Duke Energy Progress, LLC

Transitional Cluster Study

Phase 1 Report

February 28, 2022

Duke Energy Progress, LLC ("Duke Energy Progress" or **"DEP")** is issuing this report as Transmission Provider under the applicable joint Open Access Transmission Tariff (OATT) Attachment J Large Generator Interconnection Procedures and as the interconnecting Utility under the applicable North Carolina Interconnection Procedures (NCIP) and South Carolina Generator Interconnection Procedures (SC GIP). This report summarizes the Transitional Cluster Study Phase 1 results for all Interconnection Requests studied by Duke Energy Progress in the Transitional Cluster.

Contents

Transmission Interconnections

ID 005703
ID 005703 is a proposed 70.2MW solar Generating Facility connecting to the Blewett -Tillery 115 kV transmission line in Montgomery County, NC. The estimated cost of Interconnection Facilities is $5.368M and the total estimated cost of Upgrades currently assigned to 005703 is $22.750M. The thermal Upgrades are detailed in tables 7.1.1, 7.1.2, 7.1.3, 7.1.4, 7.1.22, and 7.1.23.

ID 010586
ID 010586 is a proposed 70.1MW solar Generating Facility connecting to the Marion - Whiteville 230 kV transmission line in Caswell County, NC. The estimated cost of Interconnection Facilities is $5.559M and the total estimated cost of Upgrades currently assigned to 010586 is $7.345M. The thermal Upgrades are detailed in tables 7.1.14, 7.1.15, and 7.1.24.

ID 016321
ID 016321 is a proposed 70MW solar Generating Facility connecting to the Pageland Tap, Robinson-Rockingham 115 kV transmission line in Chesterfield County, SC. The estimated cost of Interconnection Facilities is $5.221M and the total estimated cost of Upgrades currently assigned to 016321 is $38.349M. The thermal Upgrades are detailed in tables 7.1.1, 7.1.2, 7.1.4,7.1.6, 7.1.7, 7.1.8, 7.1.9, 7.1.14, 7.1.15, 7.1.18, 7.1.19, 7.1.20, 7.1.22, and 7.1.23.

ID 017658
ID 017658 is a proposed 80MW solar Generating Facility connecting to the Florence DuPont - Marion 115 kV transmission line in Marion County, SC. The estimated cost of Interconnection Facilities is $5.458M and the total estimated cost of Upgrades currently assigned to 017658 is $10.568M. The thermal Upgrades are detailed in tables 7.1.14, 7.1.15, 7.1.16, 7.1.17, 7.1.24.

ID 019397
ID 019397 is a proposed 75MW solar Generating Facility connecting to the Florence DuPont - SCPSA Hemingway 115 kV transmission line in Florence County, SC. The estimated cost of Interconnection Facilities is $5.458M and the total estimated cost of Upgrades currently assigned to 019397 is $8.527M. The thermal Upgrades are detailed in tables 7.1.14, 7.1.15, 7.1.16, 7.1.17, 7.1.18, 7.1.19, and 7.1.24.

ID 021764
ID 021764 is a proposed 8MW solar Generating Facility connecting to the Kinston DuPont 115kV transmission line in Lenoir County, NC. The estimated cost of Interconnection Facilities is $2.231M and the total estimated cost of Upgrades currently assigned to 021764 is $4.000M.

ID 021772
ID 021772 is a proposed 8MW solar Generating Facility connecting to the Kinston DuPont 115kV transmission line in Lenoir County, NC. The estimated cost of Interconnection Facilities is $2.231M and the total estimated cost of Upgrades currently assigned to 021772 is $4.000M.

ID 022128
ID 022128 is a proposed 79.8MW solar Generating Facility connecting to the Lee - Wommack 230 kV North transmission line in Lenoir County, NC. The estimated cost of Interconnection Facilities is $5.322M and the total estimated cost of Upgrades currently assigned to 022128 is $2.598M. The thermal Upgrades are detailed in tables 7.1.1, 7.1.2, 7.1.22, and 7.1.23.

ID 024078

ID 024078 is a proposed 79.8MW solar Generating Facility connecting to the Robinson - Camden Junction 115 kV transmission line in Kershaw County, SC. The estimated cost of Interconnection Facilities is $5.494M and the total estimated cost of Upgrades currently assigned to 024078 is $8.712M. The thermal Upgrades are detailed in tables 7.1.14, 7.1.15, 7.1.18, 7.1.19, and 7.1.24.

ID 030708

ID 030708 is a proposed 78.32MW solar Generating Facility connecting to the Person - Rocky Mount 230 kV transmission line in Nash County, NC. The estimated cost of Interconnection Facilities is $2.064M and the total estimated cost of Upgrades currently assigned to 030708 is $11.229M.

ID 032986

ID 032986 is a proposed 80MW solar Generating Facility connecting to the Cumberland - Whiteville 230 kV transmission line in Bladen County, NC. The estimated cost of Interconnection Facilities is $5.559M and the total estimated cost of Upgrades currently assigned to 032986 is $15.826M. The thermal Upgrades are detailed in tables 7.1.1, 7.1.2, 7.1.10, 7.1.11, 7.1.12, 7.1.13, 7.1.14, 7.1.15, 7.1.21, 7.1.22, and 7.1.23.

ID 067146

ID 067146 is a proposed 80MW solar Generating Facility connecting to the Robinson - Florence 230 kV transmission line in Darlington County, SC. The estimated cost of Interconnection Facilities is $5.826M and the total estimated cost of Upgrades currently assigned to 067146 is $14.824M. The thermal Upgrades are detailed in tables 7.1.6, 7.1.7, 7.1.8, 7.1.9, 7.1.14, 7.1.15, 7.1.16, 7.1.17, 7.1.18, 7.1.19, and 7.1.24.

ID 119904

ID 119904 is a proposed 18.4MW storage Generating Facility connecting to the Fort Bragg Longstreet Rd 230 kV transmission line in Cumberland County, NC. The estimated cost of Transmission Provider Interconnection Facilities is $1.103M and the total estimated cost of Network Upgrades currently assigned to 119904 is $3.519M. The thermal Upgrades are detailed in tables 7.1.14 and 7.1.15.

ID 126008

ID 126008 is a proposed 75MW solar Generating Facility connecting to the Rocky Mount - Wilson 230 kV transmission line in Wilson County, NC. The estimated cost of Interconnection Facilities is $5.818M and the total estimated cost of Upgrades currently assigned to 126008 is $2.106M.

ID 138340

ID 138340 is a proposed 74MW solar Generating Facility connecting to the Weatherspoon - LOF 115 kV transmission line in Robeson County, NC. The estimated cost of Interconnection Facilities is $5.393M and the total estimated cost of Upgrades currently assigned to 138340 is $25.357M. The thermal Upgrades are detailed in tables 7.1.1, 7.1.2, 7.1.6, 7.1.7, 7.1.8, 7.1.9, 7.1.10, 7.1.11, 7.1.12, 7.1.13, 7.1.14, 7.1.15, 7.1.16, 7.1.17, 7.1.22, and 7.1.23.

ID 169712

ID 169712 is a proposed 80MW solar Generating Facility connecting to the Biscoe - Rockingham 230 kV transmission line in Montgomery County, NC. The estimated cost of Interconnection Facilities is $5.559M and the total estimated cost of Upgrades currently assigned to 169712 is $4.939M. The thermal Upgrades are detailed in tables 7.1.1, 7.1.2, 7.1.4, 7.1.22, and 7.1.23.

ID 169716

ID 169716 is a proposed 80MW solar Generating Facility connecting to the Cumberland - Delco 230 kV transmission line in Bladen County, NC. The estimated cost of Interconnection Facilities is $2.064M and the total estimated cost of Upgrades currently assigned to 169716 is $16.762M. The thermal Upgrades are detailed in tables 7.1.1, 7.1.2, 7.1.14, 7.1.15, 7.1.21, 7.1.22, and 7.1.23.

ID 170274

ID 170274 is a proposed 275MW solar and storage Generating Facility connecting to the Laurinburg - Richmond 230 kV transmission line in Richmond County, NC. The estimated cost of Transmission Provider Interconnection Facilities is $2.064M and the total estimated cost of Upgrades currently assigned to 170274 is $89.682M. The thermal Network Upgrades are detailed in tables 7.1.1, 7.1.2, 7.1.4, 7.1.5, 7.1.6, 7.1.7, 7.1.8, 7.1.9, 7.1.10, 7.1.11, 7.1.12, 7.1.13, 7.1.14, 7.1.15, 7.1.16, 7.1.17, 7.1.20, 7.1.22, and 7.1.23.

