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August 27, 2021

<u>VIA ELECTRONIC FILING</u>

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

RE: North Carolina Transmission Planning Collaborative Final Report (January 15, 2021)
Docket No. E-100, Sub 165

Dear Ms. Dunston:

Pursuant to the Commission's August 24, 2021 *Order Scheduling Technical Conference and Denying Motion for Evidentiary Hearing*, I enclose the Final Report on the North Carolina Transmission Planning Collaborative ("NCTPC") 2020-2030 Transmission Plan, issued on January 15, 2021 and the addendum Report on the NCTPC 2020 Offshore Wind Study, issued on June 7, 2021 (collectively, the "Report"). During the upcoming technical conference, Duke Energy Carolinas, LLC and Duke Energy Progress, LLC will summarize the major components of the Report and discuss in detail how the work of the NCTPC informs development of the Integrated Resource Plans.

If you have any questions, please do not hesitate to contact me.

Sincerely,

Jack E. Jirak

Enclosures

cc: Parties of Record

CERTIFICATE OF SERVICE

I certify that a copy of the NCTPC Final Report on the Collaborative's 2020-2030 Transmission Plan, in Docket No. E-100, Sub 165, 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 27th day of August, 2021.

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North Carolina Transmission Planning Collaborative

Report on the NCTPC 2020–2030 Collaborative Transmission Plan

January 15, 2021
FINAL REPORT

2020 – 2030 NCTPC Transmission Plan
Table of Contents

I. Executive Summary

The North Carolina Transmission Planning Collaborative ("NCTPC") was established to:

1) provide the Participants (Duke Energy Carolinas ("DEC"), Duke Energy Progress ("DEP"), North Carolina Electric Membership Corporation ("NCEMC"), and ElectriCities of North Carolina ("ElectriCities") and other stakeholders an opportunity to participate in the electric transmission planning process for the areas of North Carolina and South Carolina served by the Participants;

2) preserve the integrity of the current reliability and least-cost planning processes;

3) expand the transmission planning process to include analysis of increasing transmission access to supply resources inside and outside the Balancing Authority Areas ("BAAs") of DEC and DEP; and

4) develop a single coordinated transmission plan for the Participants that includes Reliability and Local Economic Study Transmission Planning while appropriately balancing costs, benefits and risks associated with the use of transmission and generation resources.

The overall NCTPC Process is performed annually and includes the Reliability Planning and Local Economic Study Planning Processes, which are intended to be concurrent and iterative in nature. The NCTPC Process is designed such that there will be considerable feedback and iteration between the two processes as each effort's solution alternatives affect the other's solutions.

The 2019–2029 Collaborative Transmission Plan (the "2019 Collaborative Transmission Plan" or the "2019 Plan") was published in January 2019.

This report documents the current 2020 – 2030 Collaborative Transmission Plan ("2020 Collaborative Transmission Plan" or the "2020 Plan") for the Participants. The initial sections of this report provide an overview of the NCTPC Process as well as the specifics of the 2020 reliability planning study scope and methodology. The NCTPC Process document and 2020 Study scope document are posted in their entirety on the NCTPC website at http://www.nctpc.org/nctpc/.

The scope of the 2020 reliability planning process was focused on the annual base reliability study. The base reliability study assessed the reliability of the transmission systems of both DEC and DEP in order to ensure reliability of service in accordance with North American Electric Reliability Corporation ("NERC"), SERC Reliability Corporation ("SERC"), and DEC and DEP requirements. The purpose of the base reliability study was to evaluate the transmission systems' ability to meet load growth projected for 2020 through 2030 with the Participants' planned Designated Network Resources ("DNRs").

Based on the study's input assumptions, the 2020 Study allowed for identification of any new system impacts not currently addressed by existing transmission plans, in which case solutions were developed. The 2020 Study also allowed for adjustments to existing plans where necessary.

The NCTPC reliability study results affirmed that the planned DEC and DEP transmission projects identified in the 2019 Plan continue to satisfactorily address the reliability concerns identified in the 2019 Study for the near-term (5 year) and the long-term (10 year) planning horizons. The 2020 Plan is detailed in Appendix B which identifies the new and updated projects planned with an estimated cost of greater than $10 million.

The total estimated cost for the 17 reliability projects included in the 2020 Plan is $804 million as documented in Appendix B. This compares to the original 2019 Plan estimate of $591 million for 14 reliability projects. In-service dates and cost estimates for some projects that are planned or underway have been revised based on updated information. An update to the 2019 plan was provided in the 2020 mid-year update published in June 2020 with an updated cost estimate of $632 million. See Appendix D for a detailed comparison of this year's Plan to the updated 2019 Plan.

The list of major projects will continue to be modified on an ongoing basis as new improvements are identified through the NCTPC Process and projects are placed in-service or eliminated from the list. Appendix C provides a more detailed description of each project in the 2020 Plan.

The 2020 Plan, relative to the 2019 Plan, includes 1 new DEC project:

- South Point Switching Station, Construct

The 2020 Plan, relative to the 2019 Plan, includes 5 new DEP projects:

- Wateree 115 kV Plant, Upgrade 115/100 kV Transformers.
- Carthage 230/115 kV Substation, Construct substation and loop-in Cape Fear–West End 230 kV line and West End–Southern Pines 115 kV Feeder.
- Falls 230 kV Substation, Add 300 MVAR Static Var Compensator.
- Castle Hayne–Folkstone 115 kV line, rebuild 556 MCM and 6-(2/0) copper sections to 1272 ACSR.
- Holly Ridge North 115 kV SS, construct station, loop in Castle Hayne–Folkstone 115 kV and Folkstone–Jacksonville City 115 kV, and build 0.5 mile 115 kV feeder to Jones–Onslow EMC Folkstone POD

There are revised in-service dates, estimated cost changes, and/or scope changes for the following DEC and DEP projects:

- Durham–RTP 230 kV Line project had an increase in estimated cost.
- Jacksonville–Grants Creek 230 kV Line and Grants Creek 230/115 kV Substation project was placed in-service.
- Newport–Harlowe 230 kV Line, Newport SS and Harlowe 230/115 kV Substation project was placed in-service.

- Sutton–Castle Hayne 115 kV North line project had a decrease estimated lead time.
- Asheboro–Asheboro East 115 kV North Line project had a small increase in estimated cost and its in-service date was pushed out.
- Rural Hall 100 kV SVC project was placed in-service.
- Orchard 230/100 kV Tie Station project was placed in-service.
- Windmere 100 kV Line (Dan River–Sadler) project had a decrease in estimated cost and its in-service date was pushed out.
- Wilkes 230/100 kV Tie Station project had an increase in estimated cost and its in-service date was pushed out.
- Craggy–Enka 230 kV Line project in-service date was pushed out.
- Cokesbury 100 kV Line (Coronaca–Hodges) project had a decrease in estimated cost and its in-service date was pushed out.

The following DEP project has been removed:

- Brunswick #1–Jacksonville 230 kV Line, Loop into Folkstone 230 kV Substation

For a variety of reasons (such as load growth, generation retirements, or power purchase agreements expiring), LSEs may wish to evaluate other resource supply options to meet future load demand as part of the Local Economic Study Process. These resource supply options can be either in the form of transactions or some hypothetical generators which are added to meet the resource adequacy requirements for this study. For the 2020 Study, the NCTPC evaluated a local economic impact of rapid high load growth (5–6% growth) occurring in the Union and Cabarrus County areas of North Carolina for the 2025 and 2030 summer models.

Each year, the Oversight Steering Committee ("OSC") will determine if there are any public policies driving the need for local transmission upgrades. Through this process the OSC will seek input from Transmission Advisory Group ("TAG") participants to identify any public policy impacts to be evaluated as part of the Local Planning Process. The OSC may itself identify public policies to be evaluated. For the 2020 Study, the Southeast Wind Coalition identified a public policy involving NC offshore wind development. As a result of this request, the NCTPC decided to evaluate the local public policy impacts of an NC offshore wind development as follows:

- the potential for 2,400 MW of wind generation injecting into Dominion's Landstown 230 kV area to be wheeled into the DEC/DEP areas (60%/40% ratio); and
- separately, determine 3 least-cost injection points along the NC coast and determine the transmission cost breakpoints for varying amounts of generation injection at those sites up to 5,000 MW, also split to DEC 60% and DEP 40%.

The analysis of this public policy impact was not completed in time for inclusion in this report. The NC offshore wind study results will be provided in a separate report once the full analysis is completed in early 2021.

In this 2020 NCTPC Process, the Participants validated and continued to build on the information learned from previous years' efforts. Each year the Participants will look for ways to improve and enhance the planning process. The study process confirmed again this year that the joint planning approach produces benefits for all Participants that would not have been realized without a collaborative effort.

II. North Carolina Transmission Planning Collaborative Process

II.A. Overview of the Process

The NCTPC Process was established by the Participants to:

1) provide the Participants (DEC, DEP, NCEMC, and ElectriCities) and other stakeholders an opportunity to participate in the electric transmission planning process for the areas of North Carolina and South Carolina served by the Participants;

2) preserve the integrity of the current reliability and least-cost planning processes;

3) expand the transmission planning process to include analysis of increasing transmission access to supply resources inside and outside the Balancing Authority Areas of DEC and DEP; and

4) develop a single coordinated transmission plan for the Participants that includes reliability and economic considerations while appropriately balancing costs, benefits, and risks associated with the use of transmission and generation resources.

The NCTPC Process is a coordinated Local Transmission Planning process conducted on an annual basis. The entire, iterative process ultimately results in a single Local Transmission Plan that appropriately balances the costs, benefits, and risks associated with the use of transmission, generation, and demand-side resources. The Local Transmission Plan will identify local transmission projects (Local Projects). A Local Project is defined as a transmission facility that is (1) located solely within the combined DEC–DEP transmission system footprint and (2) not selected in the regional transmission plan for purposes of regional cost allocation.

The Local Planning Process addresses transmission upgrades needed to maintain reliability and to integrate new generation resources and/or loads. The overall Local Planning Process includes several components:

- Reliability Planning Process
- Resource Supply Options Process
- Local Economic Study Process
- Local Public Policy Process

The Reliability Planning Process (base reliability study) evaluates each Transmission System's ability to meet projected load with a defined set of resources as well as the needs of firm point-to-point customers, whose needs are reflected in their transmission contracts and reservations. The Resource Supply Options Process is conducted to evaluate transmission system impacts for other potential resource supply options to meet future load requirements.

The overall Local Planning Process is designed such that there will be considerable feedback and iteration between the Reliability Planning Process and Resource Supply Options Process. This is necessary as the alternative solutions from one process affect the alternative solutions in the other process.

The Local Economic Study Process allows the TAG participants to propose economic upgrades to be studied as part of the Local Planning Process. This process evaluates the means to increase transmission access to potential supply resources inside and outside the Balancing Authority Areas of the DEC and DEP. This economic analysis provides the opportunity to study the transmission upgrades that would be required to reliably integrate new resources.

The Local Public Policy Process identifies if there are any public policies that are driving the need for local projects. Either the OSC or the TAG could identify those public policies that may drive the need for local transmission.

The OSC manages the NCTPC Process. The Planning Working Group ("PWG") implements the development of the NCTPC Process and coordinates the study development. The TAG provides advice and makes recommendations regarding the development of the NCTPC Process and the study results.

The final results of the Local Planning Process include summaries of the estimated costs and schedules to provide any transmission upgrades and/or additions needed to maintain a sufficient level of reliability necessary to serve customers. Throughout the Local Planning Process, TAG participants (including TAG participants representing transmission solutions, generation solutions, and solutions utilizing demand resources) may participate.

The purpose of the NCTPC Process is more fully described in the current Participation Agreement which is posted at http://www.nctpc.org/nctpc/.

II.B. Reliability Planning Process and Resource Supply Options Process

The Reliability Planning Process is the Transmission Planning Process that has traditionally been used by the transmission owners to provide safe and reliable transmission service at the lowest reasonable cost. Through the NCTPC, this Transmission Planning Process was expanded to include the active participation of the Participants and input from other stakeholders through the TAG.

The Reliability Planning Process is designed to follow the steps outlined below. The OSC approves the scope of the reliability study, oversees the study analysis being performed by the PWG, evaluates the study results, and approves the final reliability study results. The Reliability Planning Process begins with the incumbent transmission owners' most recent reliability planning studies and planned transmission upgrade projects.

In addition, the PWG solicits input from the Participants for different scenarios on where to include alternative supply resources to meet their load demand forecasts in the study. This is known as the Resource Supply Options Process. This step provides the opportunity for the Participants to propose the evaluation of other resource supply options to meet future load demand due to load growth, generation retirements, or the expiration of purchase power agreements. The PWG analyzes the proposed interchange transactions and/or the location of generators to determine if those transactions or generators create any reliability criteria violations. Based on this analysis, the PWG provides feedback to the Participants on the viability of the proposed interchange transactions or generator locations for meeting future load requirements. Note that new or modified interchange or generation must go through official FERC, NC, or SC Generator Interconnection or Transmission Service processes, which may find different results than the NCTPC study process. The PWG coordinates the development of the reliability study and the resource supply option study based upon the OSC approved scope and prepares a report with the recommended transmission reliability solutions.

The overall Local Planning Process is designed such that there will be considerable feedback and iteration between the Reliability Planning Process and the Resource Supply Options Process. This is necessary as the alternative solutions from one process may affect the alternative solutions in the other process.

The results of the Reliability Planning Process include summaries of the estimated costs and schedules to provide transmission upgrades and/or additions: (i) needed to maintain a sufficient level of reliability necessary to serve the native load of all Participants and (ii) needed to reliably support the resource supply options studied. The reliability study results are reviewed with the TAG, and the TAG participants are given an opportunity to provide comments on the results. All TAG feedback is reviewed by the OSC for consideration for incorporation into the final Collaborative Transmission Plan.

For the 2020 Study, the NCTPC evaluated no resource supply scenarios as no resource supply scenario requests were received by the Participants by the deadline of February 5, 2020. Resource supply scenarios will be solicited again for the 2021 Study and included if appropriate.

II.C. Local Economic Study Process

The Local Economic Study Process allows the TAG participants to propose hypothetical economic transfers to be studied as part of the Local Planning Process. The Local Economic Study Process provides the means to evaluate the impact of potential supply resources inside and outside the BAAs of the Transmission Providers. This local economic analysis provides the opportunity to study what transmission upgrades would be required to reliably integrate new resources.

The Local Economic Study Process begins with the TAG members proposing scenarios and interfaces to be studied. The proposed scenarios and interfaces are compiled by the PWG and then evaluated by the OSC to determine which ones will be included for analysis in the current planning cycle.

The OSC approves the scope of the local economic study scenarios (including any changes in the assumptions and study from those used in the reliability analysis), oversees the study analysis being coordinated by the PWG, evaluates the study results, and approves the final local economic study results.

The PWG coordinates the development of the local economic studies based upon the OSC approved scope and prepares a report which identifies recommended transmission solutions that could increase transmission access.

The results of the Local Economic Study Process include the estimated costs and schedules to provide the increased transmission capabilities.

The local economic study results are reviewed with the TAG, and the TAG participants are given an opportunity to provide comments on the results. All TAG feedback is reviewed by the OSC for consideration for incorporation into the final Local Transmission Plan.

While the overall NCTPC Process includes both a Reliability Planning Process and the Local Economic Study Process, some planning cycles may only focus on the Reliability Planning Process if stakeholders do not request any economic study scenarios for a particular planning cycle.

For the 2020 Study, the NCTPC evaluated a local economic impact of rapid high load growth (5–6% growth) occurring in the Union and Cabarrus County areas of North Carolina for the 2025 and 2030 summer models.

II.D. Local Public Policy Process

Each year, the OSC will determine if there are any public policies driving the need for local transmission upgrades. Through this process the OSC will seek input from TAG participants to identify any public policy impacts to be evaluated as part of the Local Planning Process. The OSC may itself identify public policies to be evaluated. The OSC will use the criteria below to determine if there are any public policies driving the need for local transmission as follows:

- The public policy must be reflected in state, federal, or local law or regulation (including order of a state, federal, or local agency).
- There must be existence of facts showing that the identified need cannot be met absent the construction of additional transmission facilities.

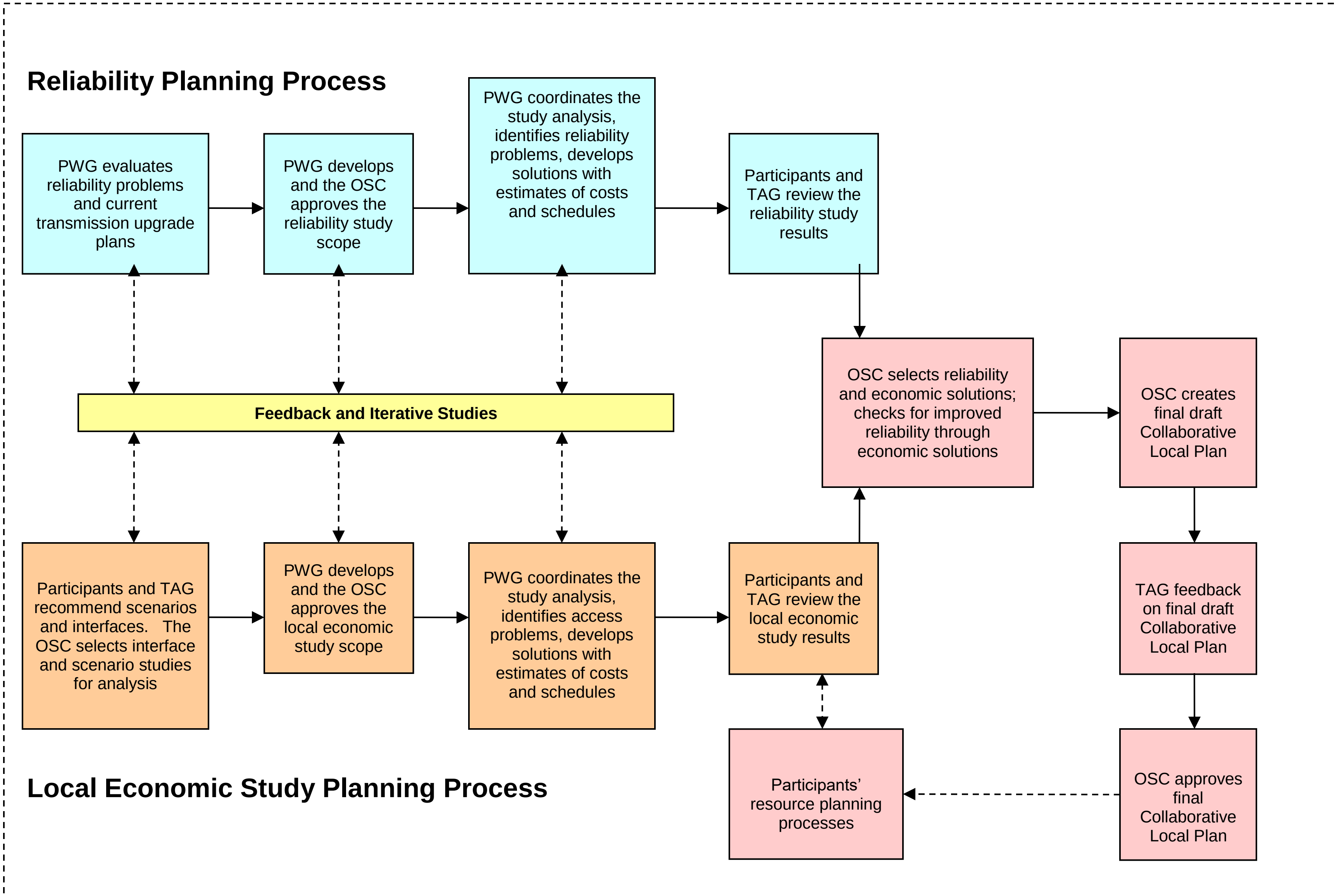
For the 2020 Study, the NCTPC evaluated local public policy impacts of an offshore wind development as follows:

- the potential for 2,400 MW of wind generation injecting into Dominion's Landstown 230 kV area to be wheeled into the DEC/DEP areas (60/40 ratio); and

- separately, determine 3 least-cost injection points along the NC coast and determine the transmission cost breakpoints for varying amounts of generation injection at those sites up to 5,000 MW, also split to DEC 60% and DEP 40%.

The analysis of this public policy impact was not completed in time for inclusion in this report. The NC offshore wind study results will be provided in a separate report once the full analysis is completed in early 2021.

2020 NCTPC Process Flow Chart



II.E. Local Transmission Plan

Once the reliability and local economic studies are completed, including any evaluations due to public policies, the OSC evaluates the results and the PWG recommendations to determine if any proposed economic projects and/or resource supply option projects will be incorporated into the Local Transmission Plan. If so, the initial plan developed based on the results of the reliability studies is modified accordingly. This process results in a single Local Transmission Plan being developed that appropriately balances the costs, benefits and risks associated with the use of transmission and generation resources. This plan is reviewed with the TAG, and the TAG participants are given an opportunity to provide comments. All TAG feedback is reviewed by the OSC for consideration for incorporation into the final Local Transmission Plan.

The annual Local Transmission Plan information is available to Participants for identification of any alternative least cost resources for potential inclusion in their respective Integrated Resource Plans. Other stakeholders can similarly use this information for their resource planning purposes.

III. 2020 Reliability Planning Study Scope and Methodology

The scope of the 2020 Reliability Planning Process was focused on the annual base reliability study. The base reliability study assessed the transmission systems of both DEC and DEP in order to ensure reliability of service in accordance with North American Electric Reliability Corporation ("NERC"), SERC Reliability Corporation ("SERC"), and DEC and DEP requirements. The purpose of the base reliability study was to evaluate the transmission systems' ability to meet load growth projected for 2025 summer through 2030 summer with the Participants' planned Designated Network Resources ("DNRs"). The 2020 Study allowed for identification of any new system impacts not currently addressed by existing transmission plans in which case solutions were developed. The 2020 Study also allowed for adjustments to existing plans where necessary.

III.A. Assumptions

1. Study Year and Planning Horizon

The 2020 Plan addressed a ten-year planning horizon through 2020. The study years chosen for the 2020 Study are listed in Table 1.

Table 1
Study Years

Study Year / Season	Analysis
2025 Summer	Near-term base reliability
2025/2026 Winter	Near-term base reliability
2030 Summer	Long-term base reliability

To identify projects required in years other than the base study years of 2025, 2025/2026 and 2030, line loading results for those base study years were extrapolated into future years assuming the line loading growth rates in Table 2. This allowed assessment of transmission needs throughout the planning horizon. The line loading growth rates are based on each BAAs individual load growth projection at the time the study process was initiated.

Table 2

Line Loading Growth Rates

Company	Line Loading Growth Rate
DEC[1]	1.2% per year (summer) 1.2% per year (winter)
DEP	1.0% per year (summer) 0.9% per year (winter)

2. Network Modeling

The network models developed for the 2020 Study included new transmission facilities and upgrades for the 2025, 2025/2026, and 2030 models, as appropriate, from the current transmission plans of DEC and DEP and from the 2019 Plan. Table 3 lists the planned major transmission facility projects (with an estimated cost of $10 million or more each) included in the 2025, 2025/2026, and 2030 models. Table 4 lists the generation facility changes included in the 2025, 2025/2026, and 2030 models.

[1] For the purpose of planning a transmission system with appropriate robustness, DEC line loading growth rates shown in Table 2 exceed the growth rates provided in DEC's IRP.

Table 3

Major Transmission Facility Projects Included in Models

Company	Transmission Facility	2025	2030
DEC	Orchard Tie 230/100 kV Tie Station, Construct	Yes	Yes
DEC	Wilkes 230/100 kV Tie Station, Construct	Yes	Yes
DEC	Cokesbury 100 kV Line (Coronaca–Hodges), Upgrade	No	Yes
DEC	South Point Switching Station, Construct	No	Yes
DEP	Jacksonville–Grants Creek 230 kV Line, Grants Creek 230/115 kV Substation	Yes	Yes
DEP	Newport–Harlowe 230 kV Line, Newport Switching Station, Harlowe 230/115 kV Substation	Yes	Yes
DEP	Sutton–Castle Hayne 115 kV North line rebuild	Yes	Yes
DEP	Asheville Plant, Replace 2-300 MVA 230/115 kV banks with 2-400 MVA banks, reconductor 115 kV ties to switchyard, upgrade breakers, and add 230 kV capacitor bank	Yes	Yes
DEP	Cane River 230 kV Substation, Construct 150 MVAR SVC	Yes	Yes
DEP	Asheboro–Asheboro East 115 kV North Line, Reconductor	Yes	Yes
DEP	Craggy–Enka 230 kV Line, Construct	No	Yes

Table 4

Major Generation[2] Facility Changes in Models

Company	Generation Facility	2025	2030
DEC	Added Lincoln County CT (525 MW)	Yes	Yes
DEC	Retired Allen 1-3 (617 MW)	Yes	Yes
DEC	Retired Allen 4-5 (564 MW)	No	Yes
DEC	Added Apex PV (30 MW)	Yes	Yes
DEC	Added Broad River PV (50 MW)	Yes	Yes
DEC	Added Cool Springs PV (80 MW)	Yes	Yes
DEC	Added Gaston PV (25 MW)	Yes	Yes
DEC	Added High Shoals PV (16 MW)	Yes	Yes
DEC	Added Lancaster PV (10 MW)	Yes	Yes
DEC	Added Lick Creek PV (50 MW)	Yes	Yes
DEC	Added Maiden Creek PV (69.3 MW)	Yes	Yes
DEC	Added Oakboro PV (40 MW)	Yes	Yes
DEC	Added Partin PV (50 MW)	Yes	Yes
DEC	Added Pelham PV (32 MW)	Yes	Yes
DEC	Added Pinson PV (20 MW)	Yes	Yes
DEC	Added Ruff PV (22 MW)	Yes	Yes
DEC	Added Speedway PV (22.6 MW)	Yes	Yes
DEC	Added Stanly PV (50 MW)	Yes	Yes
DEC	Added Stony Knoll PV (22.6 MW)	Yes	Yes
DEC	Added Sugar PV (60 MW)	Yes	Yes
DEC	Added Thinking Tree (35 MW)	Yes	Yes
DEC	Added Two Hearted PV (22 MW)	Yes	Yes
DEC	Added West River PV (40 MW)	Yes	Yes

[2] Major Generation Threshold is considered to be 10 MW or greater and connected to the transmission system

Company	Generation Facility	2025	2030
DEC	Added Westminster PV (75 MW)	Yes	Yes
DEP	Retired Asheville 1-2 (380 MW)	Yes	Yes
DEP	Retired Darlington Co 1, 2, 3, 4, 6, 7, 8, 10 (514 MW)	Yes	Yes
DEP	Retired Blewett CTs 1-4 and Weatherspoon CTs 1-4 (232 MW)	Yes	Yes
DEP	Retired Roxboro Units 1-2 (1053 MW)	No	Yes
DEP	Added Asheville CC (2 x 280 MW)	Yes	Yes
DEP	Added Crooked Run Solar (70.1 MW)	Yes	Yes
DEP	Added Bay Tree Solar (70.1 MW)	Yes	Yes

3. Interchange and Generation Dispatch

Each Participant provided a resource dispatch order for each of its DNRs for the DEC and DEP BAAs. Generation was dispatched for each Participant to meet that Participant's load in accordance with the designated dispatch order.

DEC models distribution-connected generation as being netted against the load at the transmission bus. Transmission-connected generation is modeled if it is either in-service or has an executed generator interconnection agreement at the time the models are built. Because only transmission-connected generation is modeled explicitly, the following assumptions do not apply to distribution-connected generation. Solar generation is available for dispatch up to the generator interconnection agreement value but is only dispatched at 80% of that value in summer models. Facilities with storage may be dispatched up to 100% of the generator interconnection agreement value depending on the amount of storage associated with the facility. This level of dispatch is jurisdiction-specific and is supported by operating data that can be reflective of various factors such as geography and plant design. Solar generation is not dispatched in winter models. These dispatch assumptions reflect the expected solar generation output coincident with the DEC peak load. DEC models 1098 MW of transmission-connected solar generation available for dispatch, dispatched consistent with the aforementioned dispatch assumptions.

DEP models solar generation in its power flow cases that is either in-service or has an executed generator interconnection agreement at the time the models are built. This includes transmission-connected as well as distribution-connected solar generation. The current 2025 summer power flow case has approximately 994 MW of transmission-connected and 1789 MW of distribution-connected solar generation for a total of 2783 MW. In its summer peak cases, DEP scales the solar generation down to 50% of its maximum capacity to approximate the amount of solar generation that will be on-line coincident with the DEP peak load. This level of dispatch is jurisdiction-specific and is supported by operating data that can be reflective of various factors such as geography and plant design. For winter peak studies, DEP assumes that no solar generation will be available at the time of the winter peak. DEP models all transmission upgrades that are determined necessary by the respective generation interconnection studies.

III.B. Study Criteria

The results of the base reliability study, the resource supply option study, and the local economic study were evaluated using established planning criteria. The planning criteria used to evaluate the results include:

1) NERC Reliability Standards;
2) SERC requirements; and
3) Individual company criteria.

III.C. Case Development

The base case for the base reliability study was developed using the most current 2019 series NERC Multiregional Modeling Working Group (‘MMWG”) model for the systems external to DEC and DEP. The MMWG model of the external systems, in accordance with NERC MMWG criteria, included modeling known long-term firm transmission reservations.

