW *(2 units)*	12.0 GW *(includes solar paired with storage)*	3.3 GW	600 MW	800 MW *(1 block)*		
70% by 2030 *with no App. gas, reduced supply*			800 MW *(1 unit)*		5.7 GW				
70% by 2032 w/ Add'l OSW *and constrained App. gas*		Subcritical Coal Retired by 2033	2,400 MW *(2 units)*	12.3 GW *(includes sol.+stor.)*	3.7 GW	1,200 MW	1600 MW *(2 blocks)*		
70% by 2032 w/ Add'l OSW *and no App. gas, reduced supply*			800 MW *(1 unit)*	13.9 GW *(includes sol.+stor.)*	4.9 GW				
70% by 2034 w/ SMR *and constrained App. Gas*			2,400 MW *(2 units)*	14.7 GW *(includes sol.+stor.)*	3.6 GW			1,600 MW *(BCII)*	300 MW *(1 SMR unit)*
70% by 2034 w/ SMR *and no App. gas, reduced supply*			800 MW *(1 unit)*	16.0 GW *(includes sol.+stor.)*	4.4 GW				

Snapshot: Potential Carbon Plan Portfolios in 2035

PRELIMINARY DRAFT – MODELING ONGOING AND SUBJECT TO CHANGE

PRELIMINARY PATHWAYS	Grid Edge	Coal Ret.	New CC	Total Solar	Battery & Peaker	On. Wind	Off. Wind	New Pumped Storage	New Nuclear
70% by 2030 *with constrained App. gas*	EE 1% of eligible retail sales IVVC growing to 90% circuits Winter DR & CPP	All Subcritical Coal and Marshall 3-4 Retired	2,400 MW *(2 units)*	19.1 GW *(includes solar paired with storage)*	4.8 GW	1,200 MW	800 MW *(1 block)*	1,600 MW *(BCII)*	600 MW *(2 SMR units)*
70% by 2030 *with no App. gas, reduced supply*			800 MW *(1 unit)*		6.2 GW				
70% by 2032 w/ Add'l OSW *and constrained App. gas*			2,400 MW *(2 units)*	15.2 GW *(includes sol.+stor.)*	3.7 GW		1600 MW *(2 blocks)*		
70% by 2032 w/ Add'l OSW *and no App. gas, reduced supply*			800 MW *(1 unit)*	15.6 GW *(includes sol.+stor.)*	4.9 GW				
70% by 2034 w/ SMR *and constrained App. Gas*			2,400 MW *(2 units)*	15.5 GW *(includes sol.+stor.)*	3.6 GW				
70% by 2034 w/ SMR *and no App. gas, reduced supply*			800 MW *(1 unit)*	16.3 GW *(includes sol.+stor.)*	4.4 GW				

Execution Risks

DEPENDENCY	DETAIL
Transmission & Interconnection	Significant transmission needs and associated lead times for build and generator interconnection challenge connecting the magnitude of resources needed to reach 70% reduction. Assumed interconnection levels are more than double current level. Siting, permitting, build, interconnection process and capacity constraints may hinder timely addition of renewables.
Industry Resources	High industry demand for skilled labor needed to develop and interconnect resources required for fleet transformation (generation, transmission, distribution, customer programs, engineering, etc.)
Fuel Availability	Declining coal mining and transportation industry presents concerns over fuel security and flexibility to manage transition to large scale renewables. Legal challenges of pipelines may restrict ability to provide adequate gas supply needed to replace coal generation and maintain system reliability.
Regulatory Approvals	Numerous federal and state agency regulatory approvals required across various components, including regulatory approvals supportive of continued joint system planning and allocation conventions between NC and SC.
Technology Maturity	Reliance on estimated timelines for technology maturation and cost reduction, as well as development and rapid scaling of domestic and global supply chain for emerging technologies.
Supply Chain	Constraints in material (e.g., solar, storage) and labor may restrict advancement of construction.

QUESTIONS?

Wrap Up:

- Information/feedback can be sent to DukeCarbonPlan@gpisd.net

Meeting materials/recordings will be uploaded to the website:

www.duke-energy.com/CarolinasCarbonPlan

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THANK YOU