ID 177122

ID 177122 is a proposed 69.9MW solar Generating Facility connecting to the Bennettsville - Laurinburg 230 kV transmission line in Scotland County, NC. The estimated cost of Transmission Provider Interconnection Facilities is $5.322M and the total estimated cost of Network Upgrades currently assigned to 177122 is $13.913M. The thermal Upgrades are detailed in tables 7.1.6, 7.1.7, 7.1.8, 7.1.9, 7.1.14, 7.1.15, 7.1.16, and 7.1.17.

ID 179866

ID 179866 is a proposed 150MW solar Generating Facility connecting to the Florence - Kingstree 230 kV transmission line in Williamsburg County, SC. The estimated cost of Transmission Provider Interconnection Facilities is $5.559M and the total estimated cost of Network Upgrades currently assigned to 179866 is $22.655M. The thermal Upgrades are detailed in tables 7.1.1, 7.1.2, 7.1.4, 7.1.10, 7.1.11, 7.1.12, 7.1.13, 7.1.14, 7.1.15, 7.1.16, 7.1.17, 7.1.18, 7.1.19, 7.1.22, 7.1.23, and 7.1.24.

ID 179996

ID 179996 is a proposed 74.9MW solar Generating Facility connecting to the Kingstree - Sumter 115 kV transmission line in Williamsburg County, SC. The estimated cost of Transmission Provider Interconnection Facilities is $5.368M and the total estimated cost of Network Upgrades currently assigned to 179996 is $7.525M. The thermal Upgrades are detailed in tables 7.1.14, 7.1.15, 7.1.18, 7.1.19, and 7.1.24.

ID 186310

ID 186310 is a proposed 23.3MW storage Generating Facility connecting to the Durham - DPC East Durham 230 kV transmission line in Durham County, NC. The estimated cost of Transmission Provider Interconnection Facilities is $5.559M and the total estimated cost of Network Upgrades currently assigned to 186310 is $1.142M.

ID 187960

ID 187960 is a proposed 165MW solar Generating Facility connecting to the Darlington County Plant 230 kV Switchyard transmission line in Darlington County, SC. The estimated cost of Transmission Provider Interconnection Facilities is $3.123M and the total estimated cost of Network Upgrades currently assigned to 187960 is $39.004M. The thermal Upgrades are detailed in tables 7.1.1, 7.1.2, 7.1.4, 7.1.6, 7.1.7, 7.1.8, 7.1.9, 7.1.10, 7.1.11, 7.1.12, 7.1.13, 7.1.14, 7.1.15, 7.1.16, 7.1.17, 7.1.18, 7.1.19, 7.1.22, 7.1.23, and 7.1.24.

ID 191894

ID 191894 is a proposed 30.5MW storage Generating Facility connecting to the Craggy 230 kV transmission line in Buncombe County, NC. The estimated cost of Transmission Provider Interconnection Facilities is $1.735M and the total estimated cost of Network Upgrades currently assigned to 191894 is $2.668M.

ID 200482

ID 200482 is a proposed 60MW solar Generating Facility connecting to the Rockingham - West End 230 kV East transmission line in Richmond County, NC. The estimated cost of Interconnection Facilities is $5.322M and the total estimated cost of Upgrades currently assigned to 200482 is $22.923M. The thermal Upgrades are detailed in tables 7.1.1, 7.1.2, 7.1.4, 7.1.6, 7.1.7, 7.1.8, 7.1.9, 7.1.14, 7.1.15, 7.1.20, 7.1.22, and 7.1.23.

ID 205718

ID 205718 is a proposed 74.9MW solar Generating Facility connecting to the Bennettsville - Laurinburg 230 kV transmission line in Marlboro County, SC. The estimated cost of Interconnection Facilities is $5.322M and the total estimated cost of Upgrades currently assigned to 205718 is $15.227M. The thermal Upgrades are detailed in tables 7.1.1, 7.1.2, 7.1.4, 7.1.6, 7.1.7, 7.1.8, 7.1.9, 7.1.14, 7.1.15, 7.1.16, 7.1.17, 7.1.22, and 7.1.23.

Distribution Interconnections

ID 002115

ID 002115 is a proposed 4.998 MW solar Generating Facility connecting to Feeder T2631B03 from the Weatherspoon 230kV substation in Robeson County, NC. The estimated cost of Interconnection Facilities is $125,000. The estimated transmission upgrade allocation is $0, and the estimated distribution upgrade is $366,000. The total estimated cost is **$491,000**. The distribution upgrades are detailed in section 5.7 of the distribution report. The customer will be required to build distribution facilities to a new POI 2.2 miles from the solar facility. In the event that this request chooses to move forward, it will proceed to an individual distribution-level System Impact Study (NCIP 4.4.7.1).

ID 002156

ID 002156 is a proposed 4.999 MW solar Generating Facility connecting to Feeder T2631B03 from the Weatherspoon 230kV substation in Robeson County, NC. The estimated cost of Interconnection Facilities is $125,000. The estimated transmission upgrade allocation is $0, and the estimated distribution upgrade is $366,000. The total estimated cost is **$491,000**. The distribution upgrades are detailed in section 5.7 of the distribution report. The customer will be required to build distribution facilities to a new POI 3 miles from the solar facility. In the event that this request chooses to move forward, it will proceed to an individual distribution-level System Impact Study (NCIP 4.4.7.1).

ID 004484

ID 004484 is a proposed 2.0 MW solar Generating Facility connecting to Feeder T2750B04 from the Dillon 115kV substation in Dillon County, SC. The estimated cost of Interconnection Facilities is $125,000. The estimated transmission upgrade allocation is $0, and the estimated distribution upgrade is $0. The total estimated cost is **$125,000**. The distribution upgrades are detailed in section 5.1 of the distribution report. The customer will be required to build distribution facilities to a new POI 5.1 miles from the solar facility. In the event that this request chooses to move forward, it will proceed to an individual distribution-level System Impact Study (SC GIP Appendix SC 5.3.7.1).

ID 004540
ID 004540 is a proposed 8.0 MW solar Generating Facility connecting to Feeder T3760B02 from the McColl 230kV substation in Marlboro County, SC. The estimated cost of Interconnection Facilities is $125,000. The estimated transmission upgrade allocation is $1,383,000 and the estimated distribution upgrade is $2,007,000. The total estimated cost is **$3,515,000**. The transmission upgrades are detailed in tables 7.1.6, 7.1.7, 7.1.8, 7.1.9, 7.1.14, 7.1.15, and 7.1.17 in the transmission report. The distribution upgrades are detailed in section 5.4 of the distribution report.

ID 004538
ID 004538 is a proposed 10.0 MW solar Generating Facility connecting to Feeder T2750B04 from the Dillon 115kV substation in Dillon County, SC. The estimated cost of Interconnection Facilities is $125,000. The estimated transmission upgrade allocation is $1,151,000 and the estimated distribution upgrade is $0. The total estimated cost is **$1,276,000**. The transmission upgrades are detailed in tables 7.1.14, 7.1.15, 7.1.16 and 7.1.17 in the transmission report. The distribution upgrades are detailed in section 5.1 of the distribution report. The customer will be required to build distribution facilities to a new POI 3 miles from the solar facility.

ID 005037
ID 005037 is a proposed 1.998 MW solar Generating Facility connecting to Feeder T6670B03 from the Whiteville 115kV substation in Columbus County, NC. The estimated cost of Interconnection Facilities is $125,000. The estimated transmission upgrade allocation is $0, and the estimated distribution upgrade is $0. The total estimated cost is **$125,000**. The distribution upgrades are detailed in section 5.8 of the distribution report. In the event that this request chooses to move forward, it will proceed to an individual distribution-level System Impact Study (NCIP 4.4.7.1).

ID 008286
ID 008286 is a proposed 4.992 MW solar Generating Facility connecting to Feeder T1672B03 from the Wadesboro Bowman School 230kV substation in Anson County, NC. The estimated cost of Interconnection Facilities is $125,000. The estimated transmission upgrade allocation is $0, and the estimated distribution upgrade is $1,412,000. The total estimated cost is **$1,537,000**. The distribution upgrades are detailed in section 5.6 of the distribution report. In the event that this request chooses to move forward, it will proceed to an individual distribution-level System Impact Study (NCIP 4.4.7.1).