Detailed internal models of the DEC and DEP East/West systems were merged into the base case, including DEC and DEP transmission additions planned to be in service by the period under study. In the base cases, all confirmed long-term firm transmission reservations with roll-over rights were modeled.

III.D. Transmission Reliability Margin

NERC defines Transmission Reliability Margin as:

> *The amount of transmission transfer capability necessary to provide reasonable assurance that the interconnected transmission network will be secure. TRM accounts for the inherent uncertainty in system conditions and the need for operating flexibility to ensure reliable system operation as system conditions change.*

DEP's reliability planning studies model all confirmed transmission obligations for its BAA in its base case. Included in this is TRM for use by all LSEs. TRM is composed of contracted VACAR reserve sharing and inrush impacts. DEP models TRM by scheduling the reserved amount on actual reserved interfaces as posted on the DEP Open Access Same-time Information System ("OASIS").

In the planning horizon, DEC ensures VACAR reserve sharing requirements can be met through decrementing Total Transfer Capability ("TTC") by the TRM value required on each interface. Sufficient TRM is maintained on all DEC-VACAR interfaces to allow both export and import of the required VACAR reserves. DEC posts the TRM value for each interface on the DEC OASIS.

Both DEP and DEC ensure that TRM is maintained consistent with NERC requirements. The major difference between the methodologies used in planning by the two companies to calculate TRM is that DEP uses a flow-based methodology, while DEC decrements previously calculated TTC values on each interface.

III.E. Technical Analysis and Study Results

Contingency screenings on the base case and scenarios were performed using Power System Simulator for Engineering ("PSS/E") power flow or equivalent. Each transmission planner simulated its own transmission and generation down contingencies on its own transmission system.

DEC created generator maintenance cases that assume a major unit is removed from service and the system is economically redispatched to make up for the loss of generation. Additionally, outages of transmission connected solar sites were evaluated by creating cases that reflected one of two assumptions: 1) individual solar site being unavailable or 2) a group of solar sites being unavailable. For the latter, engineering judgement was used to group sites in common geographic areas.

Generator maintenance cases were developed for the following units:

Allen 4	Allen 5	Bad Creek 1
Belews Creek 1	Catawba 1	Cliffside 5
Cliffside 6	Broad River 1	Mill Creek 1
Jocassee 1	Lee 3	Marshall 3
McGuire 1	McGuire 2	Nantahala
Oconee 1	Oconee 3	Buck CC
Dan River CC	Rowan CC	Rockingham 1
Thorpe	Lincoln 1	Lee CC
Broad River 1	Cleveland 1	Cherokee Co-gen

DEP created generation down cases which included the use of TRM, as discussed in Section III.D. DEP TRM cases model interchange to avoid netting against imports, thereby creating a worst-case import scenario. TRM cases were developed for the following units:

Brunswick 1	Robinson 2
Harris	Asheville CC1

To understand impacts on each other's system, DEC and DEP have exchanged their transmission contingency and monitored elements files in order for each company to simulate the impact of the other company's contingencies on its own transmission system. In addition, each company coordinated generation adjustments to accurately reflect the impact of each company's generation patterns.

The technical analysis was performed in accordance with the study methodology. The results from the technical analysis for the DEC and DEP systems were shared with all Participants. Solutions of known issues within DEC and DEP were discussed. New or emerging issues identified in the 2020 Study were also discussed with all Participants so that all are aware of potential issues. Appropriate solutions were developed and tested.

The results of the technical analysis were discussed throughout the study area based on thermal loadings greater than 90% for base reliability, and greater than 80% for resource supply options and local economic studies to allow evaluation of project acceleration.

III.F. Assessment and Problem Identification

DEC and DEP performed an assessment in accordance with the methodology and criteria discussed earlier in this section of this report, with the analysis work shared by DEC and DEP. The reliability issues identified from the assessments of both the base reliability cases and the local economic study scenarios were documented and shared within the PWG. These results will be reviewed and discussed with the stakeholder group for feedback.

III.G. Solution Development

The 2020 Study performed by the PWG confirmed base reliability problems already identified (i) by DEC and DEP in company-specific planning studies performed individually by the transmission owners and (ii) by the 2019 Study. The PWG participated in the review of potential solution alternatives to the identified base reliability problems and to the issues identified in the resource supply option analysis. The solution alternatives were simulated using the same assumptions and criteria described in Sections III.A through III.E. DEC and DEP developed planning cost estimates and construction schedules for the solution alternatives.

III.H. Selection of Preferred Reliability Solutions

For the base reliability study, the PWG compared solution alternatives and selected the preferred solution, balancing cost, benefit and risk. The PWG selected a preferred set of transmission improvements that provide a reliable and cost-effective transmission solution to meet customers' needs while prudently managing the associated risks.

III.I. Contrast NCTPC Report to Other Regional Transfer Assessments

For both the DEC and DEP BAAs, the results of the PWG study are consistent with SERC Long-Term Working Group ("LTWG") studies performed for similar timeframes. LTWG studies have recently been performed for the 2025 summer timeframe. The limiting facilities identified in the PWG study of base reliability have been previously identified in the LTWG studies for similar scenarios. These limiting facilities have also been identified in the individual transmission owner's internal assessments required by NERC reliability standards.

IV. Base Reliability Study Results

The 2020 Study verified that DEC and DEP have projects already planned to address reliability concerns for the near-term (5 year) and long-term (10 year) planning horizons. There were no unforeseen problems identified in the reliability studies performed on the base cases.

The 2020 Plan is detailed in Appendix B which identifies the new and updated projects planned with an estimated cost of greater than $10 million. Projects in the 2020 Plan are those projects identified in the base reliability study. For each of these projects, Appendix B provides the project status, the estimated cost, the planned in-service date, and the estimated time to complete the project.

The total estimated cost for the 17 reliability projects included in the 2020 Plan is $804 million as documented in Appendix B. This compares to the original 2019 Plan estimate of $591 million for 14 reliability projects. In-service dates and cost estimates for some projects that are planned or underway have been revised based on updated information. An update to the 2019 plan was provided in the 2020 mid-year update published in June 2020 with an updated cost estimate of $632 million. See Appendix D for a detailed comparison of this year's Plan to the updated 2019 Plan.

V. Local Economic Planning Studies

In 2020, the PWG analyzed as part of the local economic planning studies, scenarios that examine the impacts of high load growth in the Union and Cabarrus County areas of North Carolina. The study assumed 5–6% growth at Union Power Cooperative (UPC) deliveries. Table 5 identifies the two issues that resulted from this high load scenario analysis within the applicable planning window. Multiple alternatives are being investigated to address these identified overload issues other than upgrading the transmission lines. DEC is actively exploring solutions for both of these issues and is engaging NCEMC and UPC in discussions related to determining to best alternatives and solutions.

Table 5

Local Economic Planning Study – High Load Scenario (2025/2030)

Network Facility
Clear Creek 100 kV Line (Harrisburg Tie–Morning Star Tie)
Rocky River 100 kV Line (Monroe Main–Oakboro Tie)

VI. Local Public Policy Study Results

The analysis of this public policy impact was not completed in time for inclusion in this report. The NC offshore wind study results will be provided in a separate report once the full analysis is completed in early 2021.

VII. Collaborative Transmission Plan

The 2020 Plan includes 17 reliability projects with an estimated cost of $10 million or more each. These projects are listed in Appendix B. The total estimated cost for these 17 reliability projects in the 2020 Plan is $804 million. This compares to the original 2019 Plan estimate of $591 million for 14 reliability projects. In-service dates and cost estimates for some projects that are planned or underway have been revised based on updated information. An update to the 2019 plan was provided in the 2020 mid-year update published in June 2020 with an updated cost estimate of $632 million. See Appendix D for a detailed comparison of this year's Plan to the updated 2019 Plan.The list of major projects will continue to be modified on an ongoing basis as new improvements are identified through the NCTPC Process and projects are in-service or eliminated from the list. Appendix C provides a more detailed description of each project in the 2020 Plan and includes the following information:

1) Reliability Projects: Description of the project.

2) Issue Resolved: Specific driver for project.

3) Status: Status of development of the project as described below:

   a. In-Service – Projects with this status are in-service.
   b. Underway – Projects with this status range from the Transmission Owner having some money in its current year budget for the project to the Transmission Owner having completed some construction activities for the project.
   c. Planned – Projects with this status do not have money in the Transmission Owner's current year budget and the project is subject to change.
   d. Conceptual – Projects with this status are not Planned at this time but will continue to be evaluated as a potential project in the future.
   e. Deferred – Projects with this status were identified in the 2019 Report and have been deferred beyond the end of the planning horizon based on the 2020 Study results.

f. Removed - Project is cancelled and no longer in the plan.

4) Transmission Owner: Responsible equipment owner designated to design and implement the project.

5) Projected In-Service Date: The date the project is expected to be placed in service.

6) Estimated Cost: The estimated cost, in nominal dollars, which reflects the sum of the estimated annual cash flows over the expected development period for the specific project (typically 2 – 5 years), including direct costs, loadings and overheads; but not including AFUDC. Each year's cash flow is escalated to the year of the expenditures. The sum of the expected cash flows is the estimated cost.

7) Project lead time: Number of years needed to complete project. For projects with the status of Underway, the project lead time is the time remaining to complete construction of the project and place the project in service.

Appendix A
Interchange Tables

2025 SUMMER PEAK, 2025/2026 WINTER PEAK, 2030 SUMMER PEAK

DUKE ENERGY CAROLINAS

DETAILED INTERCHANGE (BASE)

Duke Energy Carolinas Modeled Imports – MW

	25S	25/26W	30s
CPLE (NCEMC)	45	45	45
CPLE (NCEMC–Hamlet)	165	165	165
PJM (DVP/PJM)	2	2	2
SCEG (Chappells)	2	2	2
SCPSA (PMPA)	219	104	242
SCPSA (Seneca)	25	19	26
SEPA (Hartwell)	180	180	180
SEPA (Thurmond)	113	113	113
SOCO (EU)	231	0	0
SOCO (NCEMC)	44	44	44
Total	**1026**	**674**	**819**

Duke Energy Carolinas Modeled Exports – MW

	25S	25/26W	30s
CPLE (Broad River)	850	850	850
CPLE (NCEMC–Catawba)	307	307	307
CPLE (CPLC)	253	25	0
PJM (NCEMC–Catawba)	100	100	100
SCPSA (Haile)	15	15	15
Total	**1525**	**1297**	**1272**

Duke Energy Carolinas Net Interchange – MW

	25S	25/26W	30s
	499	**623**	**453**

Note: Positive net interchange indicates an export and negative interchange an import.

2025 SUMMER PEAK, 2025/2026 WINTER PEAK, 2030 SUMMER PEAK

DUKE ENERGY PROGRESS (EAST)

DETAILED INTERCHANGE (BASE)

Duke Energy Progress (East) Modeled Imports – MW

	25S	**25/26W**	**30s**
PJM (NCEMC–AEP)	100	100	100
PJM (NCEMC)	75	75	75
DUK (Broad River)	850	850	850
DUK (NCEMC–Catawba)	307	307	307
DUK (CPLC)	253	25	0
PJM (SEPA–KERR)	95	95	95
Total	**1680**	**1452**	**1427**

Duke Energy Progress (East) Modeled Exports – MW

	25S	**25/26W**	**30s**
CPLW (Transfer)	0	150	0
PJM (NCEMC–Hamlet)	165	165	165
DUK (NCEMC)	45	45	45
DUK (NCEMC–Hamlet)	165	165	165
Total	**375**	**525**	**375**

Duke Energy Progress (East) Net Interchange – MW

	25S	**25/26W**	**30s**
	-1305	**-927**	**-1052**

Note: Positive net interchange indicates an export and negative interchange an import.

2025 SUMMER PEAK, 2025/2026 WINTER PEAK, 2030 SUMMER PEAK

DUKE ENERGY PROGRESS (WEST)

DETAILED INTERCHANGE (BASE)

Duke Energy Progress (West) Modeled Imports – MW

	25S	25/26W	30s
CPLE (Transfer)	0	150	0
SCPSA (Waynesville)	22	22	22
TVA (SEPA)	14	14	14
Total	**36**	**186**	**36**

Duke Energy Progress (West) Modeled Exports – MW

	25S	25/26W	30s
–--	---	---	---
Total	**---**	**---**	**---**

Duke Energy Progress (West) Net Interchange – MW

	25S	25/26W	30s
	-36	**-186**	**-36**

Note: Positive net interchange indicates an export and negative interchange an import.

2025 SUMMER PEAK, 2025/2026 WINTER PEAK, 2030 SUMMER PEAK DUKE ENERGY DUKE ENERGY PROGRESS (WEST), DUKE ENERGY PROGRESS (EAST) DETAILED INTERCHANGE (TRM)

Duke Energy Progress (West) Modeled Imports – MW

	25S, 25/26W, 30S
AEP (TRM)	69
DUK (TRM)	191
TVA (TRM)	20
Total	**280**

Duke Energy Progress (East) Modeled Imports – MW

	25S, 25/26W, 30S
AEP (TRM)	100
DUK (TRM)	773
DVP (TRM)	427
SCEG (TRM)	200
SCPSA (TRM)	326
Total	**1826**

Note: Imports and exports for TRM are in addition to Base transfers

Appendix B
Transmission Plan Major Project Listings – **Reliability Projects**

2020 Collaborative Transmission Plan – Reliability Projects (Estimated Cost > $10M) Items identified in red are changes from the previous report.						
Project ID	Reliability Project	Status[1]	Transmission Owner	Projected In-Service Date	Estimated Cost ($M)[2]	Project Lead Time (Years)[3]
0024	Durham–RTP 230 kV Line, Reconductor	Conceptual	DEP	TBD	20	4
0028	Brunswick #1–Jacksonville 230 kV Line, Loop into Folkstone 230 kV Substation	Removed	DEP	–	–	–
0031	Jacksonville–Grants Creek 230 kV Line and Grants Creek 230/115 kV Substation	In-service	DEP	6/1/2020	72	–
0032	Newport–Harlowe 230 kV Line, Newport SS and Harlowe 230/115 kV Substation	In-service	DEP	6/1/2020	55	–
0034	Sutton–Castle Hayne 115 kV North Line, Rebuild	Underway	DEP	6/1/2021	30	0.5

2020 Collaborative Transmission Plan – Reliability Projects (Estimated Cost > $10M) Items identified in red are changes from the previous report.						
Project ID	Reliability Project	Status[1]	Transmission Owner	Projected In-Service Date	Estimated Cost ($M)[2]	Project Lead Time (Years)[3]
0039	Asheboro–Asheboro East 115 kV North Line, Reconductor	Underway	DEP	6/1/2022	24	1.5
0042	Rural Hall 100 kV, Install SVC	In-service	DEC	3/17/2020	44	–
0043	Orchard Tie 230/100 kV Tie Station, Construct	In-service	DEC	8/26/2020	104	–
0046	Windmere 100 kV Line (Dan River-Sadler), Construct	Underway	DEC	8/1/2023	26	2.5

2020 Collaborative Transmission Plan – Reliability Projects (Estimated Cost > $10M)

Items identified in red are changes from the previous report.

Project ID	Reliability Project	Status[1]	Transmission Owner	Projected In-Service Date	Estimated Cost ($M)[2]	Project Lead Time (Years)[3]
0048	Wilkes 230/100 kV Tie Station, Construct	Underway	DEC	6/1/2024	69	3
0050	Craggy–Enka 230 kV Line, Construct	Conceptual	DEP	12/1/2026	80	4
0051	Cokesbury 100 kV Line (Coronaca–Hodges), Upgrade	Planned	DEC	12/1/2024	16	3
0052	South Point Switching Station, Construct	Planned	DEC	12/1/2024	110	4
0053	Wateree 115 kV Plant, Upgrade 115/100 kV Transformers	Underway	DEP	12/1/2022	12	2

2020 Collaborative Transmission Plan – Reliability Projects (Estimated Cost > $10M) Items identified in red are changes from the previous report.						
Project ID	Reliability Project	Status[1]	Transmission Owner	Projected In-Service Date	Estimated Cost ($M)[2]	Project Lead Time (Years)[3]
0054	Carthage 230/115 kV Substation, Construct Sub	Conceptual	DEP	12/1/2027	15	4
0055	Falls 230 kV Sub, Add 300 MVAR SVC	Conceptual	DEP	12/1/2028	50	4
0056	Castle Hayne–Folkstone115 kV Line, Rebuild	Conceptual	DEP	12/1/2028	52	4
0057	Holly Ridge North 115 kV Switching Station, Construct	Conceptual	DEP	12/1/2028	25	4
TOTAL					**804**	

[1] Status: ***In-service***: Projects with this status are in-service. This status was updated as of 12/1/2020.

Underway: Projects with this status range from the Transmission Owner having some money in its current year budget for the project to the Transmission Owner having completed some construction activities for the project.

***Planned**:* Projects with this status do not have money in the Transmission Owner's current year budget; and the project is subject to change.

***Conceptual**:* Projects with this status are not p*lanned* at this time but will continue to be evaluated as a potential project in the future.

***Deferred**:* Projects with this status were identified in the 2019 Report and have been deferred beyond the end of the planning horizon based on analysis performed to develop the 2020 Collaborative Transmission Plan.

Removed: Project is cancelled and no longer in the plan

[2] The estimated cost is in nominal dollars which reflects the sum of the estimated annual cash flows over the expected development period for the specific project (typically 2 – 5 years), including direct costs, loadings and overheads; but not including AFUDC. Each year's cash flow is escalated to the year of the expenditures. The sum of the expected cash flows is the estimated cost.

[3] For projects with a status of Underway, the project lead time is the time remaining to complete construction and place in-service.

Appendix C
Transmission Plan Major Project Descriptions – Reliability Projects

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Note: The estimated cost for each of the projects described in Appendix C is in nominal dollars which reflects the sum of the estimated annual cash flows over the expected development period for the specific project (typically 2 – 5 years), including direct costs, loadings and overheads; but not including AFUDC. Each year's cash flow is escalated to the year of the expenditures. The sum of the expected cash flows is the estimated cost.

Project ID and Name: 0024 – Durham–RTP 230 kV Line, Reconductor

Project Description
Reconductor approximately 10 miles of 230 kV line with 6–1590 ACSR conductor.

Status	Conceptual
Transmission Owner	DEP
Planned In-Service Date	TBD
Estimated Time to Complete	4 years
Estimated Cost	$20 M

Narrative Description of the Need for this Project
With Harris Plant down, a common tower outage of the Method (DEC)–East Durham and the Durham–Method 230 kV Lines will cause an overload of the Durham 500 kV Sub-RTP 230 kV Switching Station Line.

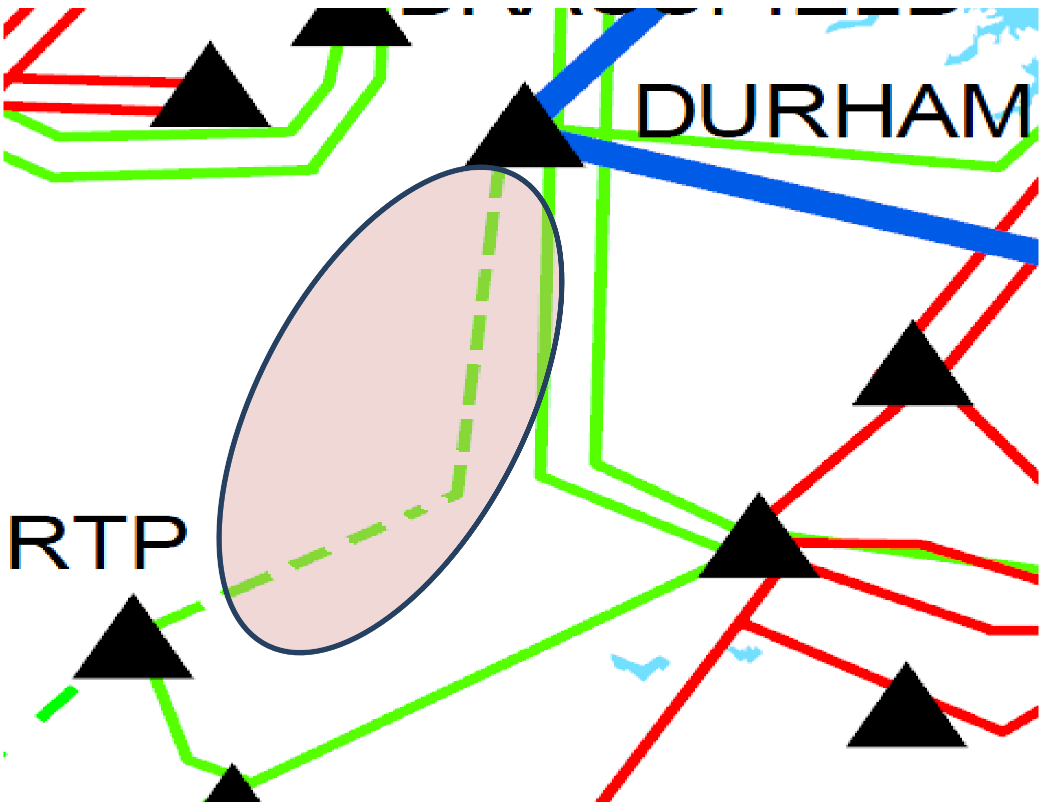
Other Transmission Solutions Considered
Construct a new line between Durham and RTP 230 kV subs.

Why this Project was Selected as the Preferred Solution
Cost and feasibility. Reconductoring is much more cost effective.

C–1

Durham–RTP 230 kV Line

- **NERC Category P3 Violation**
- **Problem:** With Harris Plant down, a common tower outage of the Method (DEC)–East Durham and the Durham–Method 230 kV Lines will cause an overload of the Durham 500 kV Sub-RTP 230 kV Switching Station Line.
- **Solution:** Reconductor approximately 10 miles of 230 kV line with 6-1590 ACSR conductor.



Project ID and Name: 0031 – Jacksonville–Grants Creek 230 kV Line and Grants Creek 230/115 kV Substation

Project Description
The project scope consists of constructing a new 230 kV Line from Jacksonville 230 kV to a new 230 kV substation in the Grants Creek area. The 230 kV line shall be constructed with 6-1590 MCM ACSR or equivalent and will convert the existing Jacksonville–Havelock 230 kV Line into Jacksonville–Grants Creek 230 kV Line and Grants Creek–Havelock 230 kV Line. The new 230 kV Grants Creek Substation will be built with 4-230 kV breakers, a new 230/115 kV transformer, and tap into the Jacksonville City–Harmon POD 115 kV Feeder with 1-115 kV breaker.

Status	**In-service**
Transmission Owner	DEP
Planned In-Service Date	6/1/2020
Estimated Time to Complete	Completed
Estimated Cost	$72 M

Narrative Description of the Need for this Project
The common tower outage of Jacksonville – Havelock 230 kV Line and Jacksonville – Jacksonville City 115 kV Line may cause the voltages in the Camp Lejeune area to fall below the planning criteria. Also, outage of the Jacksonville–New Bern 230 kV Line may cause the Havelock–Jacksonville 230 kV to overload.

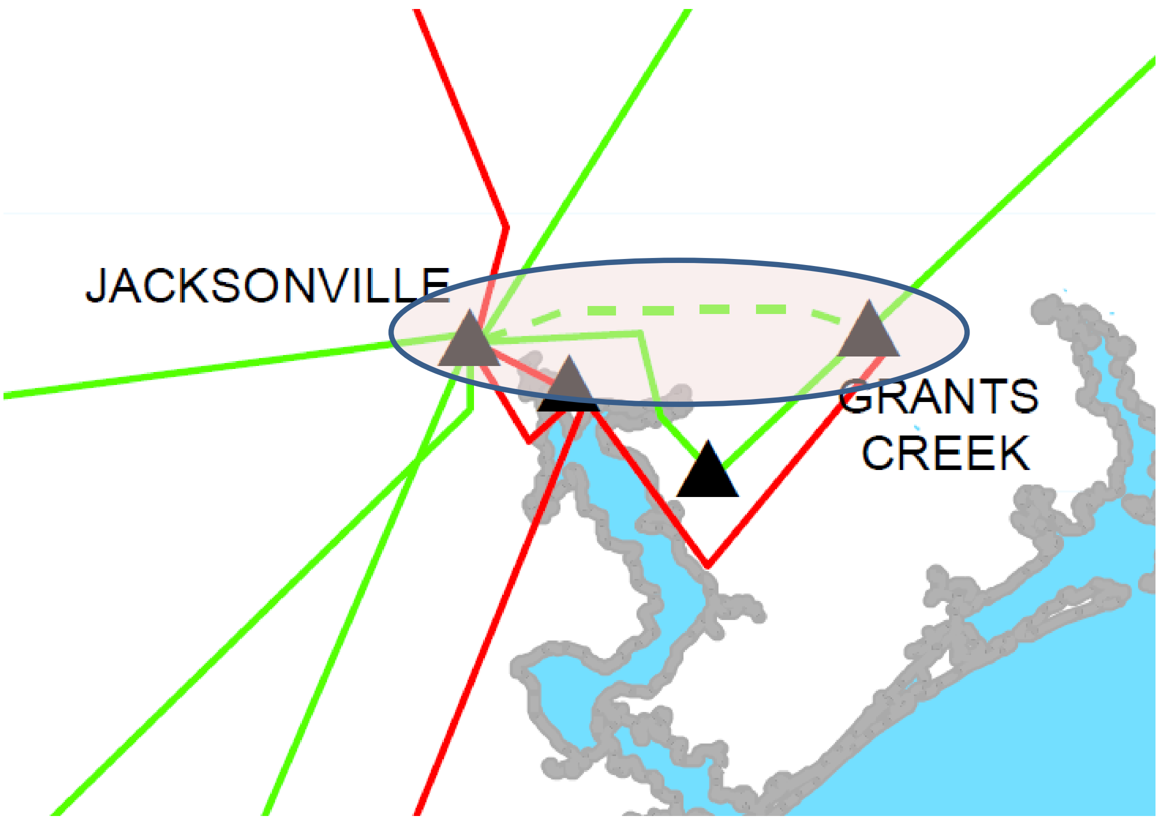
Other Transmission Solutions Considered
Construct 230 kV feeder from Jacksonville to Camp Lejeune Tap.

Why this Project was Selected as the Preferred Solution
The alternate solution was determined to be infeasible due to routing challenges.

C–2

Jacksonville–Grants Creek 230 kV Line and Grants Creek 230/115 kV Substation

- **NERC Category P7 violation**
- **Problem:** The common tower outage of Jacksonville – Havelock 230 kV Line and Jacksonville – Jacksonville City 115 kV Line may cause the voltages in the Camp Lejeune area to fall below the planning criteria. Also, outage of the Jacksonville–New Bern 230 kV Line may cause the Havelock–Jacksonville 230 kV Line to overload.
- **Solution:** Construct new 230 kV line and substation.



Project ID and Name: 0032 – Newport–Harlowe 230 kV Line, Newport SS and Harlowe 230/115 kV Substation

Project Description
Construct new 230 kV Switching Station in the Newport Area, construct new 230 kV Substation in the Harlowe Area, and construct the Newport Area–Harlowe Area 230 kV line comprised of 3-1590 MCM ACSR or equivalent. The Newport Area 230 kV Switching Station will initially consist of a 3-breaker ring bus but should be laid out for future development as a standard 230/115 kV substation with breaker-and-a-half configuration in the 230 kV yard. The Harlowe Area 230 kV Substation will initially consist of one 200 MVA (or 300MVA), 230/115 kV transformer and 3-115 kV breakers, and should be laid out for future development as a standard 230/115 kV substation with breaker-and-a-half configuration in the 230 kV yard.

Status	**In-service**
Transmission Owner	DEP
Planned In-Service Date	6/1/2020
Estimated Time to Complete	Completed
Estimated Cost	$55 M

Narrative Description of the Need for this Project
By summer 2020, an outage of the Havelock terminal of the Havelock–Morehead Wildwood 115 kV North Line will cause the voltages in the Havelock area to fall below planning criteria. The construction of this new line will mitigate this voltage problem.

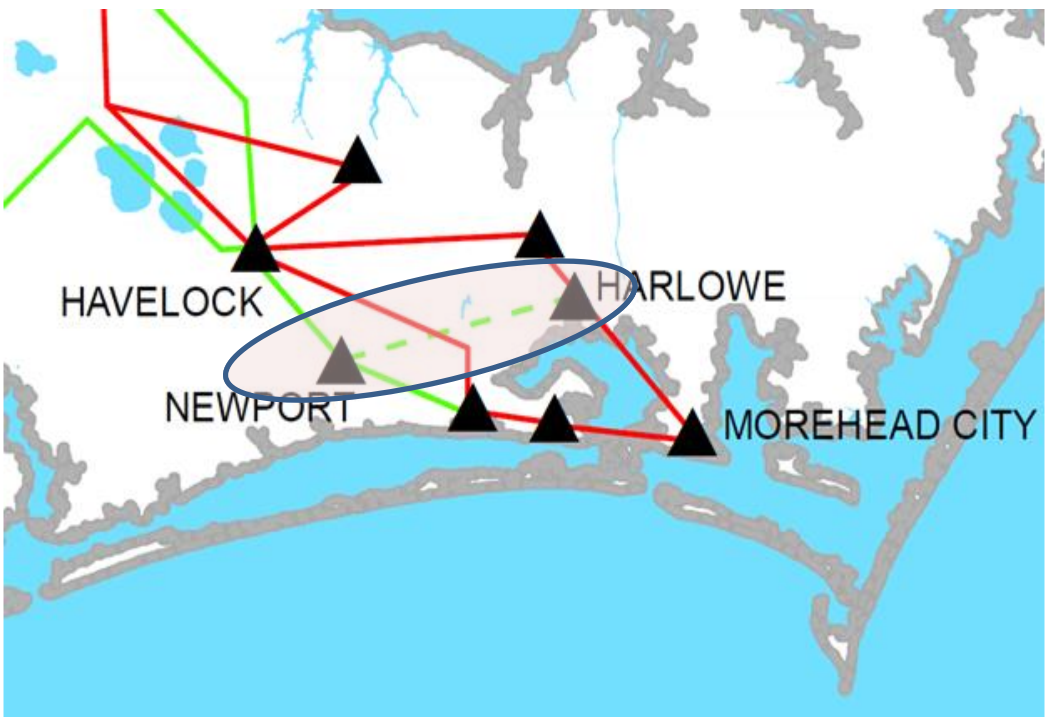
Other Transmission Solutions Considered
Convert Havelock–Morehead Wildwood115 kV North Line to 230 kV.

Why this Project was Selected as the Preferred Solution
The cost and construction feasibility are much better with selected alternative.

C–3

Newport–Harlowe 230 kV Line, Newport SS and Harlowe 230/115 kV Substation

- **NERC Category P1 violation**
- **Problem:** By summer 2020, an outage of the Havelock terminal of the Havelock–Morehead Wildwood 115 kV North Line will cause the voltages in the Havelock area to fall below planning criteria. The construction of this new line will mitigate this voltage problem.
- **Solution:** Construct new 230 kV line, switching station and substation.



Project ID and Name: 0034 – Sutton–Castle Hayne 115 kV North Line, Rebuild

Project Description
This project consists of rebuilding the Sutton Plant – Castle Hayne 115 kV North Line using 1272 MCM ACSR conductor or equivalent (approximately 8 miles). The line traps at both Sutton and Castle Hayne terminals will be removed in conjunction with the installation of OPGW. The 800 A current transformers at both line terminals will have to be uprated as part of this project.

Status	Underway
Transmission Owner	DEP
Planned In-Service Date	6/1/2021
Estimated Time to Complete	0.5 years
Estimated Cost	$30 M

Narrative Description of the Need for this Project
By 2021, with all area generation online, the loss of the Sutton Plant–Castle Hayne 115 kV South Line will cause the Sutton Plant–Castle Hayne 115 kV North Line to exceed its thermal rating.

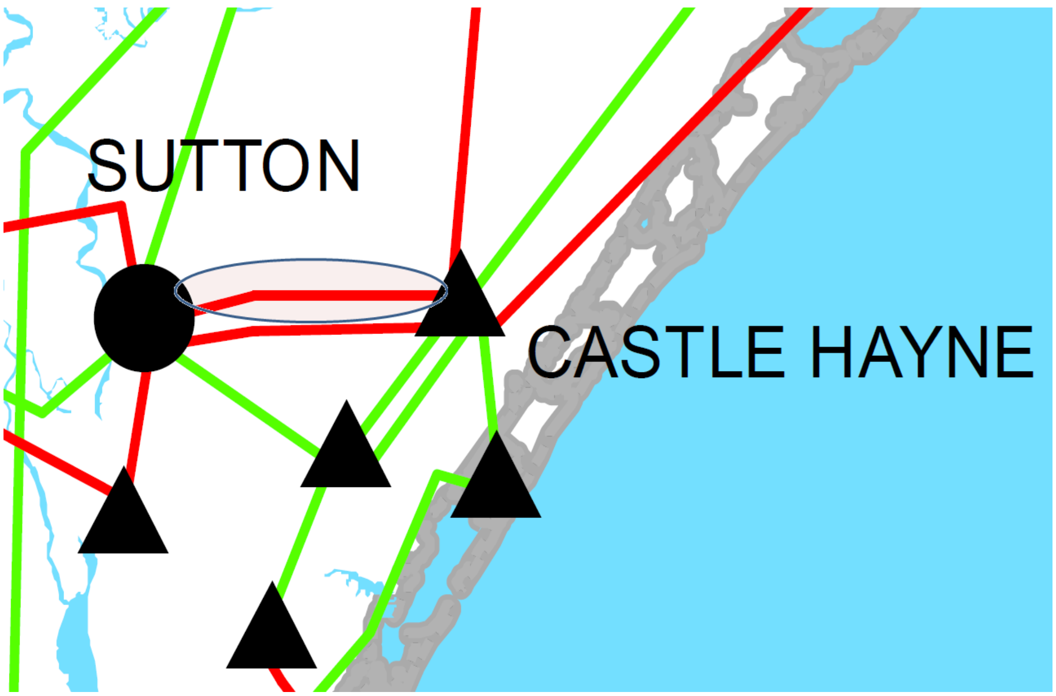
Other Transmission Solutions Considered
Convert 115 kV line to 230 kV.

Why this Project was Selected as the Preferred Solution
Cost and feasibility are much improved with selected alternative.

C–4

Sutton–Castle Hayne 115 kV North Line, Rebuild

- **NERC Category P1 violation**
- **Problem:** By 2021, with all area generation online, the loss of the Sutton Plant–Castle Hayne 115 kV South Line will cause the Sutton Plant–Castle Hayne 115 kV North Line to exceed its thermal rating.
- **Solution:** Rebuild 115 kV line.



Project ID and Name: 0039 – Asheboro–Asheboro East 115 kV North Line, Reconductor

Project Description
This project consists of rebuilding/reconductoring approximately 6.5 miles of the existing 115 kV line using 3-1590 or equivalent conductor. This project requires the replacement of disconnect switches at Asheboro 230 kV and the replacement of the breaker, the disconnect switches, and the 115 kV east bus at Asheboro East 115 kV associated with this line. Both ends of the line will also require CT/metering equipment upgrades such that they are not the limit to the line rating. The upgraded equipment for this line should be 2000 amp minimum.

Status	Underway
Transmission Owner	DEP
Planned In-Service Date	6/1/2022
Estimated Time to Complete	1.5 years
Estimated Cost	$24 M

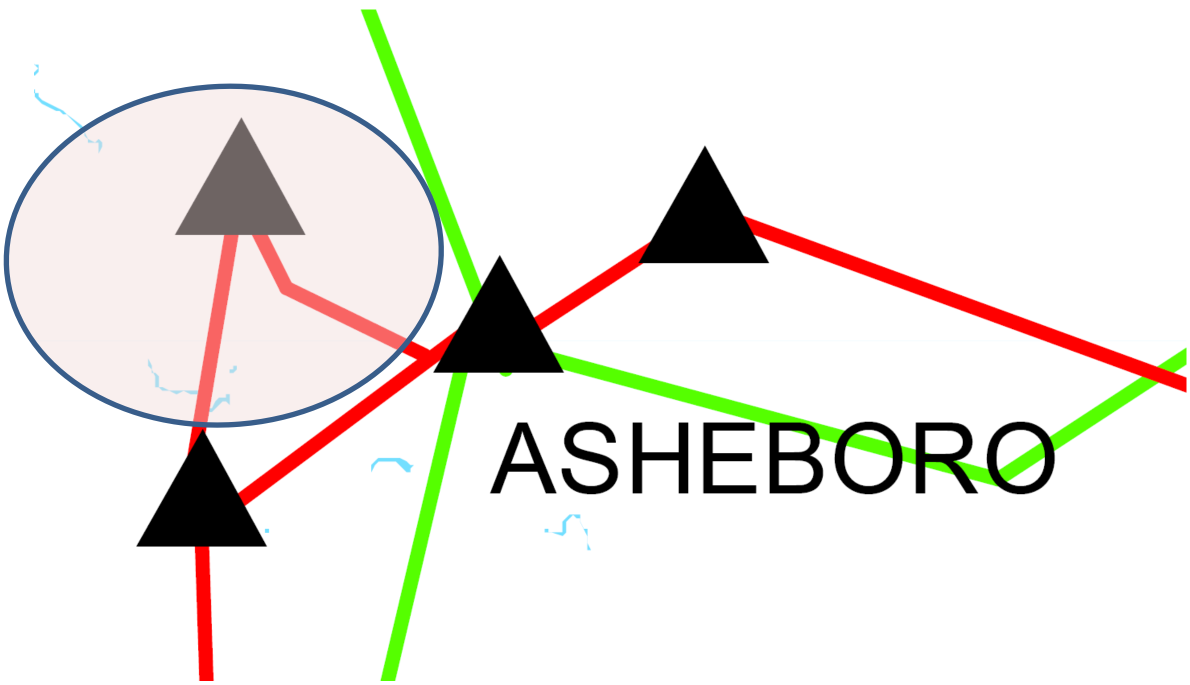
Narrative Description of the Need for this Project
This project is needed to alleviate loading on the Asheboro–Asheboro East 115 kV North line under the contingency of losing the Asheboro–Asheboro East 115 kV South line with Harris Plant down.

Other Transmission Solutions Considered
Construct a new 115 kV line from Asheboro to Asheboro East.

Why this Project was Selected as the Preferred Solution
Cost and feasibility.

Asheboro–Asheboro East 115 kV North Line, Reconductor

- **NERC Category P3 violation**
- **Problem:** By the summer of 2020, with Harris down, the loss of the Asheboro–Asheboro East 115 kV South line will cause the Asheboro–Asheboro East 115 kV North line to overload.
- **Solution:** Rebuild/reconductor the Asheboro–Asheboro East 115 kV North Line and upgrade equipment.



Project ID and Name: 0042 – Rural Hall 100 kV, Install SVC

Project Description
This project consists of installing a -100/+300 MVAR SVC at Rural Hall 100 kV.

Status	**In-service**
Transmission Owner	DEC
Planned In-Service Date	3/17/2020
Estimated Time to Complete	Completed
Estimated Cost	$44 M

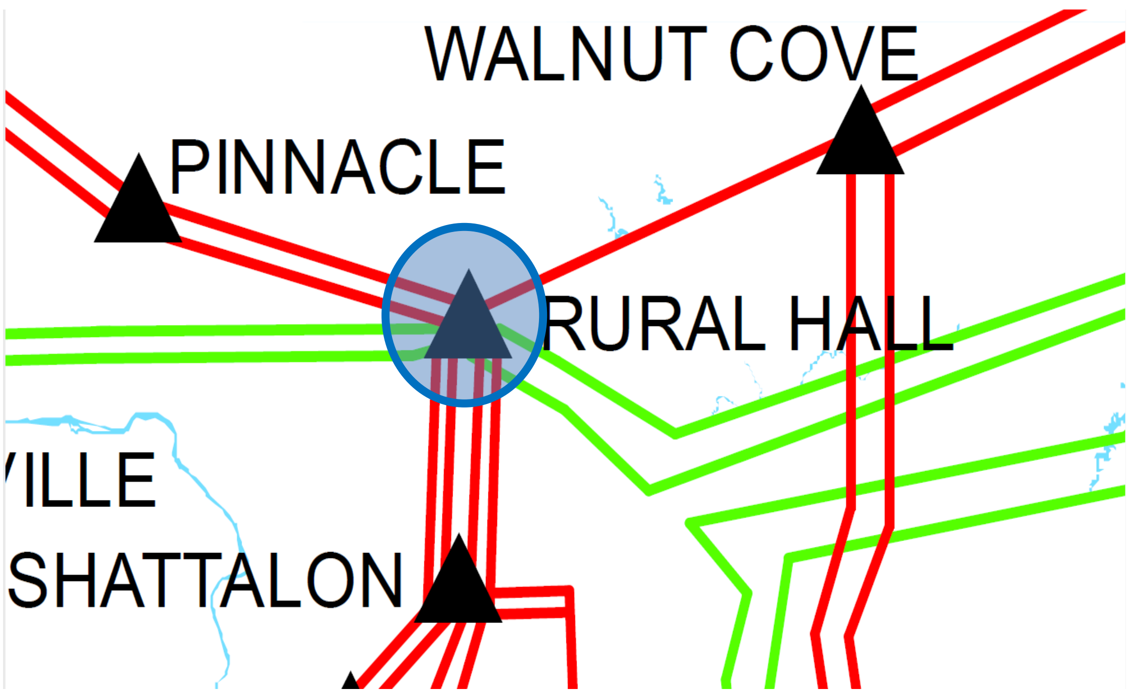
Narrative Description of the Need for this Project
Installation of an SVC at Rural Hall will mitigate dynamic voltage concerns driven by certain contingency conditions in DEC.

Other Transmission Solutions Considered
New generation.

Why this Project was Selected as the Preferred Solution
Solution can be implemented quicker than new generation and at a lower cost.

Rural Hall 100 kV, Install SVC

- **Problem:** Under certain conditions, additional voltage support is required in order to maintain system reliability.
- **Solution:** The installation of an SVC at Rural Hall 100 kV will provide voltage support to the region and increase system reliability under certain conditions. As part of the project there will be a reconfiguration of the 100 kV capacitors at Rural Hall.



Project ID and Name: 0043 – Orchard Tie 230/100 kV Tie Station, Construct

Project Description
This project consists of constructing the Orchard Tie 230/100 kV Tie Station

Status	In-Service
Transmission Owner	DEC
Planned In-Service Date	8/26/2020
Estimated Time to Complete	Completed
Estimated Cost	$104 M

Narrative Description of the Need for this Project
The installation of this new 230/100 kV tie station will provide greater ability to meet local load growth and maintain compliance with NERC Transmission Planning Standards.

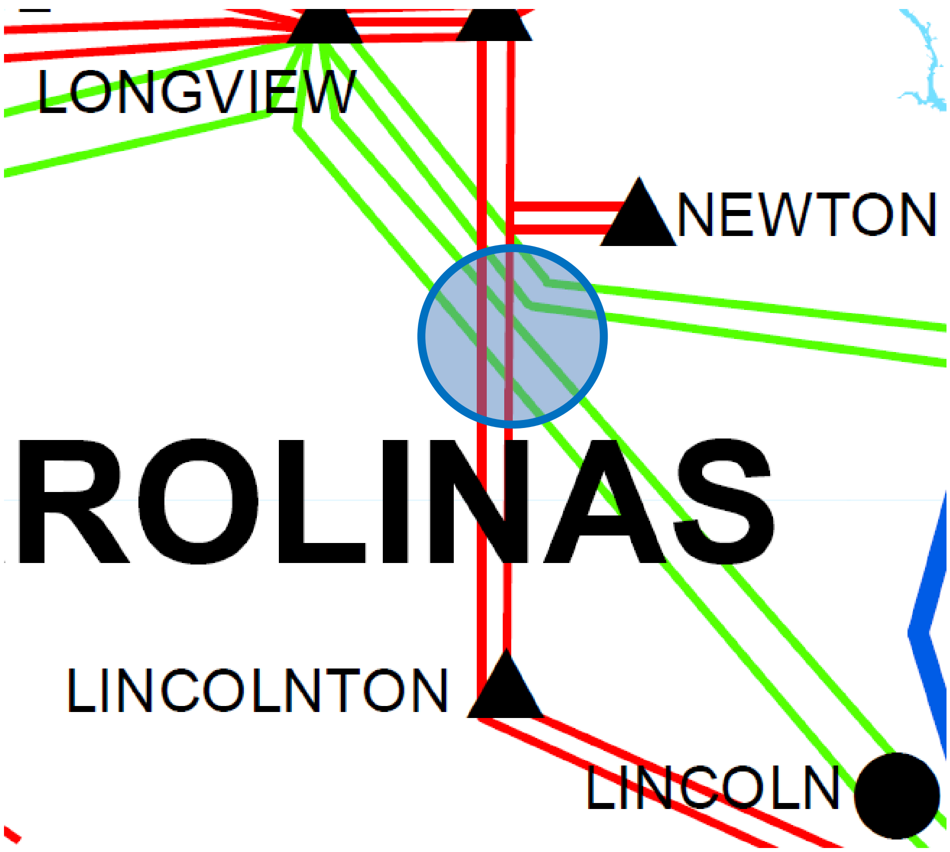
Other Transmission Solutions Considered
Upgrade ≈30 miles of 100 kV.

Why this Project was Selected as the Preferred Solution
Ability to meet local load growth and cost of rebuilding 100 kV line.

C–7

Orchard Tie 230/100 kV Tie Station, Construct

- **Problem:** Existing transmission lines are not sufficient to meet local load growth.
- **Solution:** Fold-in existing 230 kV and 100 kV lines to new station. Add sufficient transformation between 230 kV and 100 kV.



Project ID and Name: 0046 – Windmere 100 kV Line (Dan River–Sadler), Construct

Project Description
This project consists of building a new 100 kV line (954 AAC) along an existing ROW.

Status	Underway
Transmission Owner	DEC
Planned In-Service Date	8/1/2023
Estimated Time to Complete	2.5 years
Estimated Cost	$26 M

Narrative Description of the Need for this Project
The Reidsville and Wolf Creek 100 kV lines (Dan River–Sadler) can become overloaded for the loss of any of the circuits between Dan River and Sadler.

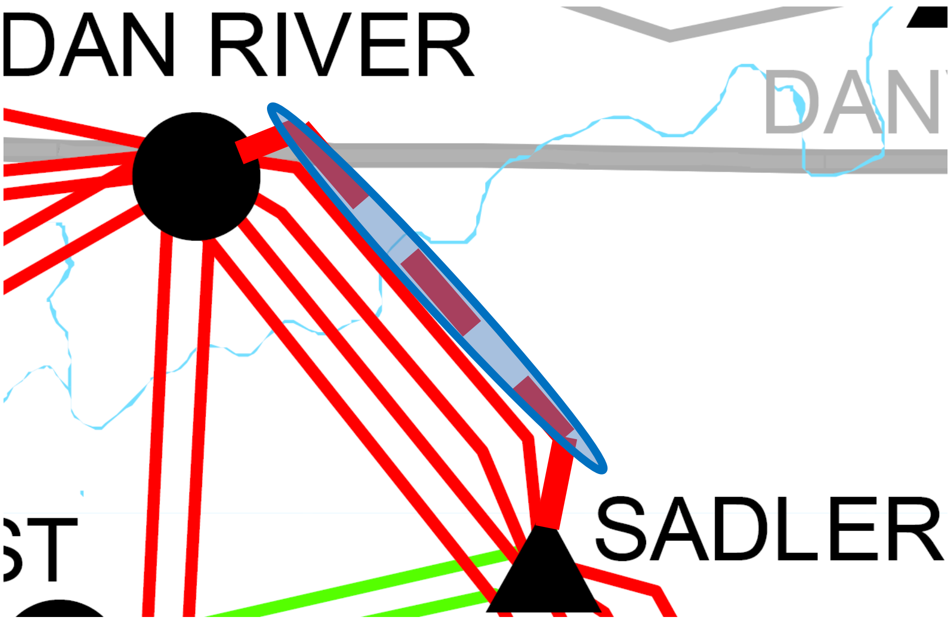
Other Transmission Solutions Considered
Rebuilding both double circuit 100 kV lines (≈8 miles each) between Dan River and Sadler.

Why this Project was Selected as the Preferred Solution
Greater operational flexibility in the area.

C–8

Windmere 100 kV Line (Dan River–Sadler), Construct

- **NERC Category P3 violation**
- **Problem:** Loss of any of the four existing 100 kV circuits between Dan River and Sadler and can overload the remaining circuits.
- **Solution:** Construct new 100 kV line.



Project ID and Name: 0048 – Wilkes 230/100 kV Tie Station, Construct

Project Description
This project consists of building a new 230/100 kV Wilkes tie station and re-routing local transmission lines.

Status	Underway
Transmission Owner	DEC
Planned In-Service Date	6/1/24
Estimated Time to Complete	3 years
Estimated Cost	$69 M

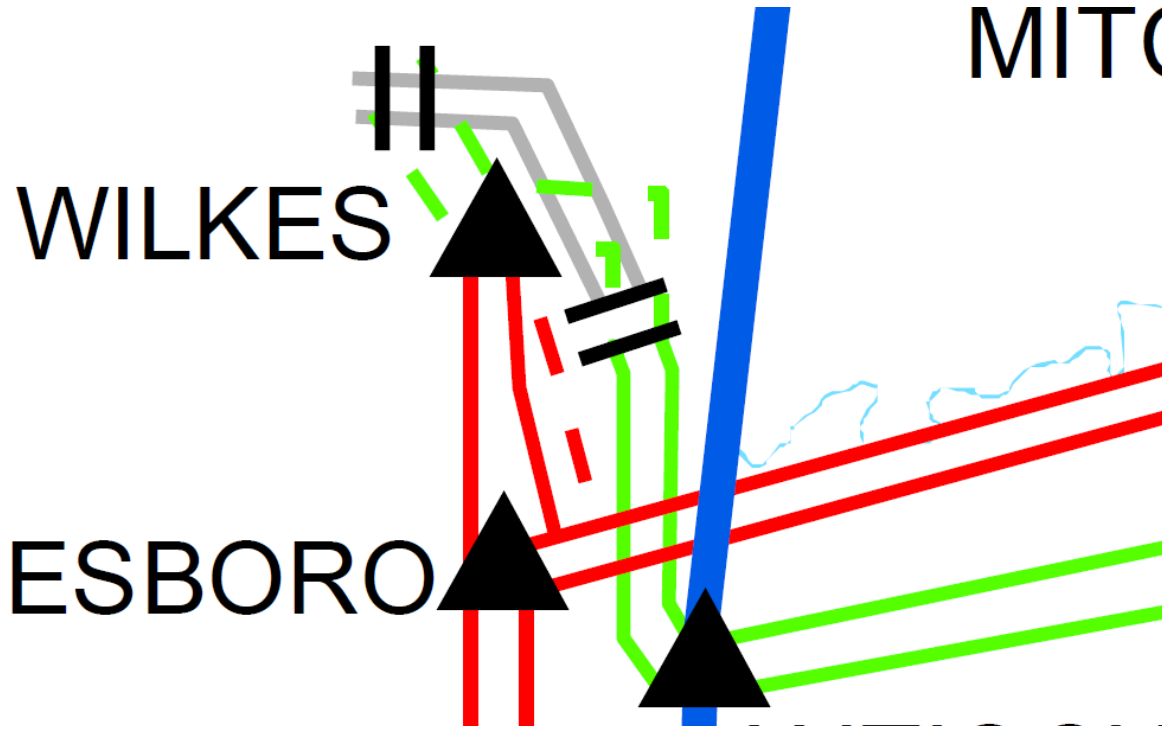
Narrative Description of the Need for this Project
The primary driver for this project is to increase support in the area around Wilkesboro NC. Contingencies, especially in the winter, have the tendency to drop voltage in the area as well as some thermal loading concerns with the loss of the Oxford 100 kV line. The secondary driver is to alleviate the need to rebuild N Wilkesboro Tie as a result of the need to install a bus junction breaker at N Wilkesboro Tie. Presently, loss of the single N Wilkesboro bus takes out six 100 kV lines, causes loss of load and low voltage problems in the area. Installation of a bus junction breaker would also cause thermal loading issues requiring a line upgrade. This project also makes use of 230 kV transmission lines that pass adjacent to the new 230/100 kV tie station.

Other Transmission Solutions Considered
Rebuild N Wilkesboro Tie to allow installation of a bus tie breaker.

Why this Project was Selected as the Preferred Solution
Greater long term value to system and operational flexibility in the area.

Wilkes 230/100 kV Tie Station, Construct

- **NERC Category P1, P2, & P3 violation**
- **Problem:** Contingency events in the Wilkesboro, NC area cause thermal loading issues, loss of load and low voltage problems in the area.
- **Solution:** Construct new 230/100 kV tie station.



Project ID and Name: 0050 – Craggy-Enka 230 kV Line, Construct

Project Description
This project consists of constructing approximately 10 miles of new 230 kV transmission line between the Craggy and Enka Substations.

Status	Conceptual
Transmission Owner	DEP
Planned In-Service Date	12/1/2026
Estimated Time to Complete	4 years
Estimated Cost	$80 M

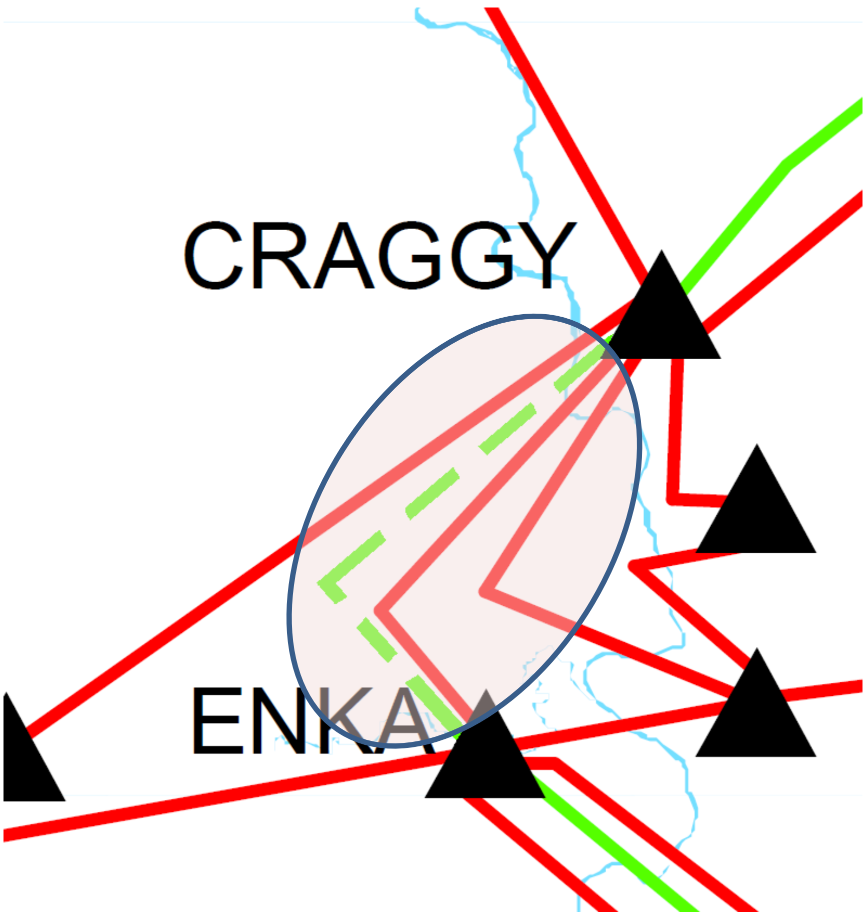
Narrative Description of the Need for this Project
Opening the Asheville end of the Oteen 115 kV West line overloads the Enka – West Asheville 115 kV line. Also, a NERC P6 outage of Craggy–Enka 115 and Asheville–Oteen 115 West lines has no viable operating procedure beginning 12/1/2026. Outage of the West Asheville 115 kV bus overloads the Craggy–Enka 115 kV line.

Other Transmission Solutions Considered
Reconductoring multiple transmission lines. These include the Enka–West Asheville 115 kV Line, the Craggy–Enka 115 kV line, the Canton–Craggy 115 kV Line, and the Asheville–Oteen 115 kV East Line.

Why this Project was Selected as the Preferred Solution
Cost and feasibility.

Craggy–Enka 230 kV Line, Construct

- **NERC Category P3 & P6 violation**
- **Problem:** Opening the Asheville end of the Oteen 115 kV West line overloads the Enka – West Asheville 115 kV line. Also, a NERC P6 outage of Craggy–Enka 115 kV and Asheville–Oteen 115 kV West lines has no viable operating procedure beginning 12-2026. Outage of the West Asheville 115 kV bus overloads the Craggy–Enka 115 kV line.
- **Solution:** Construct the Craggy–Enka 230 kV Line.



Project ID and Name: 0051 – Cokesbury 100 kV Line (Coronaca–Hodges), Upgrade

Project Description
This project consists of rebuilding 9.2 miles of the existing 477 ACSR conductor with 1272 ACSR.

Status	Planned
Transmission Owner	DEC
Planned In-Service Date	12/1/24
Estimated Time to Complete	3 years
Estimated Cost	$16 M

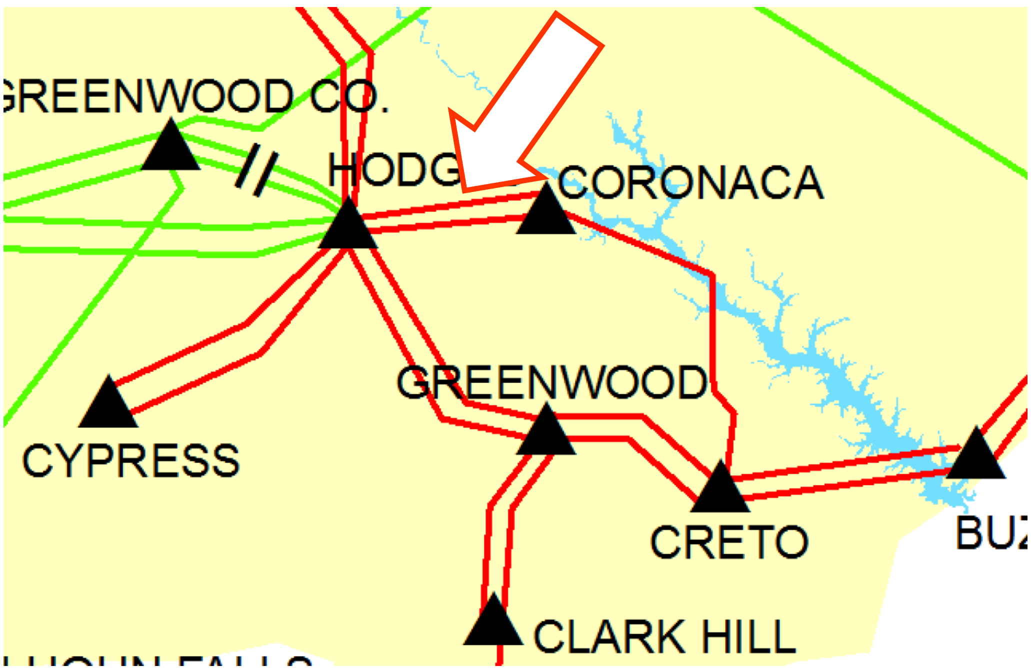
Narrative Description of the Need for this Project
These lines may become overloaded for loss of one of the circuits.