ID 016227
ID 016227 is a proposed 1.98 MW solar Generating Facility connecting to Feeder T3665B05 from the Hartsville Segars Mill 230kV substation in Darlington County, SC. The estimated cost of Interconnection Facilities is $125,000. The estimated transmission upgrade allocation is $0, and the estimated distribution upgrade is $0. The total estimated cost is **$125,000**. The distribution upgrades are detailed in section 5.2 of the distribution report. In the event that this request chooses to move forward, it will proceed to an individual distribution-level System Impact Study (SC GIP Appendix SC 5.3.7.1).

ID 016257
ID 016257 is a proposed 1.98 MW solar Generating Facility connecting to Feeder T3665B04 from the Hartsville Segars Mill 230kV substation in Darlington County, SC. The estimated cost of Interconnection Facilities is $125,000. The estimated transmission upgrade allocation is $0, and the estimated distribution upgrade is $0. The total estimated cost is **$125,000**. The distribution upgrades are detailed in section 5.2 of the distribution report. The customer will be required to build distribution facilities to a new POI 3.5 miles from the solar facility. In the event that this request chooses to move forward, it will proceed to an individual distribution-level System Impact Study (SC GIP Appendix SC 5.3.7.1).

ID 019139
ID 019139 is a proposed 2.0 MW solar Generating Facility connecting to Feeder T3030B01 from the Mullins 115kV substation in Dillon County, SC. The estimated cost of Interconnection Facilities is $125,000. The estimated transmission upgrade allocation is $0, and the estimated distribution upgrade is $541,000. The total estimated cost is **$666,000**. The distribution upgrades are detailed in section 5.5 of the distribution report. In the event that this request chooses to move forward, it will proceed to an individual distribution-level System Impact Study (SC GIP Appendix SC 5.3.7.1).

ID 016328
ID 016328 is a proposed 2.0 MW solar Generating Facility connecting to Feeder T3760B02 from the McColl 230kV substation in Marlboro County, SC. The estimated cost of Interconnection Facilities is $125,000. The estimated transmission upgrade allocation is $314,000 and the estimated distribution upgrade is $637,000. The total estimated cost is **$1,076,000**. The transmission upgrades are detailed in tables 7.1.6, 7.1.7, 7.1.8, 7.1.9, 7.1.14, 7.1.15, and 7.1.17 in the transmission report. The distribution upgrades are detailed in section 5.4 of the distribution report.

ID 019170
ID 019170 is a proposed 2.0 MW solar Generating Facility connecting to Feeder T3760B01 from the McColl 230kV substation in Marlboro County, SC. The estimated cost of Interconnection Facilities is $125,000. The estimated transmission upgrade allocation is $314,000 and the estimated distribution upgrade is $581,000. The total estimated cost is **$1,020,000**. The transmission upgrades are detailed in tables 7.1.6, 7.1.7, 7.1.8, 7.1.9, 7.1.14, 7.1.15, and 7.1.17 in the transmission report. The distribution upgrades are detailed in section 5.4 of the distribution report.

ID 016326
ID 016326 is a proposed 2.0 MW solar Generating Facility connecting to Feeder T3760B01 from the McColl 230kV substation in Marlboro County, SC. The estimated cost of Interconnection Facilities is $125,000. The estimated transmission upgrade allocation is $314,000 and the estimated distribution upgrade is $581,000. The total estimated cost is **$1,020,000**. The transmission upgrades are detailed in tables 7.1.6, 7.1.7, 7.1.8, 7.1.9, 7.1.14, 7.1.15, and 7.1.17 in the transmission report. The distribution upgrades are detailed in section 5.4 of the distribution report.

ID 016327
ID 016327 is a proposed 2.0 MW solar Generating Facility connecting to Feeder T3760B01 from the McColl 230kV substation in Marlboro County, SC. The estimated cost of Interconnection Facilities is $125,000. The estimated transmission upgrade allocation is $314,000 and the estimated distribution upgrade is $581,000. The total estimated cost is **$1,020,000**. The transmission upgrades are detailed in tables 7.1.6, 7.1.7, 7.1.8, 7.1.9, 7.1.14, 7.1.15, and 7.1.17 in the transmission report. The distribution upgrades are detailed in section 5.4 of the distribution report.

ID 019176
ID 019176 is a proposed 2.0 MW solar Generating Facility connecting to Feeder T3760B02 from the McColl 230kV substation in Marlboro County, SC. The estimated cost of Interconnection Facilities is $125,000. The estimated transmission upgrade allocation is $314,000 and the estimated distribution upgrade is $637,000. The total estimated cost is **$1,076,000**. The transmission upgrades are detailed in tables 7.1.6, 7.1.7, 7.1.8, 7.1.9, 7.1.14, 7.1.15, and 7.1.17 in the transmission report. The distribution upgrades are detailed in section 5.4 of the distribution report.

ID 019261

ID 019261 is a proposed 6.201 MW solar Generating Facility connecting to Feeder T2200B23 from the Laurinburg 230kV substation in Scotland County, NC. The estimated cost of Interconnection Facilities is $125,000. The estimated transmission upgrade allocation is $1,209,000 and the estimated distribution upgrade is $572,000. The total estimated cost is **$1,906,000**. The transmission upgrades are detailed in tables 7.1.6, 7.1.7, 7.1.8, 7.1.9, 7.1.14, 7.1.15, 7.1.16, and 7.1.17 in the transmission report. The distribution upgrades are detailed in section 5.3 of the distribution report.

ID 020832

ID 020832 is a proposed 2.0 MW solar Generating Facility connecting to Feeder T3030B01 from the Mullins 115kV substation in Dillon County, SC. The estimated cost of Interconnection Facilities is $125,000. The estimated transmission upgrade allocation is $0, and the estimated distribution upgrade is $541,000. The total estimated cost is **$666,000**. The distribution upgrades are detailed in section 5.5 of the distribution report. In the event that this request chooses to move forward, it will proceed to an individual distribution-level System Impact Study (SC GIP Appendix SC 5.3.7.1).

ID 021892

ID 021892 is a proposed 2.0 MW solar Generating Facility connecting to Feeder T3030B01 from the Mullins 115kV substation in Dillon County, SC. The estimated cost of Interconnection Facilities is $125,000. The estimated transmission upgrade allocation is $0, and the estimated distribution upgrade is $2,400. The total estimated cost is **$127,400**. The distribution upgrades are detailed in section 5.5 of the distribution report. In the event that this request chooses to move forward, it will proceed to an individual distribution-level System Impact Study (SC GIP Appendix SC 5.3.7.1).

Duke Energy Progress, LLC

Transmission Transitional Cluster Study Phase 1 Report

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1.0 Purpose

Following are the results of the **Duke Energy Progress, LLC (DEP)** Transitional Cluster Study (Phase 1). This analysis is focused on impacts to the Duke Energy Progress Transmission system. Impacts to the **Duke Energy Progress** Distribution system are addressed in the distribution report. Where applicable, impacts to neighboring transmission systems (meaning systems other than DEP's system, referred to as Affected Systems) are identified for further evaluation as part of an Affected System Study that must be performed by the external system.

2.0 Study Assumptions

The following Transitional Cluster Study (Phase 1) results are developed from the DEP Base Cases that reflect specific conditions of the DEP system at points in time consistent with the study conditions being evaluated. At the time of the study, the Base Cases included the most recent information for load, generation, transmission, interchange, and other pertinent data necessary for analysis. Future years may include generation, transmission, and interchange modifications that are not budgeted and for which no firm commitments have been made. Further, DEP retains the right to make modifications to the Base Cases as needed if additional information is available or if specific scenarios necessitate changes. For the systems surrounding DEP, data is based on the ERAG MMWG model. For the Transitional Cluster Study, Transitional Serial projects and their associated upgrades were considered when modifying the Base Cases. Collectively, these considerations constitute the Transitional Cluster Base Cases. The suitability of the Transitional Cluster Base Cases for use by others is the sole responsibility of the user.

The results of this analysis were based on the information provided by cluster participants at the time of the study. Modifications to generation facilities' technical data or points of interconnection may require reevaluation of one or more parts of the study.

This study was based on the assumptions that the Customer would construct, own and operate the electrical infrastructure that would connect their generation to DEP's facilities, including any step up transformers and lines from the generators, but excluding the circuit breaker in the new breaker station, where applicable.

3.0 Cluster Information

The following table lists the DEP interconnection requests studied as part of the Transitional Cluster Phase 1 study:

ID	MW (Summer Peak)	MW (Winter Peak)	Generation Type	Transmission/ Distribution	Transmission POI
002115	4.998	0	Solar	Distribution	Weatherspoon 230 kV
002156	4.999	0	Solar	Distribution	Weatherspoon 230 kV
004484	2	0	Solar	Distribution	Dillon 115 kV
004538	10	0	Solar	Distribution	Dillon 115 kV
004540	8.8	0	Solar	Distribution	McColl 230 kV
005037	1.998	0	Solar	Distribution	Whiteville 115 kV
005703	70.2	0	Solar	Transmission	Blewett -Tillery 115 kV
008286	4.992	0	Solar	Distribution	Wadesboro Bowman School 230 kV
010586	70.1	0	Solar	Transmission	Marion - Whiteville 230 kV
016227	1.98	0	Solar	Distribution	Hartsville Segars Mill 230 kV
016257	1.98	0	Solar	Distribution	Hartsville Segars Mill 230 kV
016321	70	70	Solar+ Storage	Transmission	Pageland Tap, Robinson-Rockingham 115 kV
016326	2	0	Solar	Distribution	McColl 230 kV
016327	2	0	Solar	Distribution	McColl 230 kV
016328	2	0	Solar	Distribution	McColl 230 kV
017658	80	0	Solar	Transmission	Florence DuPont - Marion 115 kV
019139	2	0	Solar	Distribution	Mullins 115 kV
019170	2	0	Solar	Distribution	McColl 230 kV
019176	2	0	Solar	Distribution	McColl 230 kV
019261	6.201	0	Solar	Distribution	Laurinburg 230 kV
019397	75	0	Solar	Transmission	Florence DuPont - SCPSA Hemingway 115 kV
020832	2	0	Solar	Distribution	Mullins 115 kV
021764	8	0	Solar	Transmission	Kinston DuPont 115kV
021772	8	0	Solar	Transmission	Kinston DuPont 115kV
021892	2	0	Solar	Distribution	Mullins 115 kV
022128	79.8	0	Solar	Transmission	Lee - Wommack 230 kV North
024078	79.8	0	Solar	Transmission	Robinson - Camden Junction 115 kV
030708	78.32	0	Solar	Transmission	Person - Rocky Mount 230 kV
032986	80	0	Solar	Transmission	Cumberland - Whiteville 230 kV
067146	80	0	Solar	Transmission	Robinson - Florence 230 kV
119904	18.4	18.4	Storage	Transmission	Fort Bragg Longstreet Rd 230 kV
126008	75	0	Solar	Transmission	Rocky Mount - Wilson 230 kV
138340	74	0	Solar	Transmission	Weatherspoon - LOF 115 kV
169712	80	0	Solar	Transmission	Biscoe - Rockingham 230 kV
169716	80	0	Solar	Transmission	Cumberland - Delco 230 kV
170274	275	68.75	Solar+ Storage	Transmission	Laurinburg - Richmond 230 kV
177122	69.9	0	Solar	Transmission	Bennettsville - Laurinburg 230 kV
179866	150	0	Solar	Transmission	Florence - Kingstree 230 kV
179996	74.9	0	Solar	Transmission	Kingstree - Sumter 115 kV

ID	MW (Summer Peak)	MW (Winter Peak)	Generation Type	Transmission/ Distribution	Transmission POI
186310	23.3	23.3	Storage	Transmission	Durham - DPC East Durham 230 kV
187960	165	0	Solar	Transmission	Darlington County Plant 230 kV Switchyard
191894	30.5	30.5	Storage	Transmission	Craggy 230 kV
200482	60	0	Solar	Transmission	Rockingham - West End 230 kV East
205718	74.9	0	Solar	Transmission	Bennettsville - Laurinburg 230 kV

3.1 FERC Requests

3.1.1 Energy Resource Interconnection Service (ERIS) Only

The following FERC projects (ID) requested evaluation of only ERIS:

- none

3.1.2 Network Resource Interconnection Service (NRIS) Only

The following FERC projects (ID) requested evaluation of only NRIS:

- 177122
- 187960

3.1.3 ERIS & NRIS

The following FERC projects (ID) requested evaluation of both ERIS & NRIS:

- 119904
- 191894
- 186310
- 170274
- 179866
- 179996

3.2 State Requests

Non-FERC Interconnection Requests submitted under the NC and SC state interconnection processes are studied similarly to and in conjunction with the FERC NRIS requests.

4.0 Transmission Cost Estimate Summary

4.1 Transmission Interconnections

Shown below are Class 5 cost estimates for Transmission Provider's Interconnection Facilities, Network Upgrades at the POI (including upgrades at the remote ends of the line for relaying and communication), and Network Upgrades due to power flow thermal impacts. Upgrade and Interconnection Facilities cost estimates are assigned consistent with LGIP 10.4, NCIP 4.4, and SC GIP Appendix Duke CS 5.3.4.

	TRANSMISSION NETWORK UPGRADES			
ID	POI Network Upgrades ($M)	Power Flow (Thermal) Network Upgrades ($M)	**Total Network Upgrades ($M)**	**Transmission Provider's Interconnection Facilities ($M)**
005703	2.062	20.688	**22.750**	**5.368**
010586	2.241	5.104	**7.345**	**5.559**
016321	1.632	36.717	**38.349**	**5.221**
017658	1.968	8.600	**10.568**	**5.458**
019397	1.186	7.341	**8.527**	**5.458**
021764	4.000	0	**4.000**	**2.231**
021772	4.000	0	**4.000**	**2.231**
022128	2.088	0.510	**2.598**	**5.322**
024078	1.805	6.907	**8.712**	**5.494**
030708	11.229	0	**11.229**	**2.064**
032986	1.544	14.282	**15.826**	**5.559**
067146	2.174	12.650	**14.824**	**5.826**
119904	0	3.519	**3.519**	**1.103**
126008	2.106	0	**2.106**	**5.818**
138340	3.280	22.077	**25.357**	**5.393**
169712	1.790	3.149	**4.939**	**5.559**
169716	11.136	5.626	**16.762**	**2.064**
170274	11.136	78.546	**89.682**	**2.064**
177122	1.706	12.207	**13.913**	**5.322**
179866	1.916	20.739	**22.655**	**5.559**
179996	2.419	5.106	**7.525**	**5.368**
186310	1.142	0	**1.142**	**5.559**
187960	1.901	37.103	**39.004**	**3.123**
191894	2.668	0	**2.668**	**1.735**
200482	2.467	20.456	**22.923**	**5.322**
205718	1.530	13.697	**15.227**	**5.322**

4.2 Distribution Interconnections

Shown below are Class 5 cost estimates for only the transmission network upgrades assigned to distribution interconnections. Distribution system interconnection and upgrade costs and Retail/T-D substation upgrade costs are separately identified in the distribution report section of this Transitional Cluster Report.

	TRANSMISSION NETWORK UPGRADES				
ID	POI Network Upgrades ($M)	Relaying and Communication (Remote End) ($M)	Power Flow (Thermal) Network Upgrades ($M)	**Total Network Upgrades ($M)**	**Transmission Provider's Interconnection Facilities ($M)**
004538	0	0	1.151	**1.151**	**0**
004540	0	0	1.383	**1.383**	**0**
016326	0	0	0.314	**0.314**	**0**
016327	0	0	0.314	**0.314**	**0**
016328	0	0	0.314	**0.314**	**0**
019170	0	0	0.314	**0.314**	**0**
019176	0	0	0.314	**0.314**	**0**
019261	0	0	1.209	**1.209**	**0**

The following distribution interconnection requests are Attachment D projects under the Interconnection Settlement Agreement, as filed in North Carolina Utilities Commission in Docket No. E-100, Sub 101 on September 3, 2020 and with the Public Service Commission of South Carolina on September 4, 2020 in Docket No. 2015-362-E. Attachment D projects are subject to Transmission Contingency Violation Curtailment as defined in the Settlement and have not been assigned transmission network upgrades.