Other Transmission Solutions Considered
New transmission line(s).

Why this Project was Selected as the Preferred Solution
New transmission line(s) would require additional right-of-way, adding to the cost of the project.

Cokesbury 100 kV Line (Coronaca–Hodges), Upgrade

- **NERC Category P3 violation**
- **Problem:** Loss of one of the Greenwood–Hodges 100 kV lines may overload the remaining line.
- **Solution:** Rebuild 100 kV lines with higher capacity conductors.



Project ID and Name: 0052 – South Point Switching Station, Construct

Project Description
This project consists of replacing (in a new location) the switchyard at Allen Steam Station and upgrading the existing 230/100 kV transformers.

Status	Planned
Transmission Owner	DEC
Planned In-Service Date	6/1/24
Estimated Time to Complete	3 years
Estimated Cost	$110 M

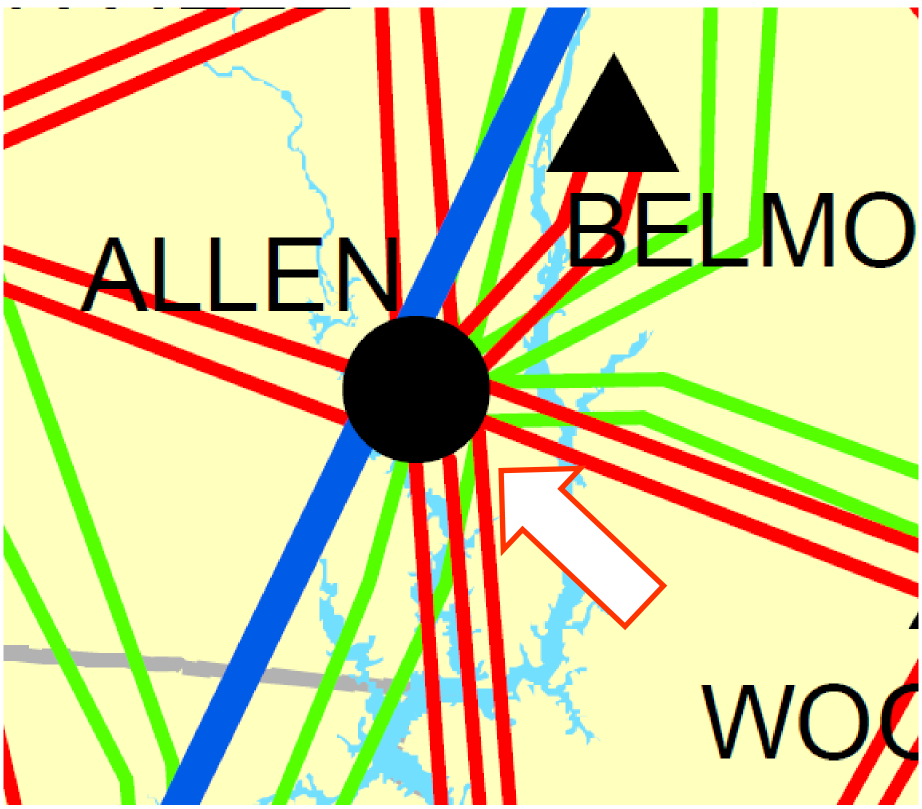
Narrative Description of the Need for this Project
The transformers may become overloaded for loss of the other transformer, and there are obsolescence issues with the existing switchyard at Allen Steam Station.

Other Transmission Solutions Considered
Convert Wylie Switching Station to 230/100 kV. Rebuild Allen Steam Station in its current location, and replace existing 230/100 kV transformers at Allen Steam Station.

Why this Project was Selected as the Preferred Solution
Cost and timing

South Point Switching Station, Construct

- **NERC Category P3 Violation**
- **Problem:** Post-generation retirement at Allen Steam Station, loss of one 230/100 kV transformers at Allen may overload the remaining transformer.
- **Solution:** Upgrade to larger transformers



Project ID and Name: 0053 – Wateree 115 kV Plant, Upgrade 115/100 kV Transformers

Project Description
This project consists of replacing the two existing 115/100 kV autotransformers at Wateree Plant with two new 168 MVA 115/100 kV autotransformers. While the two existing 115/100 kV Wateree transformers share a single breaker, the new transformers will be separately breakered so that either one can trip out with the other bank still transferring power between DEP and DEC. (The Wateree Plant is owned by DEC, but the existing 115/100 kV transformers and the 115 kV bus are owned by DEP.)

Status	Underway
Transmission Owner	DEP
Planned In-Service Date	12/1/2022
Estimated Time to Complete	2 years
Estimated Cost	$12 M

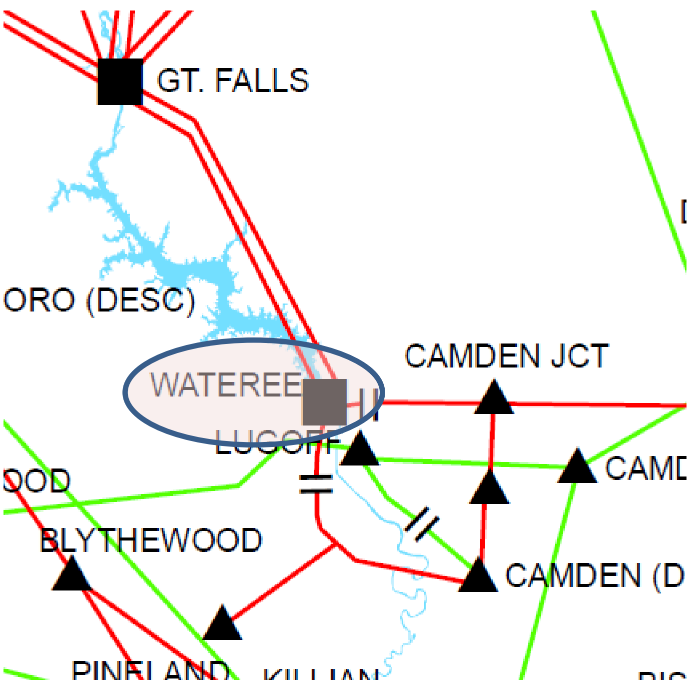
Narrative Description of the Need for this Project
By winter 2022-23, the NERC P3 outage of Robinson Nuclear plus outage of either the Richmond–Newport 500 kV line or the Camden–Lugoff 230 kV line causes an overload of the existing Wateree 115/100 kV transformers. In addition, the existing Wateree 115/100 kV transformers have reached end of life based on analysis from Asset Management.

Other Transmission Solutions Considered
New transmission lines.

Why this Project was Selected as the Preferred Solution
The cost and construction feasibility are much better with selected alternative.

Wateree 115 kV Plant, Upgrade 115/100 kV Transformers

- **NERC Category P3 violation**
- **Problem:** By winter 2022-23, the NERC P3 outage of Robinson Nuclear plus outage of either the Richmond–Newport 500 kV line or the Camden–Lugoff 230 kV line causes an overload of the existing Wateree 115/100 kV transformers. In addition, the existing Wateree 115/100 kV transformers have reached end of life based on analysis from Asset Management.
- **Solution:** Upgrade existing transformers.



Project ID and Name: 0054 – Carthage 230/115 kV Substation, Construct Substation

Project Description
Construct a new 230/115 kV substation near the existing Carthage 115 kV substation. Loop in the existing Cape Fear–West End 230 kV line and West End–Southern Pines 115 kV feeder. The new Carthage 230–West End 115 kV line will be normally open at Carthage 230.kV.

Status	Conceptual
Transmission Owner	DEP
Planned In-Service Date	12/1/2027
Estimated Time to Complete	4 years
Estimated Cost	$15 M

Narrative Description of the Need for this Project
By winter 2027-28, the NERC P1 outage of one West End transformer overloads the other and voltage at Southern Pines 115 kV drops below criteria.

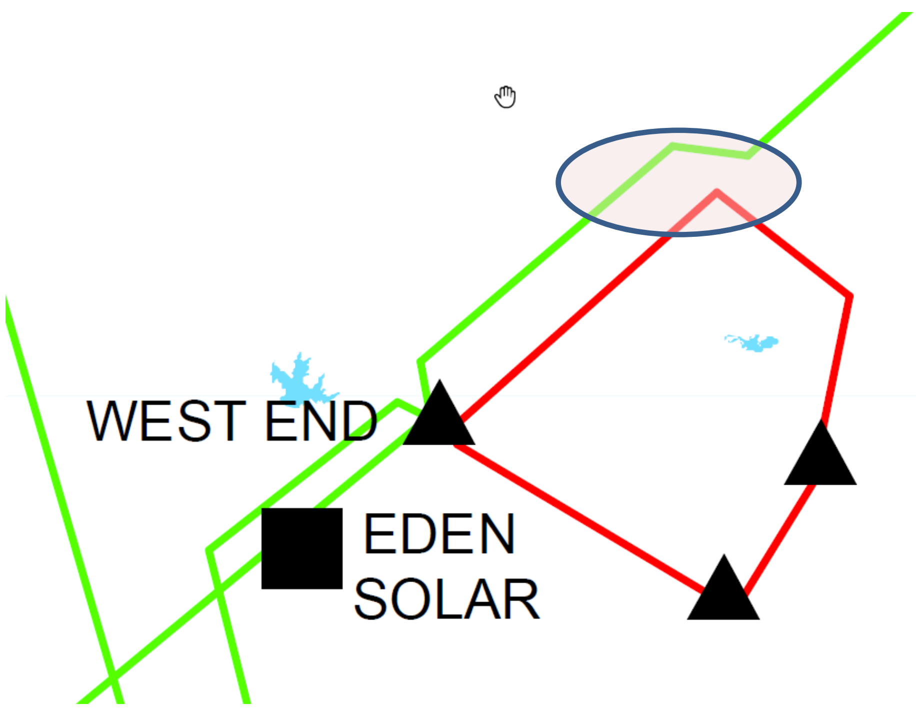
Other Transmission Solutions Considered
Convert several 115 kV substations to 230 kV.

Why this Project was Selected as the Preferred Solution
The cost and construction feasibility are much better with selected alternative.

C–14

Carthage 230/115 kV Substation, Construct Substation

- **NERC Category P1 violation**
- **Problem:** By winter 2027-28, the NERC P1 outage of one West End transformer overloads the other and voltage at Southern Pines 115 kV drops below criteria.
- **Solution:** Construct new 230/115 kV substation in the Carthage area.



Project ID and Name: 0055 – Falls 230 kV Sub, Add 300 MVAR SVC

Project Description
At Falls 230 kV Substation add a 300 MVAR 230 kV Static Var Compensator (SVC).

Status	Conceptual
Transmission Owner	DEP
Planned In-Service Date	12/1/2028
Estimated Time to Complete	4 years
Estimated Cost	$50 M

Narrative Description of the Need for this Project
With the future retirement of Roxboro and Mayo plants, several DEP areas were observed to have significant contingency voltage depression.

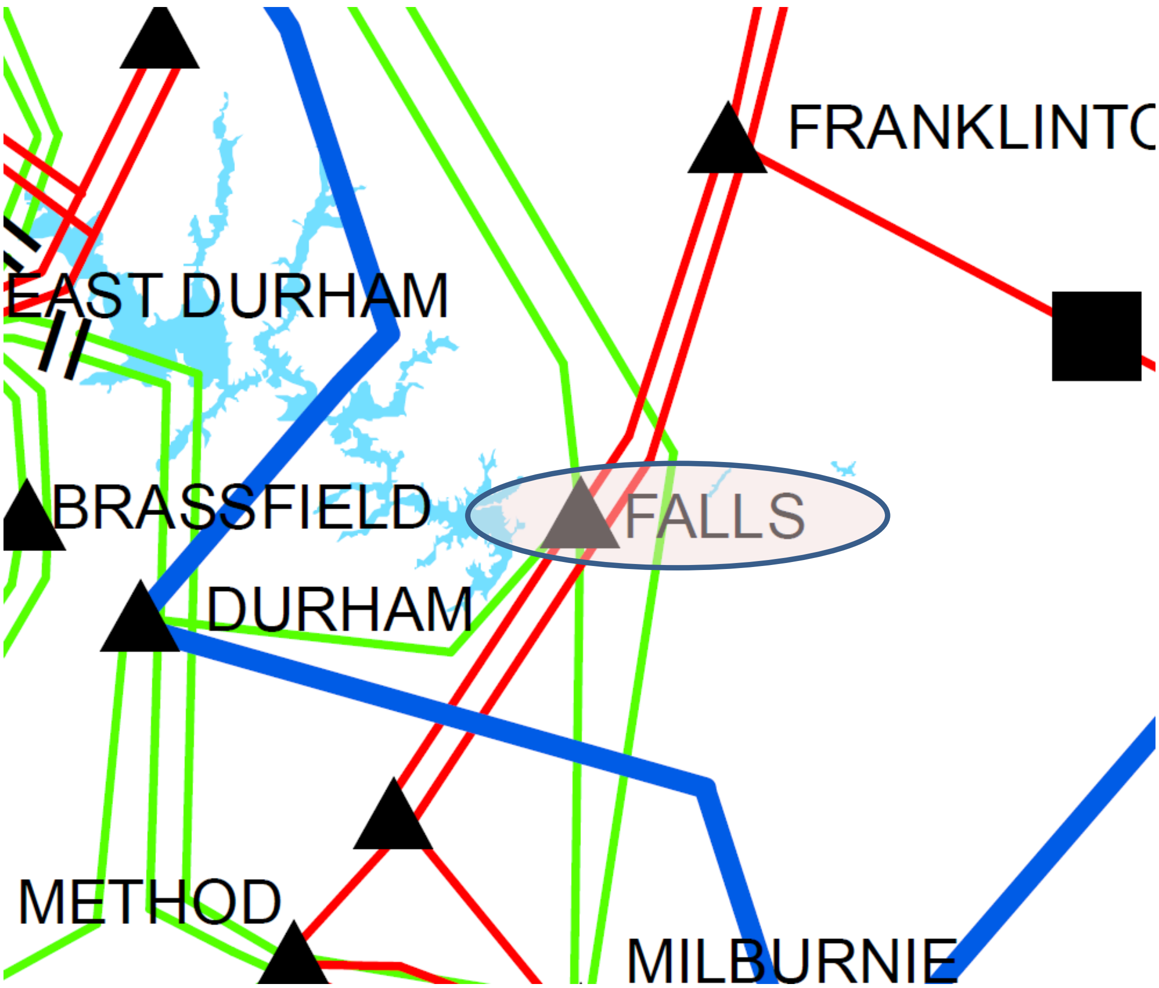
Other Transmission Solutions Considered
Replacement generation in the Roxboro area.

Why this Project was Selected as the Preferred Solution
The cost and construction feasibility are much better with selected alternative.

C–15

Falls 230 kV Sub, Add 300 MVAR SVC

- **NERC Category P1 violation**
- **Problem:** With the future retirement of Roxboro and Mayo plants, several DEP areas were observed to have significant contingency voltage depression.
- **Solution:** Add 300 MVAR SVC at the Falls 230 kV Substation.



Project ID and Name: 0056 – Castle Hayne–Folkstone 115 kV Line, Rebuild

Project Description
Rebuild approximately 25.91 miles of 115 kV line (Castle Hayne 230 kV Sub to structure #251) with 1272 MCM ACSR or equivalent.

Status	Conceptual
Transmission Owner	DEP
Planned In-Service Date	12/1/2028
Estimated Time to Complete	4 years
Estimated Cost	$52 M

Narrative Description of the Need for this Project
By winter 2028/29, an outage of the Castle Hayne – Folkstone 230 kV line will cause the Castle Hayne 230 kV Sub-Folkstone 115 kV line to overload. This project will mitigate the overload problem.

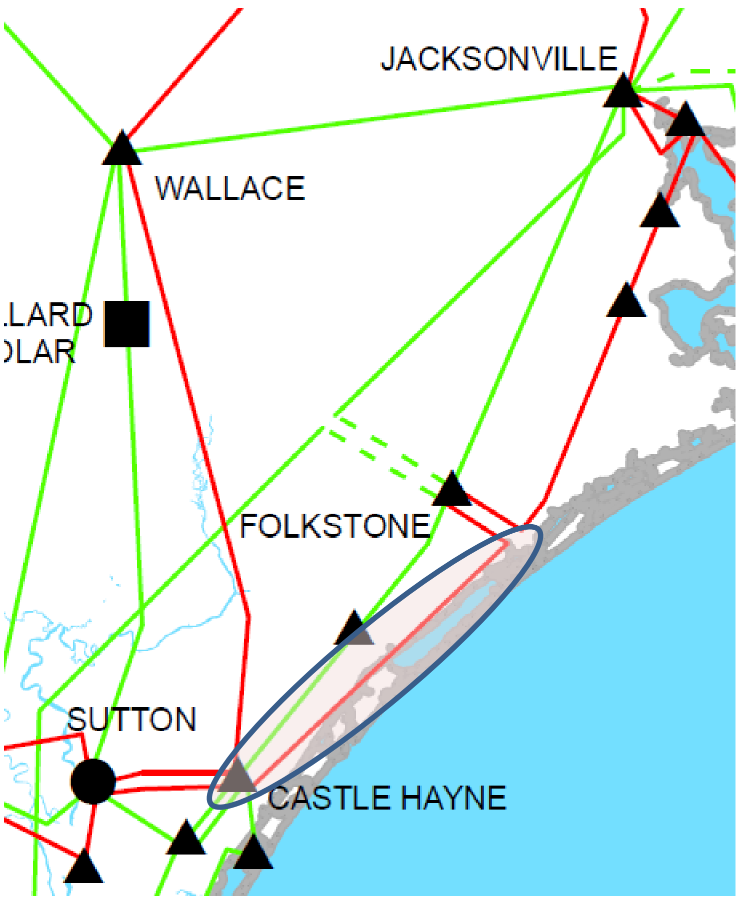
Other Transmission Solutions Considered
New 230 kV transmission lines.

Why this Project was Selected as the Preferred Solution
The cost and construction feasibility are much better with selected alternative.

C–16

Castle Hayne–Folkstone 115 kV Line, Rebuild

- **NERC Category P1 violation**
- **Problem:** By winter 2028/29, an outage of the Castle Hayne–Folkstone 230 kV line will cause the Castle Hayne 230 kV Sub-Folkstone 115 kV line to overload. This project will mitigate the overload problem.
- **Solution:** Rebuild approximately 25.91 miles of 115 kV line (Castle Hayne 230 kV Sub to structure #251) with 1272 MCM ACSR or equivalent.



Project ID and Name: 0057 – Holly Ridge North 115 kV Switching Station, Construct

Project Description
Construct a new 115 kV Switching Station northeast of Holly Ridge, NC where the Castle Hayne–Folkstone 115 kV and Folkstone–Jacksonville City 115 kV lines come together. Construct a new 115 kV feeder from the new switching station to Jones–Onslow EMC Folkstone POD.

Status	Conceptual
Transmission Owner	DEP
Planned In-Service Date	12/1/2028
Estimated Time to Complete	4 years
Estimated Cost	$25 M

Narrative Description of the Need for this Project
By winter 2028-29, the NERC P2-1 opening of the Folkstone end of the Castle Hayne–Folkstone 115 kV line results in low voltages at stations on this line.

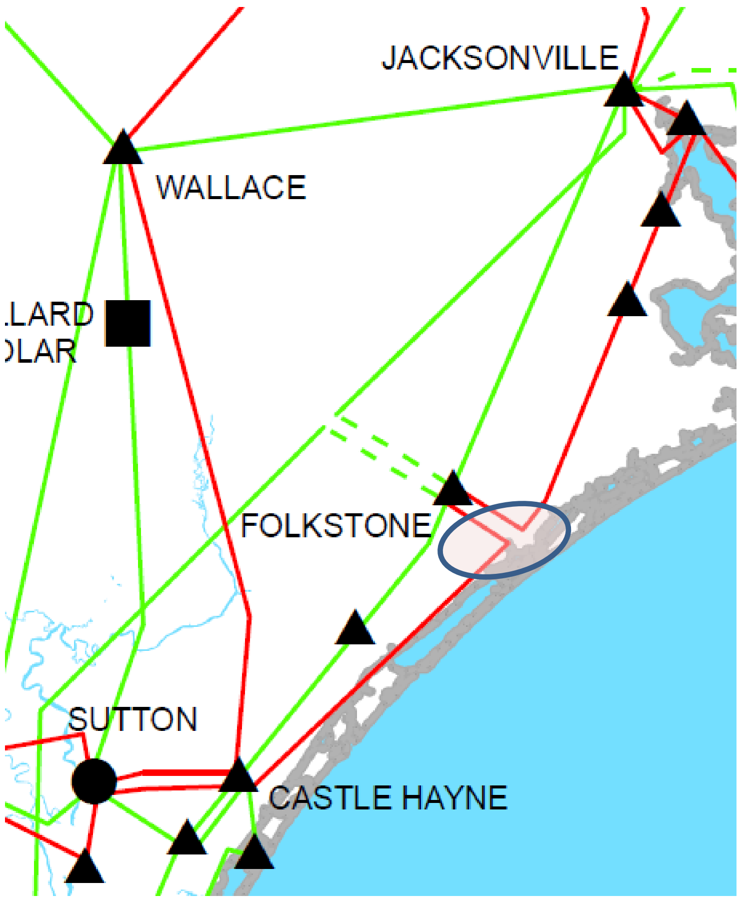
Other Transmission Solutions Considered
New 230 kV transmission lines.

Why this Project was Selected as the Preferred Solution
The cost and construction feasibility are much better with selected alternative.

C–17

Holly Ridge North 115 kV Switching Station, Construct

- **NERC Category P2-1 violation**
- **Problem:** By winter 2028-29, the NERC P2-1 opening of the Folkstone end of the Castle Hayne – Folkstone 115 kV line results in low voltages at stations on this line.
- **Solution:** Construct new 115 kV switching station northeast of Holly Ridge.



Appendix D
Collaborative Plan Comparisons

NCTPC Update on Major Projects – (Estimated Cost ≥ $10M) Items identified in red are changes from the previous report.									
			2019 Plan[1]			2020 Plan			
Project ID	Reliability Project	Transmission Owner	Status[2]	Projected In-Service Date	Estimated Cost ($M)[3]	Status[2]	Projected In-Service Date	Estimated Cost ($M)[3]	
0024	Durham–RTP 230 kV Line, Reconductor	DEP	Conceptual	TBD	15	Conceptual	TBD	20	
0028	Brunswick #1–Jacksonville 230 kV Line Loop into Folkstone 230 kV Substation	DEP	Planned	6/1/2024	35	Removed	–	–	
0031	Jacksonville–Grants Creek 230 kV Line and Grants Creek 230/115 kV Substation	DEP	Underway	6/1/2020	72	In-service	6/1/2020	72	
0032	Newport–Harlowe 230 kV Line, Newport SS and Harlowe 230/115 kV Substation	DEP	Underway	6/1/2020	55	In-service	6/1/2020	55	

NCTPC Update on Major Projects – (Estimated Cost ≥ $10M) Items identified in red are changes from the previous report.								
			2019 Plan[1]			2020 Plan		
Project ID	Reliability Project	Transmission Owner	Status[2]	Projected In-Service Date	Estimated Cost ($M)[3]	Status[2]	Projected In-Service Date	Estimated Cost ($M)[3]
0034	Sutton–Castle Hayne 115 kV North Line, Rebuild	DEP	Underway	12/31/2020	30	Underway	6/1/2021	30
0038	Harley 100 kV Lines (Tiger–Campobello), Reconductor	DEC	Conceptual	TBD	–	Removed	–	–
0039	Asheboro–Asheboro East 115 kV North Line, Reconductor	DEP	Underway	6/1/2020	24	Underway	6/1/2022	24
0042	Rural Hall 100 kV, Install SVC	DEC	Underway	4/1/2020	44	In-service	3/17/2020	44
0043	Orchard 230/100 kV Tie Station, Construct	DEC	Planned	12/1/2020	104	In-service	8/26/2020	104

NCTPC Update on Major Projects – (Estimated Cost ≥ $10M) Items identified in red are changes from the previous report.									
			2019 Plan[1]			2020 Plan			
Project ID	Reliability Project	Transmission Owner	Status[2]	Projected In-Service Date	Estimated Cost ($M)[3]	Status[2]	Projected In-Service Date	Estimated Cost ($M)[3]	
0046	Windmere 100 kV Line (Dan River–Sadler), Construct	DEC	Planned	6/1/2023	23	Underway	8/1/2023	26	
0048	Wilkes 230/100 kV Tie Station, Construct	DEC	Planned	12/1/2023	69	Underway	6/1/2024	69	
0049	Ballantyne Switching Station, Construct	Underway	DEC	12/5/2019	23	In-service	12/5/2019	–	
0050	Craggy–Enka 230 kV Line, Construct	DEP	Conceptual	12/1/2025	80	Conceptual	12/1/2026	80	
0051	Cokesbury 100 kV Line (Coronaca–Hodges), Upgrade	DEC	Planned	6/1/2024	16	Planned	12/1/2024	16	

NCTPC Update on Major Projects – (Estimated Cost ≥ $10M) Items identified in red are changes from the previous report.									
			2019 Plan[1]			2020 Plan			
Project ID	Reliability Project	Transmission Owner	Status[2]	Projected In-Service Date	Estimated Cost ($M)[3]	Status[2]	Projected In-Service Date	Estimated Cost ($M)[3]	
0052	South Point Switching Station, Construct	DEC	–	–	–	Planned	12/1/2024	110	
0053	Wateree 115 kV Plant, Upgrade 115/100 kV Transformers	DEP	–	–	–	Underway	12/1/2022	12	
0054	Carthage 230/115 kV Substation, Construct Sub	DEP	–	–	–	Conceptual	12/1/2027	15	
0055	Falls 230 kV Sub, Add 300 MVAR SVC	DEP	–	–	–	Conceptual	12/1/2028	50	
0056	Castle Hayne–Folkstone115 kV Line, Rebuild	DEP	–	–	–	Conceptual	12/1/2028	52	

NCTPC Update on Major Projects – (Estimated Cost ≥ $10M) Items identified in red are changes from the previous report.									
			2019 Plan[1]			2020 Plan			
Project ID	Reliability Project	Transmission Owner	Status[2]	Projected In-Service Date	Estimated Cost ($M)[3]	Status[2]	Projected In-Service Date	Estimated Cost ($M)[3]
0057	Holly Ridge North 115 kV Switching Station, Construct	DEP	–	–	–	Conceptual	12/1/2028	25
TOTAL					632			804

[1] Information reported in Appendix B of the NCTPC 2019–2027 Collaborative Transmission Plan" dated January 17, 2020 and updated to reflect the mid-year plan report dated June 22, 2020 .

[2] Status: ***In-service***: Projects with this status are in-service. This status was updated as of 12/1/2020.

Underway: Projects with this status range from the Transmission Owner having some money in its current year budget for the project to the Transmission Owner having completed some construction activities for the project.

Planned: Projects with this status do not have money in the Transmission Owner's current year budget; and the project is subject to change.

Conceptual: Projects with this status are not p*lanned* at this time but will continue to be evaluated as a potential project in the future.

Deferred: Projects with this status were identified in the 2019 Report and have been deferred beyond the end of the planning horizon based on analysis performed to develop the 2020 Collaborative Transmission Plan.

Removed: Project is cancelled and no longer in the plan

[3] The estimated cost is in nominal dollars which reflects the sum of the estimated annual cash flows over the expected development period for the specific project (typically 2 – 5 years), including

direct costs, loadings and overheads; but not including AFUDC. Each year's cash flow is escalated to the year of the expenditures. The sum of the expected cash flows is the estimated cost.