IDs under Attachment D	**Total Network Upgrades ($M)**
002115	**0**
002156	**0**
004484	**0**
005037	**0**
008286	**0**
016227	**0**
016257	**0**
019139	**0**
020832	**0**
021892	**0**

5.0 Transmission Interconnections

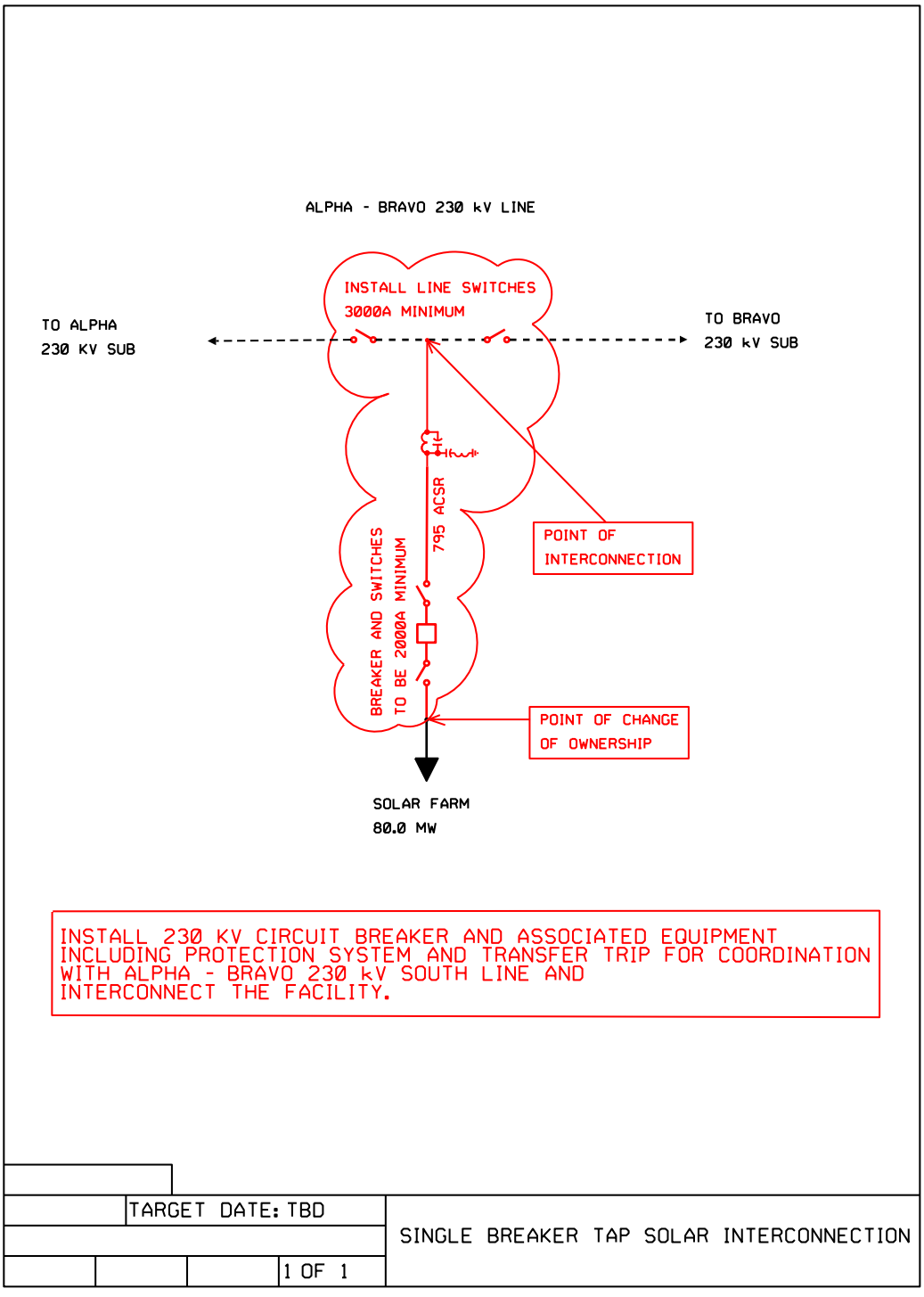
Customer should verify that the MVA ratings of the Customer's Interconnection Facilities are sufficient to accommodate delivering the total MVA output to the point of interconnection at the required power factor.

5.1 Tap to 230 kV or 115 kV Transmission Circuit

The following projects are proposing interconnection to a 230 kV or 115 kV Transmission Circuit:

Single Breaker Tap Station	
115 kV	**230 kV**
005703	010586
016321	022128
017658	032986
019397	067146
024078	126008
138340	169712
179996	169716
	177122
	186310
	200482
	205718

For projects tapping to a 230 kV or 115 kV transmission circuit, a general one-line diagram is shown below. The line switch on either side of the tap may be unnecessary if there is an existing switch within one mile on that side of the solar tap.



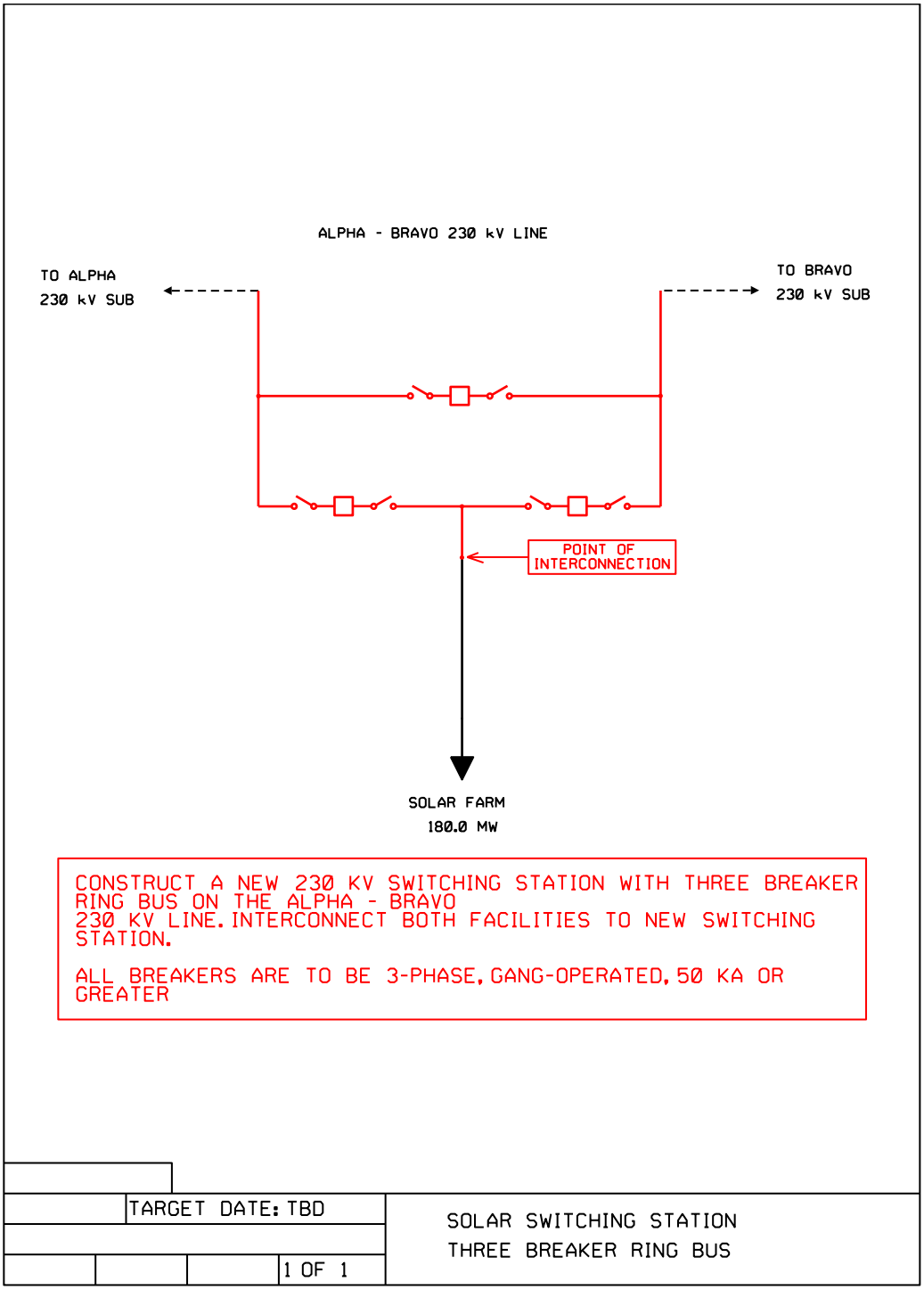
5.2 Tap to Line With Three-Breaker Ring Bus

For projects connecting to the DEP transmission system with a total generation at a site greater than 100 MW, a full transmission switching station with a three-breaker ring bus will be required. For projects that contribute to a total tapped generation along a line exceeding 200 MW, a full transmission switching station will be required at some location on the line. The exact location will be determined on a case-by-case basis considering specific local conditions.

The following projects will require interconnection with a new three-breaker ring bus switching station:

Three-Breaker Ring Bus	
115 kV	**230 kV**
	030708
	170274
	179866

For projects requiring interconnection to a new switching station with a three-breaker ring bus, a general one-line diagram is shown below:



5.3 Interconnection to an Existing Station

The following projects will interconnect to an existing station. Each has a unique arrangement as described:

ID	Interconnection Summary
021764	Connect to 115 kV side of existing station
021772	Connect to 115 kV side of existing station
119904	Connect to existing 12kV bus at existing station
187960	Connect to new 230 kV double breaker bay in existing station
191894	Connect to existing 230kV breaker-and-a-half bay in existing station

6.0 Relay and Communication Equipment

In DEP, communications for Direct Transfer Trip of tapped generators will be through the existing communication medium on the line, which is either Optical Ground Wire (OPGW) or Power Line Carrier (PLC). If the line does not currently have communication, PLC will be installed. In either case, preliminary estimates of these costs are included in the "POI Network Upgrades" costs of section 4.0.

7.0 Power-Flow Analysis Results

The power-flow cases used in the study were developed from the following DEP Transitional Cluster Base Cases: 2025 summer and 2025/26 winter. The Transitional Cluster Base Cases were modified to include the generation proposed in the Transitional Cluster Study. The economic generation dispatch was modified by adding the new generation and forcing it on prior to the dispatch of the remaining DEP Balancing Authority Area units. Generators requesting only Energy Resource Interconnection Service (ERIS) are not dispatched as part of the Network Resource Interconnection Service (NRIS) evaluation. State requests are included in the NRIS analysis.

Facilities that may require upgrade within the first five years following the study years are identified. Based on projected load growth on the DEP transmission system, facilities of concern are those with pre- or post-contingency loadings of **95%** or greater of their thermal rating and low voltage of **92%** and below, in the study cases. The identification of these facilities is crucial due to the construction lead times necessary for certain system upgrades. This study methodology will ensure that appropriate focus is given to these problem areas to investigate whether construction of upgrade projects is achievable to accommodate the requested in-service and commercial operation dates.

7.1 Network Resource Interconnection Service Evaluation

The NRIS power-flow study uses the results of **DEP** Transmission Planning's annual internal screening and prior generator interconnection studies as a baseline to determine the impact of new generation.

The following Network Upgrades are required to mitigate thermal loading issues due to the addition of generation in this cluster:

Network Upgrade	Mileage	Estimated Cost ($ M)	Estimated Lead Time (months)[1]
Badin 115/100 Transformer #1 (Cube Hydro owned)	N/A	6.938	42
Badin 115/100 Transformer #2 (Cube Hydro owned)	N/A	6.938	42
Reconductor Blewett – Rockingham 115 kV Line (Blewett – Str #1A)	0.07	0.934	60
Reconductor Blewett – Tillery 115 kV Line (Q381 – Tillery)	4.83	13.682	54
Raise Cape Fear – Method 115 kV (Cape Fear – Moncure)	0.68	0.520	24
Reconductor Cape Fear – West End 230 kV Line (Sanford US1 – Sanford Garden St.)	2.57	8.704	66
Reconductor Cape Fear – West End 230 kV Line (Sanford Garden St. – CEMC Center Church)	6.48	20.661	66
Reconductor Cape Fear – West End 230 kV Line (CEMC Center Church – West End)	17.6	57.258	66
Raise Cape Fear – West End 230 kV Line (Sanford Deep River – Sanford Horner Blvd.)	4.44	1.261	66
Reconductor Erwin – Fayetteville 115 kV (Erwin Mills Tap – Godwin)	7.99	20.621	54
Reconductor Erwin – Fayetteville 115 kV (SREMC Wade - Beard)	6.8	20.752	54
Reconductor Erwin – Fayetteville 115 kV (Beard – Fay Slocomb Tap)	1.92	5.589	54
Reconductor Erwin – Fayetteville 115 kV (Erwin 115 – Erwin Mills Tap)	0.05	0.129	54
Reconductor Erwin – Fayetteville East 230 kV (Linden – Fay East)	12.2	54.720	60
Reconductor Erwin – Fayetteville East 230 kV (Erwin - Linden)	10.95	50.197	60
Reconductor Fayetteville – Fay. DuPont 115 kV (Fayetteville – Hope Mills Church St.)	4.88	12.036	48

[1] Unless otherwise noted, the estimated lead time reflects the duration of time required to complete the specific project after the applicable generators have executed an Interconnection Agreement.

Network Upgrade	Mileage	Estimated Cost ($ M)	Estimated Lead Time (months)[1]
Reconductor Laurinburg - Raeford 115 kV (Maxton Airport Tap – LREMC Allendale)	1.97	5.549	36
Reconductor Robinson - Rockingham 115 kV (Sneedsboro Solar - Cordova)	13.07	29.26	54
Reconductor Robinson - Rockingham 115 kV (Cordova - Rockingham)	4.01	9.022	54
Raise Rockingham – West End 230 kV West (Eden Solar – West End)	3.55	1.749	36
Raise Sutton Plant - Wallace 230 kV (Crooked Run Solar - Wallace)	7.75	0.589	24
Raise Weatherspoon – Marion 115 kV (Dillon Tap – Marion)	14.6	6.686	48
Raise Tillery – Badin 115 kV Black Line	14.3	3.133	42
Raise Tillery – Badin 115 kV White Line	14.3	3.133	42

For each identified network upgrade, cost allocations were developed consistent with LGIP 10.4, NCIP 4.4, and SC GIP Appendix Duke CS 5.3.4 and the associated cost allocation is provided.

- MW Output = Real power output of the generator
- Distribution Factor (DFax): The proportion of a generator's MW Output that flows on a transmission facility under the worst contingency
- MW Impact = MW Output x DFax
- Loading Impact = MW Impact / Facility Rating
- Cost Allocation Factor (%) = Individual MW Impact / Total MW Impact
- Cost Allocation ($) = Cost Allocation Factor x Total ($)

7.1.1 Badin 115/100 Transformer #1 (Cube Hydro owned)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)	Cost Allocation Factor (%)	Cost Allocation (MM $)
005703	70.2	28.620	20.091	20.091	48.192	3.344
032986	80	1.338	1.070	1.070	2.568	0.178
016321	70	2.507	1.755	1.755	4.209	0.292
205718	74.9	1.401	1.049	1.049	2.517	0.175
200482	60	2.018	1.211	1.211	2.904	0.202
022128	79.8	1.322	1.055	1.055	2.530	0.176
138340	74	1.485	1.099	1.099	2.636	0.183
170274	275	1.668	4.587	4.587	11.003	0.763
169716	80	1.384	1.107	1.107	2.656	0.184
169712	80	6.974	5.579	5.579	13.383	0.928
179866	150	0.867	1.301	1.301	3.119	0.216
187960	165	1.082	1.785	1.785	4.282	0.297
				41.690	100	6.938

7.1.2 Badin 115/100 Transformer #2 (Cube Hydro owned)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)	Cost Allocation Factor (%)	Cost Allocation (MM $)
005703	70.2	27.894	19.582	19.582	48.196	3.344
032986	80	1.304	1.043	1.043	2.568	0.178
016321	70	2.443	1.710	1.710	4.209	0.292
205718	74.9	1.365	1.022	1.022	2.516	0.175
200482	60	1.967	1.180	1.180	2.905	0.202
022128	79.8	1.289	1.029	1.029	2.532	0.176
138340	74	1.447	1.071	1.071	2.636	0.183
170274	275	1.625	4.469	4.469	10.999	0.763
169716	80	1.349	1.079	1.079	2.656	0.184
169712	80	6.797	5.438	5.438	13.384	0.929
179866	150	0.845	1.268	1.268	3.120	0.216
187960	165	1.054	1.739	1.739	4.280	0.297
				40.629	100	6.938