Appendix E
Acronyms

ACRONYMS

ACSR	Aluminum Conductor Steel Reinforced
ACSS/TW	Aluminum Conductor Steel Supported/Trapezoidal Wire
AEP	American Electric Power
AFUDC	Allowance for Funds Used During Construction
BAA	Balancing Authority Area
CC	Combined Cycle
CPLE	Carolina Power & Light East, or DEP East
CPLW	Carolina Power & Light West, or DEP West
CT	Combustion Turbine
DEC	Duke Energy Carolinas
DEP	Duke Energy Progress
DNR	Designated Network Resource
DVP	Dominion Virginia Power
ERAG	Eastern Interconnection Reliability Assessment Group
EU	Energy United
FSA	Facilities Study Agreement
GTP	North Carolina Global TransPark
ISA	Interconnection Service Agreement
kV	Kilovolt
LGIA	Large Generator Interconnection Agreement
LSE	Load Serving Entity
LTWG	SERC Long-Term Working Group
M	Million
MCM	Thousand Circular Mils
MMWG	Multiregional Modeling Working Group
MVA	Megavolt-Ampere
MVAR	Megavolt-Ampere Reactive
MW	Megawatt
NCEMC	North Carolina Electric Membership Corporation
NCEMPA	North Carolina Eastern Municipal Power Agency

NCMPA1	North Carolina Municipal Power Agency Number 1
NCTPC	North Carolina Transmission Planning Collaborative
NERC	North American Electric Reliability Corporation
NTE	NTE Energy
OASIS	Open Access Same-time Information System
OATT	Open Access Transmission Tariff
OSC	Oversight Steering Committee
OTDF	Outage Transfer Distribution Factor
PJM	PJM Interconnection, LLC
PMPA	Piedmont Municipal Power Agency
POD	Point of Delivery
PSS/E	Power System Simulator for Engineering
PWG	Planning Working Group
ROW	Right of Way
RTP	Research Triangle Park
SCEG	South Carolina Electric & Gas Company
SCPSA	South Carolina Public Service Authority
SE	Steam Electric (Plant)
SEPA	South Eastern Power Administration
SERC	SERC Reliability Corporation
SOCO	Southern Company
SS	Switching Station
SVC	Static VAR Compensator
TAG	Transmission Advisory Group
TRM	Transmission Reliability Margin
TSR	Transmission Service Request
TTC	Total Transfer Capability
TVA	Tennessee Valley Authority
VACAR	Virginia-Carolinas Reliability Agreement
VAR	Volt Ampere Reactive

North Carolina Transmission Planning Collaborative

Report on the NCTPC 2020 Offshore Wind Study

June 7, 2021
FINAL REPORT

2020 – 2030 NCTPC Offshore Wind Study
Table of Contents

I. Executive Summary

The 2020-2030 Collaborative Transmission Plan (the “2020 Collaborative Transmission Plan” or the “2020 Plan”) was published in January 2021. This addendum documents the offshore wind study performed in response to a Local Public Policy Request.

The Southeastern Wind Coalition (SEWC) requested a study of the feasibility and costs of injecting up to 5000 MW of offshore wind power at up to 3 sites in eastern DEP, or possibly connecting to and wheeling offshore wind power from Dominion Virginia Power (Dominion, DVP). The power from the offshore wind plants would be delivered 40% to DEP and 60% to DEC. Rather than studying pre-determined MW levels, SEWC requested that NCTPC find the MW breakpoints at which transmission upgrades would be needed.

The offshore wind study started with the 2030 summer peak base case prepared for the 2020 NCTPC studies. The planned 2640 MW Dominion offshore wind plant was then added to the Dominion Fentress 500kV bus, dispatched against existing Dominion generation. No other generation from the DEC, DEP, or PJM generator interconnection queues was added. These generator interconnection queues contain thousands of MW of possible generation that may or may not actually interconnect and which could significantly affect the flows on the DEC, DEP, and Dominion transmission systems in unknown ways. The results of this study could change significantly depending on which and how much generation in those queues moves forward to interconnection.

The focus of this offshore wind study was to estimate the amount of generation that could be injected at various locations in eastern part DEP, within a reasonable distance from the Atlantic coast, and transmitted to DEP and DEC customers. The initial screening list of injection points included 29 major transmission substations and switching stations in eastern DEP as well as two stations in Dominion. Later in the process, another possible future DEP station, Sutton North, was added to the list. Linear transfer capability analysis was performed for each injection station, sending the injected power 60% to DEC and 40% to DEP. Basic transmission upgrades and their costs were estimated for transmission limits encountered. Transfer analysis and transmission upgrade estimation were repeated for each site until costs per injected MW escalated beyond reasonable levels. This screening analysis of 32 sites is described in Section II, with details shown in Appendix A.

Based on the results of screening the 32 sites, the three preferred sites chosen for analysis at higher levels of offshore wind power injection were:

- New Bern 230kV
- Greenville 230kV
- Sutton North 230kV

The first two are existing DEP stations and the last, Sutton North, is a proposed future DEP 230kV switching station.

Based on system knowledge and the 2012 offshore wind study results, and the goal to inject 1000s of MW of offshore wind power at each site, 500kV transmission lines were added to connect each of the three preferred sites to the existing DEP 500kV transmission system further inland. These upgrades are necessary to carry significant power from the coast, where DEP has only moderate amounts of customer load, to DEP's major load center in the Raleigh, NC area.

The results of this study showed that 100s of MW of offshore wind generation can be injected at numerous substations in eastern DEP with moderate upgrades, up to around 1000 MW or so at some sites, again with moderate upgrades (less than $100M). Table 1 summarizes the best cost per Watt found at the 32 sites screened. Network upgrade costs as well as cost estimates for interconnection lines from the beach landing to the DEP substation are included in Total Cost. Costs of undersea cables to bring power from the offshore wind farm site to the beach landing are not included.

Note that the results for the two Dominion buses (Fentress 500 kV and Landstown 230 kV) do not include any possible required upgrades in the Dominion system nor any wheeling fees[1]. Recent PJM interconnection studies have found significant transmission overloads for generation sites in southeastern Dominion.

[1] PJM wheeling fees were $63,045/(MW-year) as of 10/31/2020. For the approximately 2300 MW injection level shown in Table 1 for Dominion buses, PJM wheeling fees would total $2.9 billion over 20 years. This wheeling rate is subject to change.

Table 1. Best Cost per Watt Found at 32 Sites Screened

Point of Interconnection	MW Injection	Total Cost ($M)	Total Cost ($/W)
Fentress 500 (DVP)	2307	$ 100	$ 0.04[2]
Landstown 230 (DVP)	2257	$ 65	$ 0.03[3]
Cumberland 500	1700	$ 380	$ 0.22
Cumberland 230	1461	$ 375	$ 0.26
Wake 230	1458	$ 464	$ 0.32
New Bern 230	1449	$ 181	$ 0.12
Wommack 230	1432	$ 259	$ 0.18
Wake 500	1417	$ 460	$ 0.32
Lee 230	1151	$ 360	$ 0.31
Greenville 230	1106	$ 425	$ 0.38
Jacksonville 230	1049	$ 118	$ 0.11
Delco 230	1036	$ 183	$ 0.18
Castle Hayne 230	994	$ 34	$ 0.03
Grants Creek 230	966	$ 79	$ 0.08
Florence 230	911	$ 400	$ 0.44
Marion 230	876	$ 288	$ 0.33
Havelock 230	859	$ 20	$ 0.02
Clinton 230	853	$ 321	$ 0.38
Kinston Dupont 230	851	$ 154	$ 0.18
Weatherspoon 230	788	$ 302	$ 0.38
Whiteville 230	770	$ 175	$ 0.23
Sutton North 230	695	$ 25	$ 0.04

[2] PJM network upgrades and wheeling fees not included.

[3] PJM network upgrades and wheeling fees not included.

Point of Interconnection	MW Injection	Total Cost ($M)	Total Cost ($/W)
Kingstree 230	667	$ 225	$ 0.34
Mt. Olive 230	637	$ 312	$ 0.49
Sumter 230	558	$ 375	$ 0.67
Morehead Wildwood 230	550	$ 27	$ 0.05
Wallace 230	548	$ 160	$ 0.29
Aurora 230	544	$ 230	$ 0.42
Folkstone 230	518	$ 7	$ 0.01
Latta 230	425	$ 265	$ 0.62
Brunswick 1 230	387	$ 26	$ 0.07
Brunswick 2 230	277	$ 30	$ 0.11

Injecting 2000 to 3000 MW or more at any location in DEP will require larger transmission investments at the 500kV voltage level, costing approximately $900M to $2.0B depending on location and MW injection level. For the three sites studied at higher MW injection levels, Table 2 shows the selected injection levels found with and without construction of 500kV lines.

Injecting 5000 MW at a single site was not found to be feasible, but equivalent total injection at multiple sites might be. However, simultaneous injections at multiple sites were not analyzed in this study.

This study estimated transmission infrastructure needed only in the Duke Energy regions. The Greenville site in particular would require an Affected System Study by PJM that could result in significant additional upgrade costs.

Table 2. Selected Injection Levels at Preferred Sites

Point of Interconnection	MW Injection	Total Cost ($M)	Total Cost ($/W)
Without 500 kV Additions			
New Bern 230 *kV*	1449	$ 181	$ 0.12
Greenville 230 *kV*	1106	$ 425	$ 0.38
Sutton North 230 *kV*	1217	$ 270	$ 0.22
Build New Bern - Wommack - Wake 500 kV lines			
New Bern 500 *kV*	3252	$ 1,177	$ 0.36
Build Greenville - Wommack - Wake 500 kV lines			
Greenville 230 *kV*	3587	$ 2,010	$ 0.56
Build Sutton North - Cumberland 500 kV line			
Sutton North 500 *kV*	2272	$ 917	$ 0.40

II. 2020 Offshore Wind Study Scope and Methodology

This offshore wind study was requested by the Southeastern Wind Coalition (SEWC) as a Local Public Policy study request. NCTPC had previously performed an offshore wind study in 2012. The 2012 study focused on the transmission infrastructure needed to accommodate preset levels of MW injection to the grid from offshore wind generation. SEWC asked for an update to that study with a focus on finding natural breakpoints where transmission upgrades would be needed, instead of preset MW test levels. Offshore wind injections up to 5000 MW were requested.

II.A. Generator Interconnections and Base Case

Any study by NCTPC for potential new generation connected to the Duke Energy transmission system is subject to limitations in accuracy and applicability. The official processes to connect generation to the Duke Energy systems in North and South Carolina are the FERC Large Generator Interconnection Procedures (LGIP) and Small Generator Interconnection Procedures (SGIP) and the North and South Carolina state interconnection procedures. Those procedures prioritize generator interconnections on a first come, first served basis, and those interconnection queues are currently backlogged with dozens of requests. Similarly, the PJM generator interconnection process, which covers Dominion territory in northeastern NC and Virginia, also has a large, backlogged queue. Any offshore wind developer wanting to connect their project to the Duke Energy grid would need to enter the appropriate interconnection queue behind those generators already in the queue.

NCTPC studies do not attempt to replicate the official generation interconnection procedures. The official generator interconnection queues have many requests that may or may not move forward to interconnection and operation. Historically, 50% or fewer requests complete the process to operation. It is not possible to accurately predict which generators in the queues will go forward to completion.

As per the normal NCTPC modeling process, the 2030 Summer peak model only included generators that are operational or have fully executed interconnection agreements. This offshore wind study started with that 2030 summer model and made one prospective generator addition – the 2640 MW offshore wind interconnection request at Dominion's Fentress 500kV substation. This addition was made due to the project's relevance to the study at hand and its public announcement by Dominion. Other generation in the Dominion Virginia Balancing Authority Area was scaled down to compensate.

DEP TRM[4] cases were also created from the above offshore wind base case. However, those cases ended up being less limiting than the main offshore wind base case for the most part. DEP TRM cases result in reduced DEP generation and DEP additional imports, whereas the purpose of the offshore wind study is to add offshore wind generation to the DEP area and export 60% of it to DEC, thus netting lower flows in the TRM cases versus the base case.

II.B. Injection Capability Calculation via Transfer Capability Analysis

The method to test injection of offshore wind power at various stations in eastern DEP in this study was using linear transfer capability analysis with the TARA software from PowerGEM. One at a time, power was ramped up at each of the 32 injection sites, keeping track of transmission limits found. As power was increased at each injection site, an equivalent amount of generation was decreased in DEC (60%) and DEP (40%) using participation

[4] Transmission Reliability Margin – more fully described in the NCTPC 2020 Annual Planning Report

factors provided by each company. This method is called First Contingency Incremental Transfer Capability (FCITC).

For each transmission limit found, a rough upgrade was determined based on the transmission owner's knowledge of the limiting element. For example, transmission lines that were limited by low line conductor clearances were assumed to be upgraded by raising the clearance of the line. Lines that were limited by the line conductor already at maximum clearance were assumed to be reconductored to a larger conductor. Limiting transmission transformers were upgraded to a larger size. Assumed standard upgrade costs are provided in Appendix B.

For each injection site, limiting lines and transformers were upgraded and the total cumulative upgrade cost at each site was recorded. Analysis and upgrades at a given site continued until cost per MW rose too high, using engineering judgement.

Full detailed MW injection capabilities and costs are provided in Appendix A. The results are for non-simultaneous injection at one site at a time. Injection of offshore wind generation at multiple sites was not studied. The results shown are indicative only and official interconnection and network upgrade costs would be determined in the official interconnection process.

For the two sites in Dominion, Fentress 500kV and Landstown 230kV, the injected power was sent to DEC (60%) and DEP (40%), same as with the DEP sites. Potential overloads and upgrade costs in Dominion/PJM were not included in the analysis, nor were PJM wheeling fees to transport the power across the Dominion/PJM system to Duke Energy.

This study included only power flow analysis, and only DEC and DEP transmission flows were monitored. Stability and short circuit analysis were not included and would be a significant requirement for an official system impact study for offshore wind generation, possibly incurring additional transmission upgrade costs.

II.C. Three Sites Analyzed at Higher Injection Levels

1. Three Sites Selected

Based on the results of screening the 32 sites for MW injection levels and costs, three sites were selected for further analysis and injection of higher MW levels. The first site that stood out for high MW capability at relatively lower cost was DEP's New Bern 230kV Substation. The initial screening results showed injection capability at New Bern 230kV of well over 1000 MW for well under $0.20 per Watt. New Bern benefits from already having five 230kV lines, two of which head in the direction of the DEP Raleigh load center. In addition, DEP has a partial right-of-way (ROW) available from New Bern 230kV to Wommack 230kV and a full 500kV ROW from Wommack 230kV to Wake 500kV.

None of the other sites stood out for both high MW and low cost, but the other two sites were selected for geographic diversity. Greenville 230kV was selected for its high initial MW screening levels, although the cost is also high per Watt injected. Another caveat with Greenville 230kV is that it borders the PJM/Dominion area, and there may be additional significant upgrades required in the PJM/Dominion area that were not determined in this study.

For diversity, a site in the more south-eastern part of DEP was desired. Sites very close to the coast, such as Brunswick or Castle Hayne, are not ideal due to known constraints in getting more power out of those areas. However, DEP has been aware of a possible new 230kV switching station site north of the Sutton Plant where three 230kV transmission lines share a ROW. This potential future Sutton North 230kV Switching Station was chosen as the third site. This site was added to the initial screening analysis as a 32nd site for screening to put it on the same basis as the original 31 sites.

2. 500kV Transmission Infrastructure

Because the study scope was looking for injection levels in the 1000s of MW, and since the three selected sites had already been screened with basic upgrades of existing 230kV and 115kV lines, this additional analysis of the three selected sites started with building a 500kV transmission path from each site to the existing DEP 500kV transmission system.

As mentioned, New Bern 230kV already has potential ROW to Wommack and on to Wake 500kV, so two new 500kV lines were specified for New Bern: New Bern – Wommack 500kV and Wommack – Wake 500kV. See Figure 1. New Bern and Wommack started with a single 500/230kV transformer rated 1000/1120 MVA like other existing DEP transformers. It was quickly determined that New Bern would need two such transformers, and they could be upsized to 1500/1680 MVA like some transformers utilized by DEC to achieve even higher levels of MW injection.

Due to the existing 500kV ROW from Wommack to Wake, the Greenville site 500kV path was built as a Greenville-Wommack 500kV line and then the same Wommack-Wake 500kV line as the New Bern option. See Figure 2.

The Sutton North site was studied with two different 500kV options because neither route stood out as obviously superior. One path was a 500kV line from Sutton North to Wommack, and then build the Wommack-Wake 500kV line. See Figure 3. While this does take advantage of the existing Wommack-Wake 500kV ROW, it is a long distance from Sutton North to Wommack. The other option analyzed for Sutton North was a 500kV line built directly from Sutton North to the existing Cumberland 500kV Substation. See Figure 4. This is a shorter total 500kV line length, but all new ROW would have to be acquired, and prior generation studies have shown low injection limits at Cumberland.

For each of the three sites, once a 500kV bus was added, generation could be interconnected at either 230kV or 500kV buses. Each of these was separately analyzed.

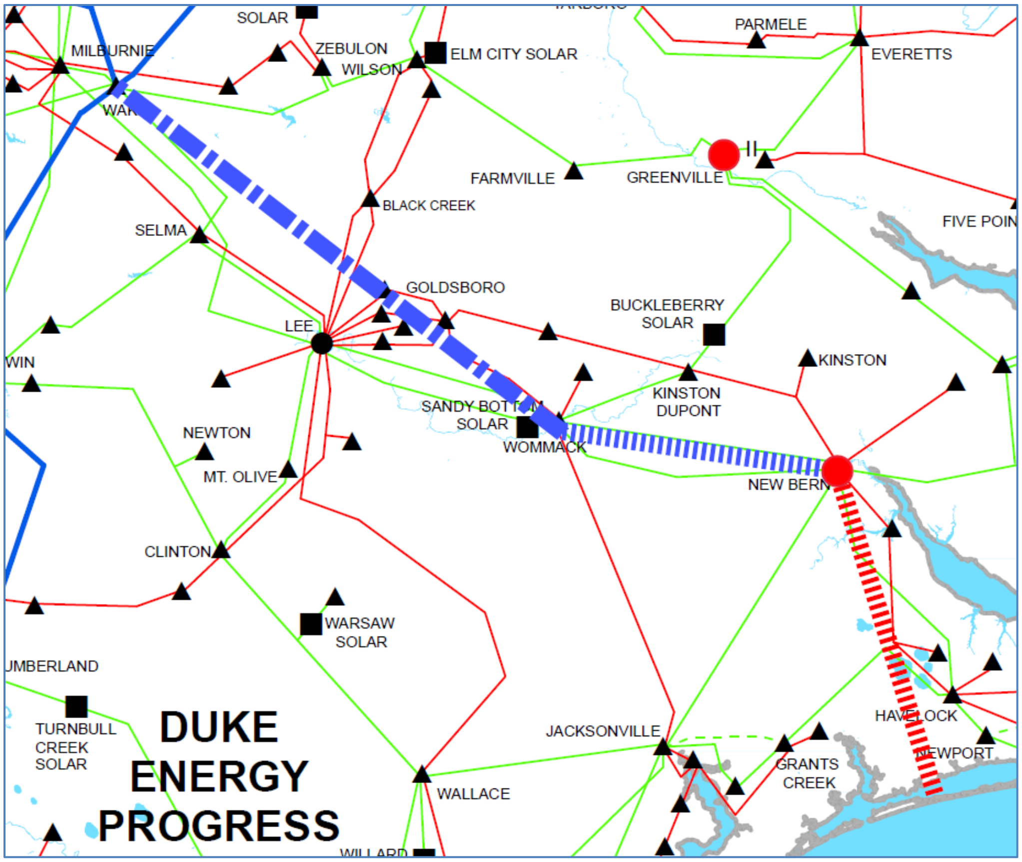


Figure 1. New Bern – Wommack – Wake 500kV Path

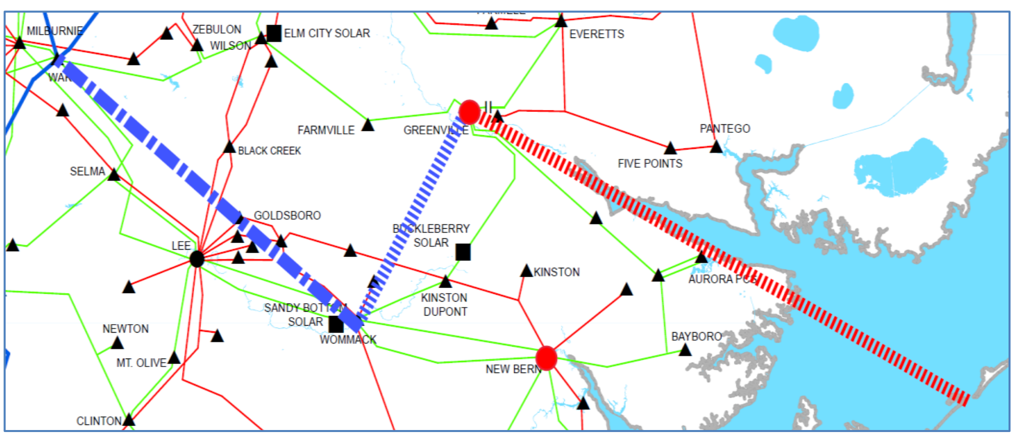


Figure 2. Greenville – Wommack – Wake 500kV Path

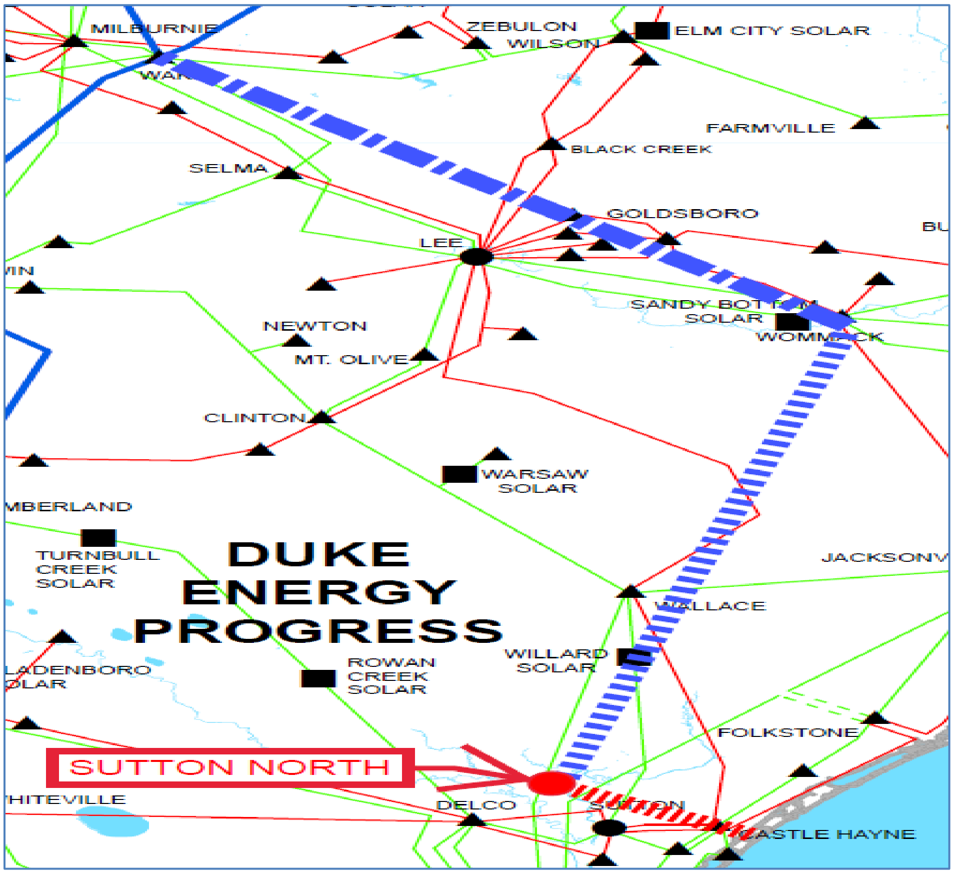


Figure 3. Sutton North – Wommack – Wake 500kV Path

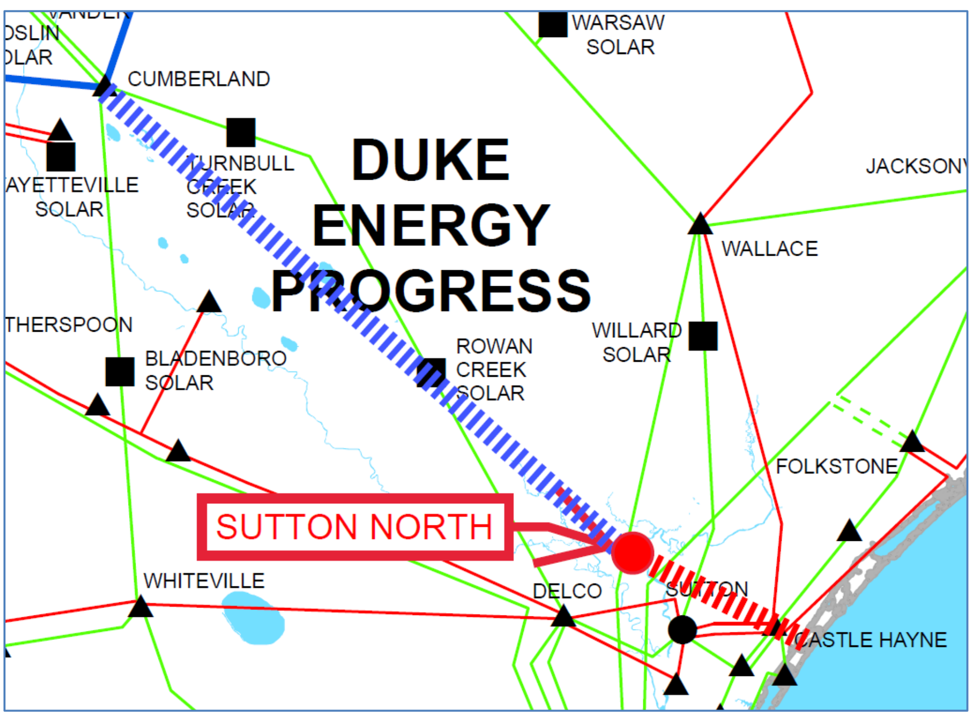


Figure 4. Sutton North – Cumberland 500kV Path

3. Results for Three Selected Sites at Higher Injection Levels

Appendix A.2 gives the full analysis results for the three selected sites with 500kV line build-out, and a summary was provided in the Executive Summary. New Bern and Greenville injection levels were able to reach well over 3000 MW each, but the costs per Watt were much higher than with the initial screening at lower MW levels. Costs were also high at Sutton North but limited to lower MW levels before costs began escalating even higher.

At New Bern, costs of achieving over 3000 MW of offshore wind generation injection are in the $0.40 per Watt range. Greenville was more expensive at $0.60 per Watt and higher for over 3000 MW of offshore wind injection. As mentioned before, the Greenville site may also have some significant unknown costs in PJM/Dominion. Sutton North was able to achieve costs of a little over $0.40 per Watt with the 500kV line to Cumberland, but only up to around 2500 MW. The Sutton North route to Wommack and Wake was also limited to a similar MW level, but this route cost more at around $0.60 per Watt.

As a reminder, this study does not include generation from the DEC, DEP, or PJM generator interconnection queues, and the results of this study could change significantly depending on what generation moves to construction and operation before any proposed offshore wind generation. Results are non-simultaneous and do not include consideration of stability and short-circuit levels.

Appendix A
Detailed Results

Yellow Highlight: Selected lower-cost injection levels at each site
Green Highlight: Three sites selected for investigation of higher injection levels
Gray Highlight: Existing transmission projects

An incremental cost per Watt of "#DIV/0!" in the tables below is not an error. In a few cases an upgrade did not increase injection capability at all (0 MW increase) because the following limit was at the same MW injection level.