7.1.3 Reconductor Blewett – Rockingham 115 kV Line (Blewett – Str #1A)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)	Cost Allocation Factor (%)	Cost Allocation (MM $)
005703	70.2	100.000	58.992	70.200	100.000	0.934
				70.200	100	0.934

7.1.4 Reconductor Blewett – Tillery 115 kV Line (Q381 – Tillery)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)	Cost Allocation Factor (%)	Cost Allocation (MM $)
005703	70.2	70.485	41.580	49.480	73.428	10.046
016321	70	4.606	2.709	3.224	4.785	0.655
205718	74.9	1.622	1.021	1.215	1.803	0.247
200482	60	2.601	1.311	1.561	2.316	0.317
170274	275	2.073	4.791	5.701	8.460	1.157
169712	80	2.794	1.878	2.235	3.317	0.454
179866	150	1.065	1.342	1.598	2.371	0.324
187960	165	1.438	1.994	2.373	3.521	0.482
				67.386	100	13.682

7.1.5 Raise Cape Fear – Method 115 kV (Cape Fear – Moncure)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)	Cost Allocation Factor (%)	Cost Allocation (MM $)
170274	275	0.784	1.428	2.156	100.000	0.520
				2.156	100	0.520

7.1.6 Reconductor Cape Fear – West End 230 kV Line (Sanford US1 – Sanford Garden St.)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)	Cost Allocation Factor (%)	Cost Allocation (MM $)
016321	70	5.496	0.751	3.847	8.492	0.739
205718	74.9	3.894	0.570	2.917	6.438	0.560
200482	60	13.534	1.586	8.120	17.924	1.560
067146	80	3.329	0.520	2.663	5.878	0.512
138340	74	3.485	0.504	2.579	5.692	0.495
170274	275	5.785	3.107	15.909	35.114	3.056
187960	165	3.366	1.085	5.554	12.259	1.067
177122	69.9	3.936	0.537	2.751	6.073	0.529
004540	8.8	3.876	0.067	0.341	0.753	0.066
016328	2	3.876	0.015	0.078	0.171	0.015
019170	2	3.876	0.015	0.078	0.171	0.015
016326	2	3.876	0.015	0.078	0.171	0.015
016327	2	3.876	0.015	0.078	0.171	0.015
019176	2	3.876	0.015	0.078	0.171	0.015
019261	6.201	3.819	0.046	0.237	0.523	0.045
				45.306	100	8.704

7.1.7 Reconductor Cape Fear – West End 230 kV Line (Sanford Garden St. – CEMC Center Ch.)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)	Cost Allocation Factor (%)	Cost Allocation (MM $)
016321	70	5.496	0.710	3.847	8.492	1.754
205718	74.9	3.894	0.538	2.917	6.438	1.330
200482	60	13.534	1.498	8.120	17.924	3.703
067146	80	3.329	0.491	2.663	5.878	1.215
138340	74	3.485	0.476	2.579	5.692	1.176
170274	275	5.785	2.935	15.909	35.114	7.255
187960	165	3.366	1.025	5.554	12.259	2.533
177122	69.9	3.936	0.508	2.751	6.073	1.255
004540	8.8	3.876	0.063	0.341	0.753	0.156
016328	2	3.876	0.014	0.078	0.171	0.035
019170	2	3.876	0.014	0.078	0.171	0.035
016326	2	3.876	0.014	0.078	0.171	0.035
016327	2	3.876	0.014	0.078	0.171	0.035
019176	2	3.876	0.014	0.078	0.171	0.035
019261	6.201	3.819	0.044	0.237	0.523	0.108
				45.306	100	20.661

7.1.8 Reconductor Cape Fear – West End 230 kV Line (CEMC Center Church – West End)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)	Cost Allocation Factor (%)	Cost Allocation (MM $)
016321	70	5.496	0.710	3.847	8.492	4.862
205718	74.9	3.894	0.538	2.917	6.438	3.686
200482	60	13.534	1.498	8.120	17.924	10.263
067146	80	3.329	0.491	2.663	5.878	3.366
138340	74	3.485	0.476	2.579	5.692	3.259
170274	275	5.785	2.935	15.909	35.114	20.106
187960	165	3.366	1.025	5.554	12.259	7.019
177122	69.9	3.936	0.508	2.751	6.073	3.477
004540	8.8	3.876	0.063	0.341	0.753	0.431
016328	2	3.876	0.014	0.078	0.171	0.098
019170	2	3.876	0.014	0.078	0.171	0.098
016326	2	3.876	0.014	0.078	0.171	0.098
016327	2	3.876	0.014	0.078	0.171	0.098
019176	2	3.876	0.014	0.078	0.171	0.098
019261	6.201	3.819	0.044	0.237	0.523	0.299
				45.306	100	57.258

7.1.9 Raise Cape Fear – West End 230 kV Line (Sanford Deep River – Sanford Horner Blvd.)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)	Cost Allocation Factor (%)	Cost Allocation (MM $)
016321	70	5.496	0.763	3.847	8.492	0.107
205718	74.9	3.894	0.579	2.917	6.438	0.081
200482	60	13.534	1.611	8.120	17.924	0.226
067146	80	3.329	0.528	2.663	5.878	0.074
138340	74	3.485	0.512	2.579	5.692	0.072
170274	275	5.785	3.156	15.909	35.114	0.443
187960	165	3.366	1.102	5.554	12.259	0.155
177122	69.9	3.936	0.546	2.751	6.073	0.077
004540	8.8	3.876	0.068	0.341	0.753	0.009
016328	2	3.876	0.015	0.078	0.171	0.002
019170	2	3.876	0.015	0.078	0.171	0.002
016326	2	3.876	0.015	0.078	0.171	0.002
016327	2	3.876	0.015	0.078	0.171	0.002
019176	2	3.876	0.015	0.078	0.171	0.002
019261	6.201	3.819	0.047	0.237	0.523	0.007
				45.306	100	1.261

7.1.10 Reconductor Erwin – Fayetteville 115 kV (Erwin Mills Tap – Godwin)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)	Cost Allocation Factor (%)	Cost Allocation (MM $)
032986	80	1.553	1.044	1.242	14.468	2.984
138340	74	1.704	1.060	1.261	14.684	3.029
170274	275	1.179	2.725	3.242	37.756	7.788
179866	150	0.877	1.105	1.316	15.319	3.160
187960	165	0.925	1.283	1.526	17.773	3.666
				8.587	100	20.627

7.1.11 Reconductor Erwin – Fayetteville 115 kV (SREMC Wade - Beard)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)	Cost Allocation Factor (%)	Cost Allocation (MM $)
032986	80	1.553	1.044	1.242	14.468	3.002
138340	74	1.704	1.060	1.261	14.684	3.047
170274	275	1.179	2.725	3.242	37.756	7.835
179866	150	0.877	1.105	1.316	15.319	3.179
187960	165	0.925	1.283	1.526	17.773	3.688
				8.587	100	20.752

7.1.12 Reconductor Erwin – Fayetteville 115 kV (Beard – Fay Slocomb Tap)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)	Cost Allocation Factor (%)	Cost Allocation (MM $)
032986	80	1.553	1.044	1.242	14.468	0.848
138340	74	1.704	1.060	1.261	14.684	0.860
170274	275	1.179	2.725	3.242	37.756	2.212
179866	150	0.877	1.105	1.316	15.319	0.898
187960	165	0.925	1.283	1.526	17.773	1.041
				8.587	100	5.859

7.1.13 Reconductor Erwin – Fayetteville 115 kV (Erwin 115 – Erwin Mills Tap)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)	Cost Allocation Factor (%)	Cost Allocation (MM $)
032986	80	1.553	1.044	1.242	14.468	0.019
138340	74	1.704	1.060	1.261	14.684	0.019
170274	275	1.179	2.725	3.242	37.756	0.049
179866	150	0.877	1.105	1.316	15.319	0.020
187960	165	0.925	1.283	1.526	17.773	0.023
				8.587	100	0.129