Appendix A.1 – Results for 32 Injection Sites without 500kV Additions

POI	MW Limit	Increm. MW	Increm Cost ($M)	Increm. Cost ($/W)	Total Cost ($M)	Total Cost ($/W)	Limiting Element	Miles	Upgrade	New Rate A	New Rate B	Increm Cost ($M)
6AURORASST							Interconnection	46	Interconnection from the Beach	n/a	n/a	$ 230
6AURORASST	544	544	$ 230	$ 0.42	$ 230	$ 0.42	304454 AURORA SS TT 230 304449 EDWARDS TAP 230 1	0.96	Raise to 212F	594	594	$ 2
6AURORASST	548	4	$ 2	$ 0.48	$ 232	$ 0.42	304454 AURORA SS TT 230 304434 BAYBORO TAP 230 1	10.74	Raise to 212F	594	594	$ 21
6AURORASST	558	10	$ 21	$ 2.15	$ 253	$ 0.45	304449 EDWARDS TAP 230 304473 PA-WASHINTON 230 1	19.03	Raise to 212F	594	594	$ 38
6AURORASST	576	18	$ 38	$ 2.11	$ 291	$ 0.51	304445 CHOCOWINITY 230 304451 GREENVILE TT 230 1	18.57	Raise to 212F	482	482	$ 37
6AURORASST	577	1	$ 37	$ 37.14	$ 329	$ 0.57	304434 BAYBORO TAP 230 305142 E16-FAIRFELD 230 1	8.53	Raise to 212F	594	594	$ 17
6AURORASST	589	12	$ 17	$ 1.42	$ 346	$ 0.59	305142 E16-FAIRFELD 230 304463 NEW BERN WES 230 1	7.46	Raise to 212F	594	594	$ 15
6AURORASST	601	12	$ 15	$ 1.24	$ 361	$ 0.60	304463 NEW BERN WES 230 304465 NEWBERN230TT 230 1	1.02	Raise to 212F	594	594	$ 2
6AURORASST	605	4	$ 2	$ 0.51	$ 363	$ 0.60	304473 PA-WASHINTON 230 304445 CHOCOWINITY 230 1	0.04	Raise to 212F	594	594	$ 0
6AURORASST	619	14	$ 0	$ 0.01	$ 363	$ 0.59	304445 CHOCOWINITY 230 304451 GREENVILE TT 230 1	18.57	Reconductor to 6-1590 ACSR	1195	1195	$ 74
6BRUN1230T							Interconnection	5	Interconnection from the Beach	n/a	n/a	$ 25
6BRUN1230T	255	255	$ 25	$ 0.10	$ 25	$ 0.10	304022 BRUN1 230 TT 230 304610 SPRT &PA TAP 230 1	0.09	Reconductor to 6-1590 ACSR	1195	1195	$ 0
6BRUN1230T	368	113	$ 0	$ 0.00	$ 25	$ 0.07	304022 BRUN1 230 TT 230 305009 E1-DAWSCREEK 230 1	12.9	Station/relay upgrades	846	846	$ 1
6BRUN1230T	387	19	$ 1	$ 0.05	$ 26	$ 0.07	304610 SPRT &PA TAP 230 305010 E1-BOLIVIA 230 1	13.16	9th line	-	-	$ 100
6BRUN2230T							Interconnection	5	Interconnection from the Beach	n/a	n/a	$ 25
6BRUN2230T	159	159	$ 25	$ 0.16	$ 25	$ 0.16	304020 BRUN2 230 TT 230 305005 E1-SOUTHPORT 230 1	2.34	Raise to 212F	594	594	$ 5
6BRUN2230T	277	118	$ 5	$ 0.04	$ 30	$ 0.11	304020 BRUN2 230 TT 230 304621 TOWN CRK TT 230 1	14.67	Raise to 212F	846	846	$ 29
6BRUN2230T	308	31	$ 29	$ 0.95	$ 59	$ 0.19	304621 TOWN CRK TT 230 304615 BARNCRK E TT 230 2	1.42	9th line - Brunswick - Sutton North	-	-	$ 100
6CASTLEH230T							Interconnection	9	Interconnection from the Beach	n/a	n/a	$ 45
6CASTLEH230T							304551 CASTLH115ETT 115 304532 VISTA 115 1	15.96	Existing Project	297	297	$ -
6CASTLEH230T							304532 VISTA 115 305063 E9-HUGHBATTS 115 1	1.88	Existing Project	297	297	$ -
6CASTLEH230T	534	534	$ -	$ -	$ -	$ -	304550 CASTLEH230TT 230 304564 SCOTT TAP 230 1	6.18	Double Breaker Wallace 230	-	-	$ 5
6CASTLEH230T	547	13	$ 5	$ 0.38	$ 5	$ 0.01	304550 CASTLEH230TT 230 304545 CASTLH115WTT 115 1	-	Replace with 336 MVA	336	427	$ 4
6CASTLEH230T	752	205	$ 4	$ 0.02	$ 9	$ 0.01	304550 CASTLEH230TT 230 304564 SCOTT TAP 230 1	6.18	Reconductor to 6-1590 ACSR	1195	1195	$ 25
6CASTLEH230T	994	242	$ 25	$ 0.10	$ 34	$ 0.03	304545 CASTLH115WTT 115 304533 INDUSTR TAP 115 1	2.55	Reconductor to 3-1590 ACSR	311	311	$ 10
6CASTLEH230T	1048	54	$ 10	$ 0.19	$ 44	$ 0.04	304533 INDUSTR TAP 115 304513 BURGAW SUB 115 1	14.31	Raise to 212F	131	131	$ 29
6CLINTON230T							Interconnection	60	Interconnection from the Beach	n/a	n/a	$ 300
6CLINTON230T	758	758	$ 300	$ 0.40	$ 300	$ 0.40	304205 CLINTON230TT 230 304255 CLINTON115TT 115 1	-	Add 2nd bank (336 MVA)	336	427	$ 7
6CLINTON230T	717	-41	$ 7	$ (0.17)	$ 307	$ 0.43	304255 CLINTON115TT 115 305131 E15-HARGROVE 115 1	3.97	Raise to 212F	164	164	$ 8
6CLINTON230T	768	51	$ 8	$ 0.16	$ 315	$ 0.41	305131 E15-HARGROVE 115 304266 FAISNHWYIND 115 1	2.92	Raise to 212F	164	164	$ 6
6CLINTON230T	815	47	$ 6	$ 0.12	$ 321	$ 0.39	304278 MT OLV115 TT 115 304237 MT OLIVE TAP 115 1	0.09	Reconductor to 3-1590 ACSR	311	311	$ 0

POI	MW Limit	Increm. MW	Increm Cost ($M)	Increm. Cost ($/W)	Total Cost ($M)	Total Cost ($/W)	Limiting Element	Miles	Upgrade	New Rate A	New Rate B	Increm Cost ($M)
6CLINTON230T	853	38	$ 0	$ 0.01	$ 321	$ 0.38	304266 FAISNHWYIND 115 304278 MT OLV115 TT 115 1	6.38	Raise to 212F	164	164	$ 13
6CLINTON230T	936	83	$ 13	$ 0.15	$ 334	$ 0.36	304237 MT OLIVE TAP 115 304270 MT OLV WEST 115 1	1.35	Raise to 212F	164	164	$ 3
6CLINTON230T	946	10	$ 3	$ 0.27	$ 337	$ 0.36	304255 CLINTON115TT 115 305131 E15-HARGROVE 115 1	3.97	Reconductor to 3-1590 ACSR	311	311	$ 16
6CUMBLND230T							Interconnection	72	Interconnection from the Beach	n/a	n/a	$ 360
6CUMBLND230T	1018	1018	$ 360	$ 0.35	$ 360	$ 0.35	304390 CUMBLND230TT 230 304387 FAY 230 TT 230 2	13.73	Add 2nd 500/230kV bank	1120	1120	$ 15
6CUMBLND230T	1461	443	$ 15	$ 0.03	$ 375	$ 0.26	304389 FAYEAST230TT 230 304305 LINDEN SUB 230 1	12.2	Reconductor to 6-1590 ACSR	1195	1195	$ 49
6CUMBLND230T	1461	0	$ 49	#DIV/0!	$ 424	$ 0.29	304305 LINDEN SUB 230 304196 ERWIN230 TT 230 1	10.95	Reconductor to 6-1590 ACSR	1195	1195	$ 44
6CUMBLND230T	1729	268	$ 44	$ 0.16	$ 468	$ 0.27	304390 CUMBLND230TT 230 304387 FAY 230 TT 230 2	13.74	Reconductor to 6-1590 ACSR	1195	1195	$ 55
6DELCO230T							Interconnection	30	Interconnection from the Beach	n/a	n/a	$ 150
6DELCO230T	486	486	$ 150	$ 0.31	$ 150	$ 0.31	304582 DELCO230 TT 230 304587 DELCO115W TT 115 1	-	Replace with 336 MVA	336	427	$ 4
6DELCO230T	728	242	$ 4	$ 0.02	$ 154	$ 0.21	304039 SUTTON230 TT 230 304554 WILM N&O TAP 230 1	5.38	Reconductor to 6-1590 ACSR	1195	1195	$ 22
6DELCO230T	843	115	$ 22	$ 0.19	$ 176	$ 0.21	305880 CROOKDSOLTAP 230 304515 WALLACE230TT 230 1	3.57	Raise to 212F	594	594	$ 7
6DELCO230T	1036	193	$ 7	$ 0.04	$ 183	$ 0.18	304039 SUTTON230 TT 230 304520 WILM INVISTA 230 1	1.79	Raise to 212F	594	594	$ 4
6DELCO230T	1049	13	$ 4	$ 0.28	$ 186	$ 0.18	305470 WILARDSOLTAP 230 305880 CROOKDSOLTAP 230 1	4.39	Raise to 212F	594	594	$ 9
6DELCO230T	1125	76	$ 9	$ 0.12	$ 195	$ 0.17	304520 WILM INVISTA 230 304534 WILM PRAX 230 1	0.39	Raise to 212F	594	594	$ 1
6DELCO230T	1150	25	$ 1	$ 0.03	$ 196	$ 0.17	304516 WILM BASF 230 305470 WILARDSOLTAP 230 1	20.22	Raise to 212F	594	594	$ 40
6DELCO230T	1223	73	$ 40	$ 0.55	$ 236	$ 0.19	304554 WILM N&O TAP 230 304552 WILM EAST 230 1	2.72	Reconductor to 6-1590 ACSR	1195	1195	$ 11
6FLOSUB230T							Interconnection	64	Interconnection from the Beach	n/a	n/a	$ 320
6FLOSUB230T	553	553	$ 320	$ 0.58	$ 320	$ 0.58	306416 WATEREE 100 306375 GT FALL1 100 1	20	Reconductor to 954 ACSR	232	260	$ 80
6FLOSUB230T	911	358	$ 80	$ 0.22	$ 400	$ 0.44	304662 FLO SUB230TT 230 304663 LATTA SS TT 230 1	23.59	Reconductor to 6-1590 ACSR	1195	1195	$ 94
6FLOSUB230T	1199	288	$ 94	$ 0.33	$ 494	$ 0.41	304662 FLO SUB230TT 230 304707 FLOSUB115ETT 115 2	-	Replace with 448 MVA	448	560	$ 4
6FOLKSTN230T							Interconnection	10	Interconnection from the Beach	n/a	n/a	$ 50
6FOLKSTN230T							304543 FOLKSTN115TT 115 305061 E9-DAWSON 115 1	8.77	Existing Project	221	221	$ -
6FOLKSTN230T	328	328	$ -	$ -	$ -	$ -	304542 FOLKSTN230TT 230 304543 FOLKSTN115TT 115 1	-	Add 2nd bank (336 MVA)	336	427	$ 7
6FOLKSTN230T	518	190	$ 7	$ 0.04	$ 7	$ 0.01	304543 FOLKSTN115TT 115 305061 E9-DAWSON 115 1	8.77	Reconductor to 3-1590 ACSR	340	340	$ 35
6FOLKSTN230T	577	59	$ 35	$ 0.59	$ 42	$ 0.07	305061 E9-DAWSON 115 305073 E9-SOUTHWEST 115 1	18.5	Reconductor to 3-1590 ACSR	340	340	$ 74
6GREENVIL230							Interconnection	85	Interconnection from the Beach	n/a	n/a	$ 425
6GREENVIL230	1106	1106	$ 425	$ 0.38	$ 425	$ 0.38	304451 GREENVILE TT 230 314574 6EVERETS 230 1	22.21	Reconductor to 6-1590 ACSR	1195	1195	$ 89
6GREENVIL230	1184	78	$ 89	$ 1.14	$ 514	$ 0.43	304451 GREENVILE TT 230 304452 GREENVILE W 230 1	4.1	Reconductor to 6-1590 ACSR	1195	1195	$ 16
6GREENVIL230	1224	40	$ 16	$ 0.41	$ 530	$ 0.43	304452 GREENVILE W 230 304229 PA-FARMVILLE 230 1	9.61	Reconductor to 6-1590 ACSR	1195	1195	$ 38
6GREENVIL230	1283	59	$ 38	$ 0.65	$ 569	$ 0.44	304229 PA-FARMVILLE 230 304228 WILSON230 TT 230 1	20.28	Reconductor to 6-1590 ACSR	1195	1195	$ 81
6GREENVIL230	1465	182	$ 81	$ 0.45	$ 650	$ 0.44	304451 GREENVILE TT 230 304445 CHOCOWINITY 230 1	18.61	Reconductor to 6-1590 ACSR	1195	1195	$ 74
6GREENVIL230	1601	136	$ 74	$ 0.55	$ 724	$ 0.45	304473 PA-WASHINTON 230 304449 EDWARDS TAP 230 1	19.03	Raise to 212F	594	594	$ 38
6GREENVIL230	1628	27	$ 38	$ 1.41	$ 762	$ 0.47	304449 EDWARDS TAP 230 304454 AURORA SS TT 230 1	0.96	Raise to 212F	594	594	$ 2
6GREENVIL230	1784	156	$ 2	$ 0.01	$ 764	$ 0.43	304445 CHOCOWINITY 230 304473 PA-WASHINTON 230 1	0.04	Reconductor to 6-1590 ACSR	1195	1195	$ 0
6GREENVIL230	1825	41	$ 0	$ 0.00	$ 764	$ 0.42	304454 AURORA SS TT 230 304434 BAYBORO TAP 230 1	10.74	Raise to 212F	594	594	$ 21
6GREENVIL230	1902	77	$ 21	$ 0.28	$ 786	$ 0.41	304434 BAYBORO TAP 230 305142 E16-FAIRFELD 230 1	8.53	Raise to 212F	594	594	$ 17

POI	MW Limit	Increm. MW	Increm Cost ($M)	Increm. Cost ($/W)	Total Cost ($M)	Total Cost ($/W)	Limiting Element	Miles	Upgrade	New Rate A	New Rate B	Increm Cost ($M)
6GREENVIL230	1933	31	$ 17	$ 0.55	$ 803	$ 0.42	305142 E16-FAIRFELD 230 304463 NEW BERN WES 230 1	7.46	Raise to 212F	594	594	$ 15
6GREENVIL230	1948	15	$ 15	$ 0.99	$ 818	$ 0.42	304449 EDWARDS TAP 230 304454 AURORA SS TT 230 1	0.96	Reconductor to 6-1590 ACSR	1195	1195	$ 4
6GRNTSCK230T							Interconnection	14	Interconnection from the Beach	n/a	n/a	$ 70
6GRNTSCK230T	746	746	$ 70	$ 0.09	$ 70	$ 0.09	304518 GRNTSCK230TT 230 304527 SWANSBORO 230 1	4.73	Double Breaker New Bern 230	-	-	$ 4
6GRNTSCK230T	758	12	$ 4	$ 0.33	$ 74	$ 0.10	304518 GRNTSCK230TT 230 305078 E9-PINEY GR2 230 1	1	Double Breaker Grants Cr 230	-	-	$ 5
6GRNTSCK230T	966	208	$ 5	$ 0.02	$ 79	$ 0.08	304527 SWANSBORO 230 305018 E2-MAYSVILLE 230 1	3.73	Reconductor to 6-1590 ACSR	1195	1195	$ 15
6GRNTSCK230T	1055	89	$ 15	$ 0.17	$ 94	$ 0.09	305077 E9-RAMSEY RD 230 305076 E9-HORACE 230 1	13.14	Reconductor to 6-1590 ACSR	1195	1195	$ 53
6HAVELOK230T							Interconnection	4	Interconnection from the Beach	n/a	n/a	$ 20
6HAVELOK230T	859	859	$ 20	$ 0.02	$ 20	$ 0.02	304484 HAVELOK230TT 230 304465 NEWBERN230TT 230 1	23.47	Raise to 212F	594	594	$ 47
6HAVELOK230T	1001	142	$ 47	$ 0.33	$ 67	$ 0.07	304484 HAVELOK230TT 230 304465 NEWBERN230TT 230 1	23.47	Reconductor to 6-1590 ACSR	1195	1195	$ 94
6JACKSON230T							Interconnection	20	Interconnection from the Beach	n/a	n/a	$ 100
6JACKSON230T	897	897	$ 100	$ 0.11	$ 100	$ 0.11	304518 GRNTSCK230TT 230 304527 SWANSBORO 230 1	4.73	Double Breaker New Bern 230	-	-	$ 4
6JACKSON230T	929	32	$ 4	$ 0.13	$ 104	$ 0.11	304471 CC WD EN TAP 230 304465 NEWBERN230TT 230 1	2.12	Reconductor to 6-1590 ACSR	1195	1195	$ 8
6JACKSON230T	979	50	$ 8	$ 0.17	$ 112	$ 0.11	304524 JACKSON230TT 230 305077 E9-RAMSEY RD 230 1	1.26	Reconductor to 6-1590 ACSR	1195	1195	$ 5
6JACKSON230T	1049	70	$ 5	$ 0.07	$ 118	$ 0.11	305077 E9-RAMSEY RD 230 305076 E9-HORACE 230 1	13.14	Reconductor to 6-1590 ACSR	1195	1195	$ 53
6JACKSON230T	1050	1	$ 53	$ 52.56	$ 170	$ 0.16	304525 JACKSN115ETT 115 305065 E9-GUMBRNCH 115 1	4.69	Raise to 212F	221	221	$ 9
6JACKSON230T	1068	18	$ 9	$ 0.52	$ 179	$ 0.17	305076 E9-HORACE 230 304528 RHEMS 230 1	7.64	Reconductor to 6-1590 ACSR	1195	1195	$ 31
6KINDUP230TT							Interconnection	30	Interconnection from the Beach	n/a	n/a	$ 150
6KINDUP230TT	722	722	$ 150	$ 0.21	$ 150	$ 0.21	304475 WEYER TAP 115 304466 NEWBER115NTT 115 1	6.08	Double Breaker New Bern 230	-	-	$ 4
6KINDUP230TT	851	129	$ 4	$ 0.03	$ 154	$ 0.18	304475 WEYER TAP 115 304466 NEWBER115NTT 115 1	6.08	Raise to 212F	202	202	$ 12
6KINDUP230TT	858	7	$ 12	$ 1.74	$ 166	$ 0.19	304480 KINSDUP115TT 115 304477 VOA TAP 115 1	10.94	Raise to 212F	202	202	$ 22
6KINDUP230TT	878	20	$ 22	$ 1.09	$ 188	$ 0.21	304477 VOA TAP 115 304475 WEYER TAP 115 1	12.53	Raise to 212F	202	202	$ 25
6KINDUP230TT	1055	177	$ 25	$ 0.14	$ 213	$ 0.20	304474 KINSDUP230TT 230 304480 KINSDUP115TT 115 1	-	Uprate	336	427	$ 1
6KINDUP230TT	1103	48	$ 1	$ 0.02	$ 214	$ 0.19	304480 KINSDUP115TT 115 304481 PA-AYDEN 115 1	1.27	Raise to 212F	202	202	$ 3
6KINDUP230TT	1202	99	$ 3	$ 0.03	$ 217	$ 0.18	304481 PA-AYDEN 115 304459 GRIFTON 115 1	0.01	Raise to 212F	202	202	$ 0
6KINGSTR230T							Interconnection	45	Interconnection from the Beach	n/a	n/a	$ 225
6KINGSTR230T	667	667	$ 225	$ 0.34	$ 225	$ 0.34	304675 LAKE CITY 230 304674 OLANTA 230 1	8.08	Raise to 212F	542	542	$ 16
6KINGSTR230T	681	14	$ 16	$ 1.15	$ 241	$ 0.35	304674 OLANTA 230 304671 FLOR SARDIS 230 1	7.45	Raise to 212F	542	542	$ 15
6KINGSTR230T	687	6	$ 15	$ 2.48	$ 256	$ 0.37	304677 KINGSTR230TT 230 304676 KINGSTREE N 230 1	5.71	Raise to 212F	594	594	$ 11
6KINGSTR230T	704	17	$ 11	$ 0.67	$ 267	$ 0.38	304671 FLOR SARDIS 230 304673 FLOR EBENEZR 230 1	9.38	Raise to 212F	542	542	$ 19
6KINGSTR230T	705	1	$ 19	$ 18.76	$ 286	$ 0.41	304675 LAKE CITY 230 304674 OLANTA 230 1	8.08	Reconductor to 6-1590 ACSR	1195	1195	$ 32
6KINGSTR230T	709	4	$ 32	$ 8.08	$ 319	$ 0.45	304676 KINGSTREE N 230 304675 LAKE CITY 230 1	11.08	Raise to 212F	594	594	$ 22
6KINGSTR230T	711	2	$ 22	$ 11.08	$ 341	$ 0.48	304678 KINGSTR115TT 115 304679 KINGTREE SUB 115 1	0.15	Reconductor to 3-1590 ACSR	340	340	$ 1
6LANDSTN							Interconnection	8	Interconnection from the Beach	n/a	n/a	$ 40
6LANDSTN	1342	1342	$ 40	$ 0.03	$ 40	$ 0.03	314554 3BTLEBRO 115 304223 ROCKYMT115TT 115 1	8.5	Reconductor to 3-795 ACSS	314	314	$ 25
6LANDSTN	2257	915	$ 25	$ 0.03	$ 65	$ 0.03	314574 6EVERETS 230 304451 GREENVILE TT 230 1	22.21	Reconductor to 6-1590 ACSR	1195	1195	$ 89

POI	MW Limit	Increm. MW	Increm Cost ($M)	Increm. Cost ($/W)	Total Cost ($M)	Total Cost ($/W)	Limiting Element	Miles	Upgrade	New Rate A	New Rate B	Increm Cost ($M)
6LANDSTN	3109	852	$ 89	$ 0.10	$ 154	$ 0.05	306540 6MCGUIRE 230 306443 6MARSHAL 230 1&2	-	Rebuild in plan	-	-	$ -
6LATTASST							Interconnection	53	Interconnection from the Beach	n/a	n/a	$ 265
6LATTASST	425	425	$ 265	$ 0.62	$ 265	$ 0.62	304632 MARION115 TT 115 304653 DILLON TAP 115 1	14.6	Reconductor to 3-1590 ACSR	311	311	$ 58
6LATTASST	618	193	$ 58	$ 0.30	$ 323	$ 0.52	304663 LATTA SS TT 230 304682 DILLONMP TAP 230 1	4.43	Raise to 212F	542	542	$ 9
6LATTASST	663	45	$ 9	$ 0.20	$ 332	$ 0.50	304682 DILLONMP TAP 230 304046 WSPOON230 TT 230 1	27.96	Raise to 212F	542	542	$ 56
6LEESUB230T							Interconnection	70	Interconnection from the Beach	n/a	n/a	$ 350
6LEESUB230T	1103	1103	$ 350	$ 0.32	$ 350	$ 0.32	304251 LEESUB230 TT 230 304261 LEESUB115STT 115 2	-	Replace with 448 MVA	448	560	$ 5
6LEESUB230T	1103	0	$ 5	#DIV/0!	$ 355	$ 0.32	304251 LEESUB230 TT 230 304261 LEESUB115STT 115 1	-	Replace with 448 MVA	448	560	$ 5
6LEESUB230T	1151	48	$ 5	$ 0.10	$ 360	$ 0.31	304251 LEESUB230 TT 230 304179 WILSON MILLS 230 1	20.36	Reconductor to 6-1590 ACSR	1195	1195	$ 81
6LEESUB230T	1245	94	$ 81	$ 0.87	$ 441	$ 0.35	304251 LEESUB230 TT 230 304192 SELMA 230 TT 230 1	0.04	Reconductor to 6-1590 ACSR + ancillary	1195	1195	$ 2
6MARION230T							Interconnection	46	Interconnection from the Beach	n/a	n/a	$ 230
6MARION230T	391	391	$ 230	$ 0.59	$ 230	$ 0.59	304632 MARION115 TT 115 304653 DILLON TAP 115 1	14.6	Reconductor to 3-1590 ACSR	311	311	$ 58
6MARION230T	876	485	$ 58	$ 0.12	$ 288	$ 0.33	304631 MARION230 TT 230 304632 MARION115 TT 115 1	-	Replace with 336 MVA	336	427	$ 4
6MARION230T	907	31	$ 4	$ 0.13	$ 292	$ 0.32	304631 MARION230 TT 230 304632 MARION115 TT 115 2	-	Replace with 336 MVA	336	427	$ 4
6MARION230T	930	23	$ 4	$ 0.17	$ 296	$ 0.32	304653 DILLON TAP 115 304447 FAIRMONT TAP 115 1	13.7	Reconductor to 3-1590 ACSR	311	311	$ 55
6MORHDWW230T							Interconnection	4	Interconnection from the Beach	n/a	n/a	$ 20
6MORHDWW230T	336	336	$ 20	$ 0.06	$ 20	$ 0.06	304497 MORHDWW230TT 230 304498 MORHDWW115TT 115 1	-	Add 2nd bank (336 MVA)	336	427	$ 7
6MORHDWW230T	527	191	$ 7	$ 0.04	$ 27	$ 0.05	304498 MORHDWW115TT 115 304496 MORWW 115/24 115 1	0.04	Reconductor to 3-1590 ACSR	340	340	$ 0
6MORHDWW230T	550	23	$ 0	$ 0.01	$ 27	$ 0.05	304496 MORWW 115/24 115 305019 E2-NEWPORT 115 1	3.22	Reconductor to 3-1590 ACSR	340	340	$ 13
6MTOLV230T							Interconnection	62	Interconnection from the Beach	n/a	n/a	$ 310
6MTOLV230T	224	224	$ 310	$ 1.38	$ 310	$ 1.38	304279 MT OLV230 TT 230 304278 MT OLV115 TT 115 1	-	Double Breaker Mt. Olive 230	-	-	$ 2
6MTOLV230T	637	413	$ 2	$ 0.00	$ 312	$ 0.49	304279 MT OLV230 TT 230 304278 MT OLV115 TT 115 1	-	Replace with 336 MVA	336	427	$ 4
6NEWBERN230T							Interconnection	34	Interconnection from the Beach	n/a	n/a	$ 170
6NEWBERN230T	825	825	$ 170	$ 0.21	$ 170	$ 0.21	304465 NEWBERN230TT 230 304466 NEWBER115NTT 115 1	-	Replace with 336 MVA	336	427	$ 4
6NEWBERN230T	941	116	$ 4	$ 0.03	$ 174	$ 0.18	304465 NEWBERN230TT 230 304489 NEWBER115STT 115 2	-	Replace with 336 MVA	336	427	$ 4
6NEWBERN230T	1104	163	$ 4	$ 0.02	$ 178	$ 0.16	304489 NEWBER115STT 115 304466 NEWBER115NTT 115 Z1	-	Replace bus tie breaker	598	598	$ 1
6NEWBERN230T	1404	300	$ 1	$ 0.00	$ 179	$ 0.13	304465 NEWBERN230TT 230 304463 NEW BERN WES 230 1	1.02	Raise to 212F	594	594	$ 2
6NEWBERN230T	1449	45	$ 2	$ 0.05	$ 181	$ 0.12	304463 NEW BERN WES 230 305142 E16-FAIRFELD 230 1	7.46	Raise to 212F	594	594	$ 15
6NEWBERN230T	1496	47	$ 15	$ 0.32	$ 196	$ 0.13	304475 WEYER TAP 115 304477 VOA TAP 115 1	12.53	Raise to 212F	202	202	$ 25
6NEWBERN230T	1515	19	$ 25	$ 1.32	$ 221	$ 0.15	304477 VOA TAP 115 304480 KINSDUP115TT 115 1	10.94	Raise to 212F	202	202	$ 22
6NEWBERN230T	1773	258	$ 22	$ 0.08	$ 243	$ 0.14	304471 CC WD EN TAP 230 304528 RHEMS 230 1	5.62	Reconductor to 6-1590 ACSR	1195	1195	$ 22
6SUMTER230T							Interconnection	75	Interconnection from the Beach	n/a	n/a	$ 375
6SUMTER230T	558	558	$ 375	$ 0.67	$ 375	$ 0.67	306416 WATEREE 100 306375 GT FALL1 100 1	20	Reconductor to 954 ACSR	232	260	$ 80
6SUMTER230T	584	26	$ 80	$ 3.08	$ 455	$ 0.78	304700 SUMTER230 TT 230 304728 ELLIOTT TAP 230 1	20.41	Raise to 212F	542	542	$ 41
6SUMTER230T	608	24	$ 41	$ 1.70	$ 496	$ 0.82	304728 ELLIOTT TAP 230 304018 ROB2 230 TT 230 1	20.75	Raise to 212F	542	542	$ 42

POI	MW Limit	Increm. MW	Increm Cost ($M)	Increm. Cost ($/W)	Total Cost ($M)	Total Cost ($/W)	Limiting Element	Miles	Upgrade	New Rate A	New Rate B	Increm Cost ($M)
6SUMTER230T	748	140	$ 42	$ 0.30	$ 537	$ 0.72	304700 SUMTER230 TT 230 304728 ELLIOTT TAP 230 1	20.41	Reconductor to 6-1590 ACSR	1195	1195	$ 82
6SUTNORTH230							Interconnection	17	Interconnection from the Beach	n/a	n/a	$ 85
6SUTNORTH230	0						Build Sutton North 230kV SS	-	Build Switching Station	-	-	$ 25
6SUTNORTH230	695	695	$ 25	$ 0.04	$ 25	$ 0.04	305880 CROOKDSOLTAP 230 304515 WALLACE230TT 230 1	3.55	Raise to 212F	594	594	$ 7
6SUTNORTH230	833	138	$ 7	$ 0.05	$ 32	$ 0.04	304039 SUTTON230 TT 230 304554 WILM N&O TAP 230 1	5.45	Reconductor to 6-1590 ACSR	1195	1195	$ 22
6SUTNORTH230	852	19	$ 22	$ 1.15	$ 54	$ 0.06	305470 WILARDSOLTAP 230 305880 CROOKDSOLTAP 230 1	4.39	Raise to 212F	594	594	$ 9
6SUTNORTH230	927	75	$ 9	$ 0.12	$ 63	$ 0.07	305995 6SUTNORTH230 230 305470 WILARDSOLTAP 230 1	19	Raise to 212F	594	594	$ 38
6SUTNORTH230	1024	97	$ 38	$ 0.39	$ 101	$ 0.10	305995 6SUTNORTH230 230 304515 WALLACE230TT 230 1	27.5	Raise to 212F	594	594	$ 55
6SUTNORTH230	1136	112	$ 55	$ 0.49	$ 156	$ 0.14	305995 6SUTNORTH230 230 304515 WALLACE230TT 230 1	27.5	Reconductor to 6-1590 ACSR	1195	1195	$ 110
6SUTNORTH230	1171	35	$ 110	$ 3.14	$ 266	$ 0.23	304582 DELCO230 TT 230 304587 DELCO115W TT 115 1	-	Replace with 336 MVA	336	427	$ 4
6SUTNORTH230	1217	46	$ 4	$ 0.09	$ 270	$ 0.22	304554 WILM N&O TAP 230 304552 WILM EAST 230 1	2.72	Reconductor to 6-1590 ACSR	1195	1195	$ 11
6SUTNORTH230	1225	8	$ 11	$ 1.36	$ 281	$ 0.23	305880 CROOKDSOLTAP 230 304515 WALLACE230TT 230 1	3.55	Reconductor to 6-1590 ACSR	1195	1195	$ 14
6WAKE230TT							Interconnection	90	Interconnection from the Beach	n/a	n/a	$ 450
6WAKE230TT	786	786	$ 450	$ 0.57	$ 450	$ 0.57	304156 ROL/SQD TAP 230 304276 KNIGHT HODG 230 1	4.83	Raise to 212F	1084	1084	$ 10
6WAKE230TT	849	63	$ 10	$ 0.15	$ 460	$ 0.54	304276 KNIGHT HODG 230 304162 MILBUR230 TT 230 1	2.19	Raise to 212F	1084	1084	$ 4
6WAKE230TT	1458	609	$ 4	$ 0.01	$ 464	$ 0.32	304190 WAKE 230 TT 230 304156 ROL/SQD TAP 230 1	0.17	New line	-	-	$ 100
6WALLACE230T							Interconnection	32	Interconnection from the Beach	n/a	n/a	$ 160
6WALLACE230T	548	548	$ 160	$ 0.29	$ 160	$ 0.29	304515 WALLACE230TT 230 305075 E9-W ONSLOW 230 1	19.7	Double Breaker Wallace 230	-	-	$ 5
6WALLACE230T	567	19	$ 5	$ 0.26	$ 165	$ 0.29	304515 WALLACE230TT 230 305075 E9-W ONSLOW 230 1	19.7	Raise to 212F	594	594	$ 39
6WALLACE230T	584	17	$ 39	$ 2.32	$ 204	$ 0.35	305075 E9-W ONSLOW 230 304521 CATHERN LAKE 230 1	7.69	Raise to 212F	594	594	$ 15
6WALLACE230T	618	34	$ 15	$ 0.45	$ 220	$ 0.36	304521 CATHERN LAKE 230 304524 JACKSON230TT 230 1	3.42	Raise to 212F	594	594	$ 7
6WALLACE230T	658	40	$ 7	$ 0.17	$ 227	$ 0.34	304515 WALLACE230TT 230 305075 E9-W ONSLOW 230 1	19.7	Reconductor to 6-1590 ACSR	1195	1195	$ 79
6WALLACE230T	675	17	$ 79	$ 4.64	$ 305	$ 0.45	305075 E9-W ONSLOW 230 304521 CATHERN LAKE 230 1	7.69	Reconductor to 6-1590 ACSR	1195	1195	$ 31
6WALLACE230T	691	16	$ 31	$ 1.92	$ 336	$ 0.49	304515 WALLACE230TT 230 304517 WALLACE115TT 115 1	-	Replace with 336 MVA	336	427	$ 4
6WHITEVL230T							Interconnection	34	Interconnection from the Beach	n/a	n/a	$ 170
6WHITEVL230T	663	663	$ 170	$ 0.26	$ 170	$ 0.26	304020 BRUN2 230 TT 230 305005 E1-SOUTHPORT 230 1	2.34	Raise to 212F	594	594	$ 5
6WHITEVL230T	770	107	$ 5	$ 0.04	$ 175	$ 0.23	304580 WHITEVIL TAP 115 305003 E1-HALLSBORO 115 1	5.42	Reconductor to 3-1590 ACSR	340	340	$ 22
6WHITEVL230T	796	26	$ 22	$ 0.83	$ 196	$ 0.25	305003 E1-HALLSBORO 115 304575 LAKE WACCA 115 1	4.28	Reconductor to 3-1590 ACSR	340	340	$ 17
6WHITEVL230T	818	22	$ 17	$ 0.78	$ 213	$ 0.26	305330 BLADENSOLTAP 230 305034 E4-POWELL 230 1	1.73	Raise to 212F	594	594	$ 3
6WHITEVL230T	850	32	$ 3	$ 0.11	$ 217	$ 0.26	304600 WHITEVL230TT 230 305330 BLADENSOLTAP 230 1	15.91	Raise to 212F	594	594	$ 32
6WHITEVL230T	871	21	$ 32	$ 1.52	$ 249	$ 0.29	304575 LAKE WACCA 115 304587 DELCO115W TT 115 1	16.86	Reconductor to 3-1590 ACSR	340	340	$ 67
6WHITEVL230T	929	58	$ 67	$ 1.16	$ 316	$ 0.34	305034 E4-POWELL 230 305035 E4-TARHELL 230 1	12.91	Raise to 212F	542	542	$ 26
6WOMMACK230T							Interconnection	51	Interconnection from the Beach	n/a	n/a	$ 255
6WOMMACK230T	883	883	$ 255	$ 0.29	$ 255	$ 0.29	304500 WOMMACK230TT 230 304510 WOMACKW115TT 115 2	-	Replace with 336 MVA	336	427	$ 4
6WOMMACK230T	1432	549	$ 4	$ 0.01	$ 259	$ 0.18	304500 WOMMACK230TT 230 304507 WOMACKE115TT 115 1	-	Replace with 336 MVA	336	427	$ 4
6WOMMACK230T	1432	0	$ 4	#DIV/0!	$ 263	$ 0.18	304030 LEESEP115WTT 115 305162 E17-ROSEWOOD 115 1	4.29	Reconductor to 3-1590 ACSR	311	311	$ 17
6WOMMACK230T	1471	39	$ 17	$ 0.44	$ 280	$ 0.19	304500 WOMMACK230TT 230 304506 DOVER 230 1	8.65	Raise to 212F	594	594	$ 17

POI	MW Limit	Increm. MW	Increm Cost ($M)	Increm. Cost ($/W)	Total Cost ($M)	Total Cost ($/W)	Limiting Element					Miles	Upgrade	New Rate A	New Rate B	Increm Cost ($M)
6WOMMACK230T	1519	48	$ 17	$ 0.36	$ 297	$ 0.20	304506 DOVER	230	304465 NEWBERN230TT	230	1	23.38	Raise to 212F	594	594	$ 47
6WSPOON230T							Interconnection					58	Interconnection from the Beach	n/a	n/a	$ 290
6WSPOON230T	311	311	$ 290	$ 0.93	$ 290	$ 0.93	304046 WSPOON230 TT	230	304047 WSPOON115 TT	115	1	-	Replace with 336 MVA and 1.5 breaker	336	427	$ 8
6WSPOON230T	498	187	$ 8	$ 0.04	$ 298	$ 0.60	304046 WSPOON230 TT	230	304047 WSPOON115 TT	115	2	-	Replace with 336 MVA and 1.5 breaker	336	427	$ 4
6WSPOON230T	788	290	$ 4	$ 0.01	$ 302	$ 0.38	305410 ROSLINSOLTAP	115	304403 HOPEMILLCHUR	115	1	3.07	Reconductor to 3-1590 ACSR	311	311	$ 13
8CUMBLND500T							Interconnection					72	Interconnection from the Beach	n/a	n/a	$ 360
8CUMBLND500T	1016	1016	$ 360	$ 0.35	$ 360	$ 0.35	304391 CUMBLND500TT	500	998843 CUMBERLAND1	230	1	-	Add 2nd 500/230kV bank	1120	1120	$ 15
8CUMBLND500T	1440	424	$ 15	$ 0.04	$ 375	$ 0.26	304391 CUMBLND500TT	500	998842 CUMBERLAND2	230	2	-	Get emergency ratings	1120	1400	$ 5
8CUMBLND500T	1700	260	$ 5	$ 0.02	$ 380	$ 0.22	304378 RICHMON230TT	230	304348 ROCKHAM230TT	230	1	-	New line	-	-	-
8FENTRES							Interconnection					15	Interconnection from the Beach	n/a	n/a	$ 75
8FENTRES	1383	1383	$ 75	$ 0.05	$ 75	$ 0.05	314554 3BTLEBRO	115	304223 ROCKYMT115TT	115	1	8.5	Reconductor to 3-795 ACSS	314	314	$ 25
8FENTRES	2307	924	$ 25	$ 0.03	$ 100	$ 0.04	314574 6EVERETS	230	304451 GREENVILE TT	230	1	22.21	Reconductor to 6-1590 ACSR	1195	1195	$ 89
8FENTRES	2813	506	$ 89	$ 0.18	$ 189	$ 0.07	306540 6MCGUIRE	230	306443 6MARSHAL	230	1&2	-	Planned upgrade	-	-	-
8WAKE500TT							Interconnection					90	Interconnection from the Beach	n/a	n/a	$ 450
8WAKE500TT	1310	1310	$ 450	$ 0.34	$ 450	$ 0.34	304156 ROL/SQD TAP	230	304276 KNIGHT HODG	230	1	4.83	Raise to 212F	1084	1084	$ 10
8WAKE500TT	1417	107	$ 10	$ 0.09	$ 460	$ 0.32	304276 KNIGHT HODG	230	304162 MILBUR230 TT	230	1	2.19	Raise to 212F	1084	1084	$ 4
8WAKE500TT	1451	34	$ 4	$ 0.13	$ 464	$ 0.32	304183 WAKE 500 TT	500	998846 WAKE2	230	2	-	Double Breaker Wake 500 ???	-	-	$ 20
8WAKE500TT	1454	3	$ 20	$ 6.67	$ 484	$ 0.33	304183 WAKE 500 TT	500	998847 WAKE1	230	1	-	Double Breaker Wake 500 ???	-	-	$ -

Appendix A.2 – Results for Three Selected Injection Sites with 500kV Transmission Additions

POI	MW Limit	Increm. MW	Increm Cost ($M)	Increm. Cost ($/W)	Total Cost ($M)	Total Cost ($/W)	Limiting Element	Miles	Upgrade	New Rate A	New Rate B	Increm Cost ($M)
6GREENVIL230	0						Interconnection	85	Interconnection from the Beach	-	-	$ 850
6GREENVIL230	1106	1106	$ 850	$ 0.77	$ 850	$ 0.77	304451 GREENVILE TT 230 314574 6EVERETS 230 1	22.21	Build Grnvl-Wom-Wake 500kV	-	-	$ 845
6GREENVIL230	1773	667	$ 845	$ 1.27	$ 1,695	$ 0.96	304451 GREENVILE TT 230 314574 6EVERETS 230 1	22.21	Add 2nd 500/230kV bank	1125	1125	$ 15
6GREENVIL230	1940	167	$ 15	$ 0.09	$ 1,710	$ 0.88	304451 GREENVILE TT 230 314574 6EVERETS 230 1	22.21	Reconductor to 6-1590 ACSR	1195	1195	$ 89
6GREENVIL230	2034	93	$ 89	$ 0.95	$ 1,799	$ 0.88	304451 GREENVILE TT 230 304452 GREENVILE W 230 1	4.1	Reconductor to 6-1590 ACSR	1195	1195	$ 16
6GREENVIL230	2135	102	$ 16	$ 0.16	$ 1,815	$ 0.85	304452 GREENVILE W 230 304229 PA-FARMVILLE 230 1	9.61	Reconductor to 6-1590 ACSR	1195	1195	$ 38
6GREENVIL230	2284	149	$ 38	$ 0.26	$ 1,854	$ 0.81	304229 PA-FARMVILLE 230 304228 WILSON230 TT 230 1	20.28	Reconductor to 6-1590 ACSR	1195	1195	$ 81
6GREENVIL230	2916	631	$ 81	$ 0.13	$ 1,935	$ 0.66	304451 GREENVILE TT 230 304445 CHOCOWINITY 230 1	18.61	Reconductor to 6-1590 ACSR	1195	1195	$ 74
6GREENVIL230	3074	158	$ 74	$ 0.47	$ 2,009	$ 0.65	306540 6MCGUIRE 230 306443 6MARSHAL 230 2	13.8	Reconductor already planned	-	-	$ 0
6GREENVIL230	3227	153	$ 0	$ 0.00	$ 2,009	$ 0.62	304445 CHOCOWINITY 230 304473 PA-WASHINTON 230 1	0.04	Reconductor to 6-1590 ACSR	1195	1195	$ 0.2
6GREENVIL230	3587	360	$ 0	$ 0.00	$ 2,010	$ 0.56	304480 KINSDUP115TT 115 304481 PA-AYDEN 115 1	1.27	Raise to 212F	201.6	201.6	$ 2.5
6GREENVIL230	3590	3	$ 3	$ 0.91	$ 2,012	$ 0.56	304473 PA-WASHINTON 230 304449 EDWARDS TAP 230 1	19.03	Raise to 212F	594	594	$ 38
6GREENVIL230	3605	15	$ 38	$ 2.54	$ 2,050	$ 0.57	304156 ROL/SQD TAP 230 304276 KNIGHT HODG 230 1	4.83	Raise to 212F	1084	1084	$ 10
8GREENVIL500	0						Interconnection	85	Interconnection from the Beach	-	-	$ 850
8GREENVIL500	1106	1106	$ 850	$ 0.77	$ 850	$ 0.77	304451 GREENVILE TT 230 314574 6EVERETS 230 1	22.21	Build Grnvl-Wom-Wake 500kV	-	-	$ 845
8GREENVIL500	1687	581	$ 845	$ 1.45	$ 1,695	$ 1.00	305997 8GREENVIL500 500 998836 GREENVILLE1 230 1	-	Add 2nd 500/230kV bank	1125	1125	$ 15
8GREENVIL500	2163	476	$ 15	$ 0.03	$ 1,710	$ 0.79	304451 GREENVILE TT 230 314574 6EVERETS 230 1	22.21	Reconductor to 6-1590 ACSR	1195	1195	$ 89
8GREENVIL500	2189	26	$ 89	$ 3.42	$ 1,799	$ 0.82	304451 GREENVILE TT 230 304452 GREENVILE W 230 1	4.1	Reconductor to 6-1590 ACSR	1195	1195	$ 16
8GREENVIL500	2286	97	$ 16	$ 0.17	$ 1,815	$ 0.79	304452 GREENVILE W 230 304229 PA-FARMVILLE 230 1	9.61	Reconductor to 6-1590 ACSR	1195	1195	$ 38
8GREENVIL500	2428	142	$ 38	$ 0.27	$ 1,854	$ 0.76	304229 PA-FARMVILLE 230 304228 WILSON230 TT 230 1	20.28	Reconductor to 6-1590 ACSR	1195	1195	$ 81
8GREENVIL500	2916	488	$ 81	$ 0.17	$ 1,935	$ 0.66	304451 GREENVILE TT 230 304445 CHOCOWINITY 230 1	18.61	Reconductor to 6-1590 ACSR	1195	1195	$ 74
8GREENVIL500	3070	155	$ 74	$ 0.48	$ 2,009	$ 0.65	306540 6MCGUIRE 230 306443 6MARSHAL 230 2	13.8	Reconductor already planned	-	-	$ 0
8GREENVIL500	3227	157	$ 0	$ 0.00	$ 2,009	$ 0.62	304445 CHOCOWINITY 230 304473 PA-WASHINTON 230 1	0.04	Reconductor to 6-1590 ACSR	1195	1195	$ 0.2
8GREENVIL500	3374	147	$ 0	$ 0.00	$ 2,010	$ 0.60	305997 8GREENVIL500 500 998836 GREENVILLE1 230 1	-	Larger transformers???	2000	2000	$ 10
8GREENVIL500	3419	45	$ 10	$ 0.22	$ 2,020	$ 0.59	304156 ROL/SQD TAP 230 304276 KNIGHT HODG 230 1	4.83	Raise to 212F	1084	1084	$ 10
8GREENVIL500	3576	157	$ 10	$ 0.06	$ 2,029	$ 0.57	304276 KNIGHT HODG 230 304162 MILBUR230 TT 230 1	2.19	Raise to 212F	1084	1084	$ 4
6NEWBERN230T	0						Interconnection	34	Interconnection from the Beach	n/a	n/a	$ 340
6NEWBERN230T	825	825	$ 340	$ 0.41	$ 340	$ 0.41	304465 NEWBERN230TT 230 304466 NEWBER115NTT 115 1	115	Build NewBern-Wom-Wake 500kV	-	-	$ 570
6NEWBERN230T	1006	181	$ 570	$ 3.15	$ 910	$ 0.90	304465 NEWBERN230TT 230 304466 NEWBER115NTT 115 1	-	Replace with 336 MVA	336	504	$ 4
6NEWBERN230T	1404	398	$ 4	$ 0.01	$ 914	$ 0.65	304465 NEWBERN230TT 230 304489 NEWBER115STT 115 2	-	Replace with 336 MVA	336	504	$ 4
6NEWBERN230T	1650	246	$ 4	$ 0.02	$ 918	$ 0.56	304489 NEWBER115STT 115 304466 NEWBER115NTT 115 Z1	-	Replace bus tie breaker	598	598	$ 1
6NEWBERN230T	2137	486	$ 1	$ 0.00	$ 919	$ 0.43	304465 NEWBERN230TT 230 304463 NEW BERN WES 230 1	1.02	Raise to 212F	594	594	$ 2
6NEWBERN230T	2198	61	$ 2	$ 0.03	$ 921	$ 0.42	304475 WEYER TAP 115 304477 VOA TAP 115 1	12.53	Add 2nd 500/230kV bank	1125	1125	$ 15

POI	MW Limit	Increm. MW	Increm Cost ($M)	Increm. Cost ($/W)	Total Cost ($M)	Total Cost ($/W)	Limiting Element	Miles	Upgrade	New Rate A	New Rate B	Increm Cost ($M)
6NEWBERN230T	2324	127	$ 15	$ 0.12	$ 936	$ 0.40	304475 WEYER TAP 115 304477 VOA TAP 115 1	12.53	Raise to 212F	202	202	$ 25
6NEWBERN230T	2372	48	$ 25	$ 0.52	$ 961	$ 0.41	304465 NEWBERN230TT 230 304506 DOVER 230 1	23.38	Raise to 212F	594	594	$ 47
6NEWBERN230T	2386	14	$ 47	$ 3.34	$ 1,008	$ 0.42	304477 VOA TAP 115 304480 KINSDUP115TT 115 1	10.94	Raise to 212F	202	202	$ 22
6NEWBERN230T	2393	7	$ 22	$ 3.13	$ 1,030	$ 0.43	304506 DOVER 230 304500 WOMMACK230TT 230 1	8.65	Raise to 212F	594	594	$ 17
6NEWBERN230T	2396	3	$ 17	$ 5.77	$ 1,047	$ 0.44	304463 NEW BERN WES 230 305142 E16-FAIRFELD 230 1	7.46	Raise to 212F	594	594	$ 15
6NEWBERN230T	2485	89	$ 15	$ 0.17	$ 1,062	$ 0.43	304466 NEWBER115NTT 115 304475 WEYER TAP 115 1	6.08	Raise to 212F	221	221	$ 12
6NEWBERN230T	2520	35	$ 12	$ 0.35	$ 1,074	$ 0.43	305142 E16-FAIRFELD 230 304434 BAYBORO TAP 230 1	8.53	Raise to 212F	594	594	$ 17
6NEWBERN230T	2631	111	$ 17	$ 0.15	$ 1,091	$ 0.41	304465 NEWBERN230TT 230 304484 HAVELOK230TT 230 1	23.47	Double Breaker New Bern 230	-	-	$ 4
6NEWBERN230T	2814	183	$ 4	$ 0.02	$ 1,095	$ 0.39	304465 NEWBERN230TT 230 304506 DOVER 230 1	23.38	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 47
6NEWBERN230T	2819	5	$ 47	$ 9.35	$ 1,142	$ 0.41	304434 BAYBORO TAP 230 304454 AURORA SS TT 230 1	10.74	Raise to 212F	594	594	$ 21
6NEWBERN230T	2835	16	$ 21	$ 1.34	$ 1,163	$ 0.41	304506 DOVER 230 304500 WOMMACK230TT 230 1	8.65	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 17
6NEWBERN230T	3031	196	$ 17	$ 0.09	$ 1,181	$ 0.39	306540 6MCGUIRE 230 306443 6MARSHAL 230 2	13.8	Reconductor already planned	-	-	$ 0
6NEWBERN230T	3101	70	$ 0	$ 0.00	$ 1,181	$ 0.38	304465 NEWBERN230TT 230 304484 HAVELOK230TT 230 1	23.47	Raise to 212F	594	594	$ 47
6NEWBERN230T	3252	151	$ 47	$ 0.31	$ 1,228	$ 0.38	304465 NEWBERN230TT 230 304500 WOMMACK230TT 230 1	33.87	Reconductor to 6-1590 ACSR	1195	1195	$ 135
6NEWBERN230T	3282	30	$ 135	$ 4.52	$ 1,363	$ 0.42	304465 NEWBERN230TT 230 304463 NEW BERN WES 230 1	1.02	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 2

POI	MW Limit	Increm. MW	Increm Cost ($M)	Increm. Cost ($/W)	Total Cost ($M)	Total Cost ($/W)	Limiting Element	Miles	Upgrade	New Rate A	New Rate B	Increm Cost ($M)
8NEWBERN500	0						Interconnection	34	Interconnection from the Beach	n/a	n/a	$ 340
8NEWBERN500	825	825	$ 340	$ 0.41	$ 340	$ 0.41	304465 NEWBERN230TT 230 304466 NEWBER115NTT 115 1	115	Build NewBern-Wom-Wake 500kV	-	-	$ 570
8NEWBERN500	1687	862	$ 570	$ 0.66	$ 910	$ 0.54	305998 8NEWBERN500 500 998835 NEWBERN1 230 1	-	Add 2nd 500/230kV bank	1125	1687	$ 15
8NEWBERN500	1459	-228	$ 15	$ (0.07)	$ 925	$ 0.63	304465 NEWBERN230TT 230 304466 NEWBER115NTT 115 1	-	Replace with 336 MVA	336	504	$ 4
8NEWBERN500	2065	606	$ 4	$ 0.01	$ 929	$ 0.45	304465 NEWBERN230TT 230 304489 NEWBER115STT 115 2	-	Replace with 336 MVA	336	504	$ 4
8NEWBERN500	2372	307	$ 4	$ 0.01	$ 933	$ 0.39	304465 NEWBERN230TT 230 304506 DOVER 230 1	23.38	Raise to 212F	594	594	$ 47
8NEWBERN500	2393	21	$ 47	$ 2.23	$ 980	$ 0.41	304506 DOVER 230 304500 WOMMACK230TT 230 1	8.65	Raise to 212F	594	594	$ 17
8NEWBERN500	2413	20	$ 17	$ 0.87	$ 997	$ 0.41	304465 NEWBERN230TT 230 304463 NEW BERN WES 230 1	1.02	Raise to 212F	594	594	$ 2
8NEWBERN500	2434	21	$ 2	$ 0.10	$ 999	$ 0.41	304475 WEYER TAP 115 304477 VOA TAP 115 1	12.53	Raise to 212F	202	202	$ 25
8NEWBERN500	2440	6	$ 25	$ 4.18	$ 1,024	$ 0.42	304489 NEWBER115STT 115 304466 NEWBER115NTT 115 Z1	-	Replace bus tie breaker	598	598	$ 1
8NEWBERN500	2476	36	$ 1	$ 0.03	$ 1,025	$ 0.41	304477 VOA TAP 115 304480 KINSDUP115TT 115 1	10.94	Raise to 212F	202	202	$ 22
8NEWBERN500	2511	35	$ 22	$ 0.63	$ 1,047	$ 0.42	304463 NEW BERN WES 230 305142 E16-FAIRFELD 230 1	7.46	Raise to 212F	594	594	$ 15
8NEWBERN500	2545	34	$ 15	$ 0.44	$ 1,062	$ 0.42	304466 NEWBER115NTT 115 304475 WEYER TAP 115 1	6.08	Raise to 212F	221	221	$ 12
8NEWBERN500	2599	54	$ 12	$ 0.23	$ 1,074	$ 0.41	305142 E16-FAIRFELD 230 304434 BAYBORO TAP 230 1	8.53	Raise to 212F	594	594	$ 17
8NEWBERN500	2814	215	$ 17	$ 0.08	$ 1,091	$ 0.39	304465 NEWBERN230TT 230 304506 DOVER 230 1	23.38	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 47
8NEWBERN500	2819	5	$ 47	$ 9.35	$ 1,138	$ 0.40	304434 BAYBORO TAP 230 304454 AURORA SS TT 230 1	10.74	Raise to 212F	594	594	$ 21
8NEWBERN500	2835	16	$ 21	$ 1.34	$ 1,159	$ 0.41	304506 DOVER 230 304500 WOMMACK230TT 230 1	8.65	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 17
8NEWBERN500	3039	204	$ 17	$ 0.08	$ 1,177	$ 0.39	306540 6MCGUIRE 230 306443 6MARSHAL 230 2	13.8	Reconductor already planned	-	-	$ 0
8NEWBERN500	3252	213	$ 0	$ 0.00	$ 1,177	$ 0.36	304465 NEWBERN230TT 230 304500 WOMMACK230TT 230 1	33.87	Reconductor to 6-1590 ACSR	1195	1195	$ 135
8NEWBERN500	3282	30	$ 135	$ 4.52	$ 1,312	$ 0.40	304465 NEWBERN230TT 230 304463 NEW BERN WES 230 1	1.02	Reconductor to 6-1590 ACSR	1195	1195	$ 4
8NEWBERN500	3311	29	$ 4	$ 0.14	$ 1,316	$ 0.40	304454 AURORA SS TT 230 304449 EDWARDS TAP 230 1	0.96	Raise to 212F	594	594	$ 2
8NEWBERN500	3374	63	$ 2	$ 0.03	$ 1,318	$ 0.39	305998 8NEWBERN500 500 998833 NEWBERN2 230 2	-	Larger transformers???	2000	2000	$ 10
8NEWBERN500	3390	16	$ 10	$ 0.63	$ 1,328	$ 0.39	304449 EDWARDS TAP 230 304473 PA-WASHINTON 230 1	19.03	Raise to 212F	594	594	$ 38
8NEWBERN500	3403	13	$ 38	$ 2.93	$ 1,366	$ 0.40	304251 LEESUB230 TT 230 304192 SELMA 230 TT 230 1	16.78	Ancillary equipment	940	940	$ 1
8NEWBERN500	3445	42	$ 1	$ 0.01	$ 1,367	$ 0.40	304465 NEWBERN230TT 230 304484 HAVELOK230TT 230 1	23.47	Raise to 212F	594	594	$ 47

POI	MW Limit	Increm. MW	Increm Cost ($M)	Increm. Cost ($/W)	Total Cost ($M)	Total Cost ($/W)	Limiting Element	Miles	Upgrade	New Rate A	New Rate B	Increm Cost ($M)
8NEWBERN500	3467	22	$ 47	$ 2.13	$ 1,414	$ 0.41	304378 RICHMON230TT 230 304348 ROCKHAM230TT 230 1	5.96	Raise to 212F	1084	1084	$ 12
8NEWBERN500	3468	1	$ 12	$ 11.92	$ 1,426	$ 0.41	305142 E16-FAIRFELD 230 304434 BAYBORO TAP 230 1	8.53	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 17
8NEWBERN500	3541	73	$ 17	$ 0.23	$ 1,443	$ 0.41	304156 ROL/SQD TAP 230 304276 KNIGHT HODG 230 1	4.83	Raise to 212F	1084	1084	$ 10
8NEWBERN500	3555	14	$ 10	$ 0.69	$ 1,452	$ 0.41	304445 CHOCOWINITY 230 304451 GREENVILE TT 230 1	18.57	Raise to 212F	482	482	$ 37

6SUTNORTH230-Cumb	0						Interconnection	17	Interconnection from the Beach	n/a	n/a	$ 170
6SUTNORTH230-Cumb	695	695	$ 170	$ 0.24	$ 170	$ 0.24	305880 CROOKDSOLTAP 230 304515 WALLACE230TT 230 1	-	Build SuttNorth-Cumberland 500kV	-	-	$ 660
6SUTNORTH230-Cumb	1147	452	$ 660	$ 1.46	$ 830	$ 0.72	305880 CROOKDSOLTAP 230 304515 WALLACE230TT 230 1	-	Add 2nd 500/230kV bank	1125	1687	$ 15
6SUTNORTH230-Cumb	1256	109	$ 15	$ 0.14	$ 845	$ 0.67	305880 CROOKDSOLTAP 230 304515 WALLACE230TT 230 1	3.57	Raise to 212F	594	594	$ 7
6SUTNORTH230-Cumb	1530	274	$ 7	$ 0.03	$ 852	$ 0.56	305470 WILARDSOLTAP 230 305880 CROOKDSOLTAP 230 1	4.39	Raise to 212F	594	594	$ 9
6SUTNORTH230-Cumb	1663	133	$ 9	$ 0.07	$ 861	$ 0.52	305995 6SUTNORTH230 230 305470 WILARDSOLTAP 230 1	19	Raise to 212F	594	594	$ 38
6SUTNORTH230-Cumb	1961	298	$ 38	$ 0.13	$ 899	$ 0.46	305995 6SUTNORTH230 230 304515 WALLACE230TT 230 1	27.5	Raise to 212F	594	594	$ 55
6SUTNORTH230-Cumb	2005	44	$ 55	$ 1.25	$ 954	$ 0.48	304378 RICHMON230TT 230 304348 ROCKHAM230TT 230 1	5.96	Raise to 212F	1084	1084	$ 12
6SUTNORTH230-Cumb	2113	108	$ 12	$ 0.11	$ 966	$ 0.46	305995 6SUTNORTH230 230 304354 ROCKY POINT 230 1	8.2	Reconductor to 6-1590 ACSR	1195	1195	$ 33
6SUTNORTH230-Cumb	2131	18	$ 33	$ 1.82	$ 999	$ 0.47	305995 6SUTNORTH230 230 304516 WILM BASF 230 1	1.22	Raise to 212F	594	594	$ 2
6SUTNORTH230-Cumb	2146	15	$ 2	$ 0.16	$ 1,001	$ 0.47	304039 SUTTON230 TT 230 304554 WILM N&O TAP 230 1	5.38	Reconductor to 6-1590 ACSR	1195	1195	$ 22
6SUTNORTH230-Cumb	2179	33	$ 22	$ 0.65	$ 1,023	$ 0.47	305995 6SUTNORTH230 230 304515 WALLACE230TT 230 1	27.5	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 55
6SUTNORTH230-Cumb	2190	11	$ 55	$ 5.00	$ 1,078	$ 0.49	304520 WILM INVISTA 230 304039 SUTTON230 TT 230 1	1.79	Raise to 212F	594	594	$ 4
6SUTNORTH230-Cumb	2190	0	$ 4	#DIV/0!	$ 1,081	$ 0.49	305880 CROOKDSOLTAP 230 304515 WALLACE230TT 230 1	3.57	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 7
6SUTNORTH230-Cumb	2258	68	$ 7	$ 0.11	$ 1,088	$ 0.48	304354 ROCKY POINT 230 305069 E9-MEADOW 230 1	34.95	Reconductor to 6-1590 ACSR	1195	1195	$ 140
6SUTNORTH230-Cumb	2272	14	$ 140	$ 9.99	$ 1,228	$ 0.54	304503 WARSAW TAP 230 304205 CLINTON230TT 230 1	12.6	Reconductor to 6-1590 ACSR	1195	1195	$ 50
6SUTNORTH230-Cumb	2322	50	$ 50	$ 1.01	$ 1,279	$ 0.55	305032 E4-BLIND BRG 230 304503 WARSAW TAP 230 1	12.67	Reconductor to 6-1590 ACSR	1195	1195	$ 51
6SUTNORTH230-Cumb	2410	88	$ 51	$ 0.58	$ 1,329	$ 0.55	305069 E9-MEADOW 230 304524 JACKSON230TT 230 1	4.78	Reconductor to 6-1590 ACSR	1195	1195	$ 19
6SUTNORTH230-Cumb	2413	3	$ 19	$ 6.37	$ 1,348	$ 0.56	304516 WILM BASF 230 304534 WILM PRAX 230 1	1.99	Raise to 212F	594	594	$ 4
6SUTNORTH230-Cumb	2437	24	$ 4	$ 0.17	$ 1,352	$ 0.55	304534 WILM PRAX 230 304520 WILM INVISTA 230 1	0.39	Raise to 212F	594	594	$ 1
6SUTNORTH230-Cumb	2453	16	$ 1	$ 0.05	$ 1,353	$ 0.55	304020 BRUN2 230 TT 230 305004 E1-PROSPECT 230 1	19.31	Raise to 212F	594	594	$ 39
6SUTNORTH230-Cumb	2462	9	$ 39	$ 4.29	$ 1,392	$ 0.57	304582 DELCO230 TT 230 304587 DELCO115W TT 115 1	-	Replace with 336 MVA	336	427	$ 4
6SUTNORTH230-Cumb	2464	2	$ 4	$ 2.00	$ 1,396	$ 0.57	305470 WILARDSOLTAP 230 305880 CROOKDSOLTAP 230 1	4.39	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 9
6SUTNORTH230-Cumb	2512	48	$ 9	$ 0.18	$ 1,404	$ 0.56	305995 6SUTNORTH230 230 304516 WILM BASF 230 1	1.22	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 2
6SUTNORTH230-Cumb	2512	0	$ 2	#DIV/0!	$ 1,407	$ 0.56	304516 WILM BASF 230 304534 WILM PRAX 230 1	1.99	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 4
6SUTNORTH230-Cumb	2514	2	$ 4	$ 1.99	$ 1,411	$ 0.56	304515 WALLACE230TT 230 305031 E4-BEVERAGE 230 1	6.54	Reconductor to 6-1590 ACSR	1195	1195	$ 26
6SUTNORTH230-Cumb	2536	22	$ 26	$ 1.19	$ 1,437	$ 0.57	304534 WILM PRAX 230 304520 WILM INVISTA 230 1	0.39	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 1
6SUTNORTH230-Cumb	2536	0	$ 1	#DIV/0!	$ 1,438	$ 0.57	304378 RICHMON230TT 230 304348 ROCKHAM230TT 230 1	5.96	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 12

8SUTNORTH500-Cumb	0						Interconnection	17	Interconnection from the Beach	n/a	n/a	$ 170
8SUTNORTH500-Cumb	695	695	$ 170	$ 0.24	$ 170	$ 0.24	305880 CROOKDSOLTAP 230 304515 WALLACE230TT 230 1	-	Build SuttNorth-Cumberland 500kV	-	-	$ 660
8SUTNORTH500-Cumb	1687	992	$ 660	$ 0.67	$ 830	$ 0.49	305996 8SUTNORTH500 500 998836 SUTTONNORTH1 230 1	-	Add 2nd 500/230kV bank	1125	1687	$ 15
8SUTNORTH500-Cumb	1624	-63	$ 15	$ (0.24)	$ 845	$ 0.52	305880 CROOKDSOLTAP 230 304515 WALLACE230TT 230 1	3.57	Raise to 212F	594	594	$ 7
8SUTNORTH500-Cumb	1890	266	$ 7	$ 0.03	$ 852	$ 0.45	304378 RICHMON230TT 230 304348 ROCKHAM230TT 230 1	5.96	Raise to 212F	1084	1084	$ 12
8SUTNORTH500-Cumb	1930	40	$ 12	$ 0.30	$ 864	$ 0.45	305470 WILARDSOLTAP 230 305880 CROOKDSOLTAP 230 1	4.39	Raise to 212F	594	594	$ 9

POI	MW Limit	Increm. MW	Increm Cost ($M)	Increm. Cost ($/W)	Total Cost ($M)	Total Cost ($/W)	Limiting Element	Miles	Upgrade	New Rate A	New Rate B	Increm Cost ($M)
8SUTNORTH500-Cumb	2045	115	$ 9	$ 0.08	$ 873	$ 0.43	305995 6SUTNORTH230 230 305470 WILARDSOLTAP 230 1	19	Raise to 212F	594	594	$ 38
8SUTNORTH500-Cumb	2131	86	$ 38	$ 0.44	$ 911	$ 0.43	305995 6SUTNORTH230 230 304516 WILM BASF 230 1	1.22	Raise to 212F	594	594	$ 2
8SUTNORTH500-Cumb	2190	59	$ 2	$ 0.04	$ 913	$ 0.42	304520 WILM INVISTA 230 304039 SUTTON230 TT 230 1	1.79	Raise to 212F	594	594	$ 4
8SUTNORTH500-Cumb	2272	82	$ 4	$ 0.04	$ 917	$ 0.40	304503 WARSAW TAP 230 304205 CLINTON230TT 230 1	12.6	Reconductor to 6-1590 ACSR	1195	1195	$ 50
8SUTNORTH500-Cumb	2322	50	$ 50	$ 1.01	$ 967	$ 0.42	305032 E4-BLIND BRG 230 304503 WARSAW TAP 230 1	12.67	Reconductor to 6-1590 ACSR	1195	1195	$ 51
8SUTNORTH500-Cumb	2391	69	$ 51	$ 0.73	$ 1,018	$ 0.43	304378 RICHMON230TT 230 304348 ROCKHAM230TT 230 1	5.96	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 12
8SUTNORTH500-Cumb	2413	22	$ 12	$ 0.54	$ 1,030	$ 0.43	304516 WILM BASF 230 304534 WILM PRAX 230 1	1.99	Raise to 212F	594	594	$ 4
8SUTNORTH500-Cumb	2437	24	$ 4	$ 0.17	$ 1,034	$ 0.42	304534 WILM PRAX 230 304520 WILM INVISTA 230 1	0.39	Raise to 212F	594	594	$ 1
8SUTNORTH500-Cumb	2453	16	$ 1	$ 0.05	$ 1,035	$ 0.42	304020 BRUN2 230 TT 230 305004 E1-PROSPECT 230 1	19.31	Raise to 212F	594	594	$ 39
8SUTNORTH500-Cumb	2498	45	$ 39	$ 0.86	$ 1,073	$ 0.43	305880 CROOKDSOLTAP 230 304515 WALLACE230TT 230 1	3.57	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 7
8SUTNORTH500-Cumb	2513	15	$ 7	$ 0.48	$ 1,080	$ 0.43	304515 WALLACE230TT 230 305031 E4-BEVERAGE 230 1	6.54	Reconductor to 6-1590 ACSR	1195	1195	$ 26
8SUTNORTH500-Cumb	2516	3	$ 26	$ 8.72	$ 1,107	$ 0.44	305995 6SUTNORTH230 230 304516 WILM BASF 230 1	1.22	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 2
8SUTNORTH500-Cumb	2516	0	$ 2	#DIV/0!	$ 1,109	$ 0.44	304516 WILM BASF 230 304534 WILM PRAX 230 1	1.99	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 4
8SUTNORTH500-Cumb	2527	11	$ 4	$ 0.36	$ 1,113	$ 0.44	305530 TRNBLSOLTAP 230 304390 CUMBLND230TT 230 1	9.56	Ancillary equipment	512	512	$ 0
8SUTNORTH500-Cumb	2535	8	$ 0	$ 0.03	$ 1,113	$ 0.44	304039 SUTTON230 TT 230 304554 WILM N&O TAP 230 1	5.38	Reconductor to 6-1590 ACSR	1195	1195	$ 22
8SUTNORTH500-Cumb	2540	5	$ 22	$ 4.30	$ 1,135	$ 0.45	304534 WILM PRAX 230 304520 WILM INVISTA 230 1	0.39	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 1
8SUTNORTH500-Cumb	2575	35	$ 1	$ 0.02	$ 1,135	$ 0.44	304520 WILM INVISTA 230 304039 SUTTON230 TT 230 1	1.79	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 4
8SUTNORTH500-Cumb	2597	22	$ 4	$ 0.16	$ 1,139	$ 0.44	305995 6SUTNORTH230 230 304515 WALLACE230TT 230 1	27.5	Raise to 212F	594	594	$ 55
8SUTNORTH500-Cumb	2633	36	$ 55	$ 1.53	$ 1,194	$ 0.45	305995 6SUTNORTH230 230 304354 ROCKY POINT 230 1	8.2	Reconductor to 6-1590 ACSR	1195	1195	$ 33
8SUTNORTH500-Cumb	2692	59	$ 33	$ 0.56	$ 1,227	$ 0.46	304020 BRUN2 230 TT 230 305004 E1-PROSPECT 230 1	19.31	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 39
8SUTNORTH500-Cumb	2731	39	$ 39	$ 0.99	$ 1,265	$ 0.46	305530 TRNBLSOLTAP 230 304390 CUMBLND230TT 230 1	9.56	Raise to 212F	542	542	$ 19
8SUTNORTH500-Cumb	2732	1	$ 19	$ 19.12	$ 1,285	$ 0.47	304505 ROSE HILL 230 305032 E4-BLIND BRG 230 1	4.58	Reconductor to 6-1590 ACSR	1195	1195	$ 18
8SUTNORTH500-Cumb	2735	3	$ 18	$ 6.11	$ 1,303	$ 0.48	305470 WILARDSOLTAP 230 305880 CROOKDSOLTAP 230 1	4.39	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 9
8SUTNORTH500-Cumb	2753	18	$ 9	$ 0.49	$ 1,312	$ 0.48	304354 ROCKY POINT 230 305069 E9-MEADOW 230 1	34.95	Reconductor to 6-1590 ACSR	1195	1195	$ 140
8SUTNORTH500-Cumb	2816	63	$ 140	$ 2.22	$ 1,451	$ 0.52	305995 6SUTNORTH230 230 304515 WALLACE230TT 230 1	27.5	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 55
8SUTNORTH500-Cumb	2850	34	$ 55	$ 1.62	$ 1,506	$ 0.53	306540 6MCGUIRE 230 306443 6MARSHAL 230 2	13.8	Reconductor already planned	-	-	$ 0

POI	MW Limit	Increm. MW	Increm Cost ($M)	Increm. Cost ($/W)	Total Cost ($M)	Total Cost ($/W)	Limiting Element	Miles	Upgrade	New Rate A	New Rate B	Increm Cost ($M)
6SUTNORTH230-Wom	0						Interconnection	17	Interconnection from the Beach	n/a	n/a	$ 170
6SUTNORTH230-Wom	695	695	$ 170	$ 0.24	$ 170	$ 0.24	305880 CROOKDSOLTAP 230 304515 WALLACE230TT 230 1	-	Build SuttNorth-Wom-Wake 500kV	-	-	$ 1,110
6SUTNORTH230-Wom	1545	850	$ 1,110	$ 1.31	$ 1,280	$ 0.83	305996 8SUTNORTH500 500 998836 SUTTONNORTH1 230 1	-	Add 2nd 500/230kV bank	1125	1687	$ 15
6SUTNORTH230-Wom	1689	144	$ 15	$ 0.10	$ 1,295	$ 0.77	305880 CROOKDSOLTAP 230 304515 WALLACE230TT 230 1	3.57	Raise to 212F	594	594	$ 7
6SUTNORTH230-Wom	1923	234	$ 7	$ 0.03	$ 1,302	$ 0.68	305470 WILARDSOLTAP 230 305880 CROOKDSOLTAP 230 1	4.39	Raise to 212F	594	594	$ 9
6SUTNORTH230-Wom	2037	114	$ 9	$ 0.08	$ 1,311	$ 0.64	305995 6SUTNORTH230 230 305470 WILARDSOLTAP 230 1	19	Raise to 212F	594	594	$ 38
6SUTNORTH230-Wom	2140	103	$ 38	$ 0.37	$ 1,349	$ 0.63	305995 6SUTNORTH230 230 304516 WILM BASF 230 1	1.22	Raise to 212F	594	594	$ 2
6SUTNORTH230-Wom	2200	60	$ 2	$ 0.04	$ 1,351	$ 0.61	304520 WILM INVISTA 230 304039 SUTTON230 TT 230 1	1.79	Raise to 212F	594	594	$ 4
6SUTNORTH230-Wom	2273	73	$ 4	$ 0.05	$ 1,355	$ 0.60	304503 WARSAW TAP 230 304205 CLINTON230TT 230 1	12.6	Reconductor to 6-1590 ACSR	1195	1195	$ 50
6SUTNORTH230-Wom	2280	7	$ 50	$ 7.20	$ 1,405	$ 0.62	304582 DELCO230 TT 230 304587 DELCO115W TT 115 1	-	Replace with 336 MVA	336	427	$ 4
6SUTNORTH230-Wom	2325	45	$ 4	$ 0.09	$ 1,409	$ 0.61	305032 E4-BLIND BRG 230 304503 WARSAW TAP 230 1	12.67	Reconductor to 6-1590 ACSR	1195	1195	$ 51
6SUTNORTH230-Wom	2349	24	$ 51	$ 2.11	$ 1,460	$ 0.62	305995 6SUTNORTH230 230 304515 WALLACE230TT 230 1	27.5	Raise to 212F	594	594	$ 55
6SUTNORTH230-Wom	2421	72	$ 55	$ 0.76	$ 1,515	$ 0.63	304516 WILM BASF 230 304534 WILM PRAX 230 1	1.99	Raise to 212F	594	594	$ 4
6SUTNORTH230-Wom	2445	24	$ 4	$ 0.17	$ 1,519	$ 0.62	304534 WILM PRAX 230 304520 WILM INVISTA 230 1	0.39	Raise to 212F	594	594	$ 1

POI	MW Limit	Increm. MW	Increm Cost ($M)	Increm. Cost ($/W)	Total Cost ($M)	Total Cost ($/W)	Limiting Element	Miles	Upgrade	New Rate A	New Rate B	Increm Cost ($M)
6SUTNORTH230-Wom	2486	41	$ 1	$ 0.02	$ 1,520	$ 0.61	305880 CROOKDSOLTAP 230 304515 WALLACE230TT 230 1	3.57	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 7
6SUTNORTH230-Wom	2492	6	$ 7	$ 1.19	$ 1,527	$ 0.61	304020 BRUN2 230 TT 230 305004 E1-PROSPECT 230 1	19.31	Raise to 212F	594	594	$ 39
6SUTNORTH230-Wom	2518	26	$ 39	$ 1.49	$ 1,566	$ 0.62	304515 WALLACE230TT 230 305031 E4-BEVERAGE 230 1	6.54	Reconductor to 6-1590 ACSR	1195	1195	$ 26
6SUTNORTH230-Wom	2525	7	$ 26	$ 3.74	$ 1,592	$ 0.63	305995 6SUTNORTH230 230 304516 WILM BASF 230 1	1.22	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 2
6SUTNORTH230-Wom	2549	24	$ 2	$ 0.10	$ 1,594	$ 0.63	304039 SUTTON230 TT 230 304554 WILM N&O TAP 230 1	5.38	Reconductor to 6-1590 ACSR	1195	1195	$ 22
6SUTNORTH230-Wom	2575	26	$ 22	$ 0.83	$ 1,616	$ 0.63	305530 TRNBLSOLTAP 230 304390 CUMBLND230TT 230 1	9.56	Raise to 212F	512	512	$ 19
6SUTNORTH230-Wom	2585	10	$ 19	$ 1.91	$ 1,635	$ 0.63	304520 WILM INVISTA 230 304039 SUTTON230 TT 230 1	1.79	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 4
6SUTNORTH230-Wom	2596	11	$ 4	$ 0.33	$ 1,638	$ 0.63	305995 6SUTNORTH230 230 304354 ROCKY POINT 230 1	8.2	Reconductor to 6-1590 ACSR	1195	1195	$ 33
6SUTNORTH230-Wom	2709	113	$ 33	$ 0.29	$ 1,671	$ 0.62	304354 ROCKY POINT 230 305069 E9-MEADOW 230 1	34.95	Reconductor to 6-1590 ACSR	1195	1195	$ 140
6SUTNORTH230-Wom	2720	11	$ 140	$ 12.71	$ 1,811	$ 0.67	305470 WILARDSOLTAP 230 305880 CROOKDSOLTAP 230 1	4.39	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 9
6SUTNORTH230-Wom	2731	11	$ 9	$ 0.80	$ 1,820	$ 0.67	304587 DELCO115W TT 115 304575 LAKE WACCA 115 1	16.86	Reconductor to 3-1590 ACSR	340	340	$ 67
6SUTNORTH230-Wom	2739	8	$ 67	$ 8.43	$ 1,887	$ 0.69	304505 ROSE HILL 230 305032 E4-BLIND BRG 230 1	4.58	Reconductor to 6-1590 ACSR	1195	1195	$ 18
6SUTNORTH230-Wom	2822	83	$ 18	$ 0.22	$ 1,906	$ 0.68	305069 E9-MEADOW 230 304524 JACKSON230TT 230 1	4.78	Reconductor to 6-1590 ACSR	1195	1195	$ 19
6SUTNORTH230-Wom	2824	2	$ 19	$ 9.56	$ 1,925	$ 0.68	304525 JACKSN115ETT 115 305065 E9-GUMBRNCH 115 1	4.69	Reconductor to 3-1590 ACSR	340	340	$ 19
8SUTNORTH500-Wom	0						Interconnection	17	Interconnection from the Beach	n/a	n/a	$ 170
8SUTNORTH500-Wom	695	695	$ 170	$ 0.24	$ 170	$ 0.24	305880 CROOKDSOLTAP 230 304515 WALLACE230TT 230 1	-	Build SuttNorth-Wom-Wake 500kV	-	-	$ 1,110
8SUTNORTH500-Wom	1687	992	$ 1,110	$ 1.12	$ 1,280	$ 0.76	305996 8SUTNORTH500 500 998836 SUTTONNORTH1 230 1	-	Add 2nd 500/230kV bank	1125	1687	$ 15
8SUTNORTH500-Wom	1689	2	$ 15	$ 7.50	$ 1,295	$ 0.77	305880 CROOKDSOLTAP 230 304515 WALLACE230TT 230 1	3.57	Raise to 212F	594	594	$ 7
8SUTNORTH500-Wom	1923	234	$ 7	$ 0.03	$ 1,302	$ 0.68	305470 WILARDSOLTAP 230 305880 CROOKDSOLTAP 230 1	4.39	Raise to 212F	594	594	$ 9
8SUTNORTH500-Wom	2037	114	$ 9	$ 0.08	$ 1,311	$ 0.64	305995 6SUTNORTH230 230 305470 WILARDSOLTAP 230 1	19	Raise to 212F	594	594	$ 38
8SUTNORTH500-Wom	2140	103	$ 38	$ 0.37	$ 1,349	$ 0.63	305995 6SUTNORTH230 230 304516 WILM BASF 230 1	1.22	Raise to 212F	594	594	$ 2
8SUTNORTH500-Wom	2200	60	$ 2	$ 0.04	$ 1,351	$ 0.61	304520 WILM INVISTA 230 304039 SUTTON230 TT 230 1	1.79	Raise to 212F	594	594	$ 4
8SUTNORTH500-Wom	2273	73	$ 4	$ 0.05	$ 1,355	$ 0.60	304503 WARSAW TAP 230 304205 CLINTON230TT 230 1	12.6	Reconductor to 6-1590 ACSR	1195	1195	$ 50
8SUTNORTH500-Wom	2324	51	$ 50	$ 0.99	$ 1,405	$ 0.60	305032 E4-BLIND BRG 230 304503 WARSAW TAP 230 1	12.67	Reconductor to 6-1590 ACSR	1195	1195	$ 51
8SUTNORTH500-Wom	2425	101	$ 51	$ 0.50	$ 1,456	$ 0.60	304516 WILM BASF 230 304534 WILM PRAX 230 1	1.99	Raise to 212F	594	594	$ 4
8SUTNORTH500-Wom	2450	25	$ 4	$ 0.16	$ 1,460	$ 0.60	304534 WILM PRAX 230 304520 WILM INVISTA 230 1	0.39	Raise to 212F	594	594	$ 1
8SUTNORTH500-Wom	2482	32	$ 1	$ 0.02	$ 1,461	$ 0.59	305880 CROOKDSOLTAP 230 304515 WALLACE230TT 230 1	3.57	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 7
8SUTNORTH500-Wom	2483	1	$ 7	$ 7.14	$ 1,468	$ 0.59	304020 BRUN2 230 TT 230 305004 E1-PROSPECT 230 1	19.31	Raise to 212F	594	594	$ 39
8SUTNORTH500-Wom	2517	34	$ 39	$ 1.14	$ 1,507	$ 0.60	304515 WALLACE230TT 230 305031 E4-BEVERAGE 230 1	6.54	Reconductor to 6-1590 ACSR	1195	1195	$ 26
8SUTNORTH500-Wom	2528	11	$ 26	$ 2.38	$ 1,533	$ 0.61	304039 SUTTON230 TT 230 304554 WILM N&O TAP 230 1	5.38	Reconductor to 6-1590 ACSR	1195	1195	$ 22
8SUTNORTH500-Wom	2529	1	$ 22	$ 21.52	$ 1,554	$ 0.61	305995 6SUTNORTH230 230 304516 WILM BASF 230 1	1.22	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 2
8SUTNORTH500-Wom	2529	0	$ 2	#DIV/0!	$ 1,557	$ 0.62	304516 WILM BASF 230 304534 WILM PRAX 230 1	1.99	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 4
8SUTNORTH500-Wom	2554	25	$ 4	$ 0.16	$ 1,561	$ 0.61	304534 WILM PRAX 230 304520 WILM INVISTA 230 1	0.39	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 1
8SUTNORTH500-Wom	2564	10	$ 1	$ 0.08	$ 1,561	$ 0.61	305530 TRNBLSOLTAP 230 304390 CUMBLND230TT 230 1	9.56	Raise to 212F	512	512	$ 19
8SUTNORTH500-Wom	2584	20	$ 19	$ 0.96	$ 1,581	$ 0.61	305995 6SUTNORTH230 230 304515 WALLACE230TT 230 1	27.5	Raise to 212F	594	594	$ 55
8SUTNORTH500-Wom	2589	5	$ 55	$ 11.00	$ 1,636	$ 0.63	304520 WILM INVISTA 230 304039 SUTTON230 TT 230 1	1.79	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 4
8SUTNORTH500-Wom	2593	4	$ 4	$ 0.90	$ 1,639	$ 0.63	305995 6SUTNORTH230 230 304354 ROCKY POINT 230 1	8.2	Reconductor to 6-1590 ACSR	1195	1195	$ 33
8SUTNORTH500-Wom	2706	113	$ 33	$ 0.29	$ 1,672	$ 0.62	304354 ROCKY POINT 230 305069 E9-MEADOW 230 1	34.95	Reconductor to 6-1590 ACSR	1195	1195	$ 140
8SUTNORTH500-Wom	2717	11	$ 140	$ 12.71	$ 1,812	$ 0.67	305470 WILARDSOLTAP 230 305880 CROOKDSOLTAP 230 1	4.39	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 9
8SUTNORTH500-Wom	2729	12	$ 9	$ 0.73	$ 1,821	$ 0.67	304020 BRUN2 230 TT 230 305004 E1-PROSPECT 230 1	19.31	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 39

POI	MW Limit	Increm. MW	Increm Cost ($M)	Increm. Cost ($/W)	Total Cost ($M)	Total Cost ($/W)	Limiting Element							Miles	Upgrade	New Rate A	New Rate B	Increm Cost ($M)
8SUTNORTH500-Wom	2737	8	$ 39	$ 4.83	$ 1,859	$ 0.68	304505	ROSE HILL	230	305032	E4-BLIND BRG	230	1	4.58	Reconductor to 6-1590 ACSR	1195	1195	$ 18
8SUTNORTH500-Wom	2780	43	$ 18	$ 0.43	$ 1,877	$ 0.68	304582	DELCO230 TT	230	304587	DELCO115W TT	115	1	-	Replace with 336 MVA	336	427	$ 4
8SUTNORTH500-Wom	2803	23	$ 4	$ 0.17	$ 1,881	$ 0.67	305995	6SUTNORTH230	230	304515	WALLACE230TT	230	1	27.5	Reconductor to 6-1590 ACSR instead of raise	1195	1195	$ 55
8SUTNORTH500-Wom	2822	19	$ 55	$ 2.89	$ 1,936	$ 0.69	305069	E9-MEADOW	230	304524	JACKSON230TT	230	1	4.78	Reconductor to 6-1590 ACSR	1195	1195	$ 19
8SUTNORTH500-Wom	2824	2	$ 19	$ 9.56	$ 1,956	$ 0.69	304525	JACKSN115ETT	115	305065	E9-GUMBRNCH	115	1	4.69	Reconductor to 3-1590 ACSR	340	340	$ 19

Appendix B
Transmission Upgrade Costs Used in This Study

$M	Description	
$2	per mile to raise clearances	
$4	per mile to reconductor	
$5	per mile for interconnection/green field line	
$10	per mile for 500kV (incl. purchase of ROW)	
$5	per mile for 500kV (ROW already owned)	
$4	to replace 230/115kV transformer	
$7	to install 230/115kV transformer in new position	
$15	to install 500/230kV transformer in new position	
$25	to build Sutton North 230kV	

	Sutton North - Wommack - Wake 500kV	miles
$25	to build Sutton North 230kV	
$35	for Sutton 500kV switchyard	
$35	for Wommack 500kV switchyard	
$690	Sutton-Wommack 500kV line	69
$325	Wommack-Wake 500kV line	65
$1,110		

	Sutton North - Cumberland 500kV	miles
$25	to build Sutton North 230kV	
$35	for Sutton 500kV switchyard	
$600	Sutton-Cumberland 500kV line	60
$660		

	New Bern - Wommack - Wake 500kV	miles
$35	for New Bern 500kV switchyard	
$35	for Wommack 500kV switchyard	
$175	New Bern-Wommack 500kV line	35
$325	Wommack-Wake 500kV line	65
$570		

	Greenville - Wommack - Wake 500kV	miles
$35	for Greenville 500kV switchyard	
$35	for Wommack 500kV switchyard	
$450	Greenville-Wommack 500kV line	45
$325	Wommack-Wake 500kV line	65
$845		

Appendix C
Mileages from Substations to Coastline Used in This Study

POI Station	Miles from Coast
6AURORASST	46
6BRUN1230T	5
6BRUN2230T	5
6CASTLEH230T	9
6CLINTON230T	60
6CUMBLND230T	72
6DELCO230T	30
6FLOSUB230T	64
6FOLKSTN230T	10
6GREENVIL230	85
6GRNTSCK230T	14
6HAVELOK230T	4
6JACKSON230T	20
6KINDUP230TT	30
6KINGSTR230T	45
6LANDSTN	8
6LATTASST	53
6LEESUB230T	70
6MARION230T	46
6MORHDWW230T	4
6MTOLV230T	62
6NEWBERN230T	34
6SUMTER230T	75
6SUTNORTH230	17
6WAKE230TT	90
6WALLACE230T	32
6WHITEVL230T	34
6WOMMACK230T	51
6WSPOON230T	58
8CUMBLND500T	72
8FENTRES	15
8GREENVIL500	85
8NEWBERN500	34
8WAKE500TT	90