7.1.14 Reconductor Erwin – Fayetteville East 230 kV (Linden – Fay East)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)	Cost Allocation Factor (%)	Cost Allocation (MM $)
032986	80	6.092	0.899	4.874	6.475	3.543
010586	70.1	4.709	0.609	3.301	4.386	2.400
016321	70	4.092	0.528	2.864	3.806	2.082
017658	80	4.518	0.667	3.614	4.802	2.628
019397	75	3.859	0.534	2.894	3.845	2.104
024078	79.8	3.251	0.479	2.594	3.447	1.886
205718	74.9	5.397	0.746	4.042	5.371	2.939
200482	60	4.096	0.453	2.458	3.265	1.787
067146	80	3.864	0.570	3.091	4.107	2.247
119904	18.4	13.719	0.466	2.524	3.354	1.835
138340	74	6.369	0.870	4.713	6.262	3.426
170274	275	5.584	2.833	15.356	20.402	11.164
169716	80	4.143	0.612	3.314	4.403	2.410
179866	150	3.452	0.955	5.178	6.879	3.764
179996	74.9	3.225	0.446	2.416	3.209	1.756
187960	165	3.810	1.160	6.287	8.352	4.570
177122	69.9	5.448	0.703	3.808	5.059	2.769
004540	8.8	5.375	0.087	0.473	0.628	0.344
004538	10	5.378	0.099	0.538	0.715	0.391
016328	2	5.375	0.020	0.108	0.143	0.078
019170	2	5.375	0.020	0.108	0.143	0.078
016326	2	5.375	0.020	0.108	0.143	0.078
016327	2	5.375	0.020	0.108	0.143	0.078
019176	2	5.375	0.020	0.108	0.143	0.078
019261	6.201	6.300	0.072	0.391	0.519	0.284
				75.268	100	54.720

7.1.15 Reconductor Erwin – Fayetteville East 230 kV (Erwin - Linden)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)	Cost Allocation Factor (%)	Cost Allocation (MM $)
032986	80	6.092	0.899	4.874	6.475	3.250
010586	70.1	4.709	0.609	3.301	4.386	2.201
016321	70	4.092	0.528	2.864	3.806	1.910
017658	80	4.518	0.667	3.614	4.802	2.410
019397	75	3.859	0.534	2.894	3.845	1.930
024078	79.8	3.251	0.479	2.594	3.447	1.730
205718	74.9	5.397	0.746	4.042	5.371	2.696
200482	60	4.096	0.453	2.458	3.265	1.639
067146	80	3.864	0.570	3.091	4.107	2.062
119904	18.4	13.719	0.466	2.524	3.354	1.683
138340	74	6.369	0.870	4.713	6.262	3.143
170274	275	5.584	2.833	15.356	20.402	10.241
169716	80	4.143	0.612	3.314	4.403	2.210
179866	150	3.452	0.955	5.178	6.879	3.453
179996	74.9	3.225	0.446	2.416	3.209	1.611
187960	165	3.810	1.160	6.287	8.352	4.193
177122	69.9	5.448	0.703	3.808	5.059	2.540
004540	8.8	5.375	0.087	0.473	0.628	0.315
004538	10	5.378	0.099	0.538	0.715	0.359
016328	2	5.375	0.020	0.108	0.143	0.072
019170	2	5.375	0.020	0.108	0.143	0.072
016326	2	5.375	0.020	0.108	0.143	0.072
016327	2	5.375	0.020	0.108	0.143	0.072
019176	2	5.375	0.020	0.108	0.143	0.072
019261	6.201	6.300	0.072	0.391	0.519	0.261
				75.268	100	50.197

7.1.16 Reconductor Fayetteville – Fay. DuPont 115 kV (Fayetteville – Hope Mills Church St.)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)	Cost Allocation Factor (%)	Cost Allocation (MM $)
017658	80	2.854	1.919	2.283	11.574	1.393
019397	75	2.098	1.322	1.574	7.977	0.960
205718	74.9	2.450	1.542	1.835	9.303	1.120
067146	80	1.603	1.078	1.282	6.501	0.782
138340	74	4.775	2.969	3.534	17.913	2.156
170274	275	0.616	1.424	1.694	8.587	1.034
179866	150	1.662	2.095	2.493	12.638	1.521
187960	165	1.511	2.095	2.493	12.639	1.521
177122	69.9	2.466	1.449	1.724	8.738	1.052
004538	10	6.201	0.521	0.620	3.144	0.378
019261	6.201	3.141	0.164	0.195	0.987	0.119
				19.726	100	12.036

Note: This upgrade is also required for ERIS requests that impact this line.

7.1.17 Reconductor Laurinburg - Raeford 115 kV (Maxton Airport Tap – LREMC Allendale)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)	Cost Allocation Factor (%)	Cost Allocation (MM $)
017658	80	3.487	1.461	2.790	3.235	0.179
019397	75	2.936	1.153	2.202	2.553	0.142
205718	74.9	11.018	4.321	8.252	9.569	0.531
067146	80	2.864	1.200	2.291	2.657	0.147
138340	74	18.115	7.018	13.405	15.544	0.863
170274	275	13.432	19.339	36.938	42.831	2.377
179866	150	2.607	2.047	3.911	4.534	0.252
187960	165	2.897	2.503	4.780	5.543	0.308
177122	69.9	11.343	4.151	7.929	9.194	0.510
004540	8.8	10.878	0.501	0.957	1.110	0.062
004538	10	3.546	0.186	0.355	0.411	0.023
016328	2	10.878	0.114	0.218	0.252	0.014
019170	2	10.878	0.114	0.218	0.252	0.014
016326	2	10.878	0.114	0.218	0.252	0.014
016327	2	10.878	0.114	0.218	0.252	0.014
019176	2	10.878	0.114	0.218	0.252	0.014
019261	6.201	21.666	0.703	1.344	1.558	0.086
				86.241	100	5.549

7.1.18 Reconductor Robinson - Rockingham 115 kV (Sneedsboro Solar - Cordova)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)	Cost Allocation Factor (%)	Cost Allocation (MM $)
016321	70	48.692	20.783	34.084	61.336	17.947
019397	75	2.292	1.048	1.719	3.093	0.905
024078	79.8	5.405	2.630	4.313	7.762	2.271
067146	80	3.243	1.582	2.594	4.669	1.366
179866	150	2.356	2.155	3.534	6.359	1.861
179996	74.9	2.480	1.133	1.858	3.343	0.978
187960	165	4.526	4.554	7.468	13.439	3.932
				55.570	100	29.260

Note: This upgrade is also required for ERIS requests that impact this line.

7.1.19 Reconductor Robinson - Rockingham 115 kV (Cordova - Rockingham)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)	Cost Allocation Factor (%)	Cost Allocation (MM $)
016321	70	48.692	21.437	34.084	61.336	5.534
019397	75	2.292	1.081	1.719	3.093	0.279
024078	79.8	5.405	2.713	4.313	7.762	0.700
067146	80	3.243	1.632	2.594	4.669	0.421
179866	150	2.356	2.223	3.534	6.359	0.574
179996	74.9	2.480	1.168	1.858	3.343	0.302
187960	165	4.526	4.697	7.468	13.439	1.212
				55.570	100	9.022

Note: This upgrade is also required for ERIS requests that impact this line.

7.1.20 Raise Rockingham – West End 230 kV West (Eden Solar – West End)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)	Cost Allocation Factor (%)	Cost Allocation (MM $)
016321	70	3.569	0.488	2.498	15.907	0.278
200482	60	5.640	0.661	3.384	21.547	0.377
170274	275	3.572	1.919	9.823	62.546	1.094
				15.705	100	1.749

7.1.21 Raise Sutton Plant - Wallace 230 kV (Crooked Run Solar - Wallace)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)	Cost Allocation Factor (%)	Cost Allocation (MM $)
032986	80	3.060	0.515	2.448	20.088	0.118
169716	80	12.173	2.050	9.738	79.912	0.471
				12.186	100	0.589

7.1.22 Raise Tillery – Badin 115 kV Black Line

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)	Cost Allocation Factor (%)	Cost Allocation (MM $)
005703	70.2	28.620	20.091	20.091	48.192	1.510
032986	80	1.338	1.070	1.070	2.568	0.080
016321	70	2.507	1.755	1.755	4.209	0.132
205718	74.9	1.401	1.049	1.049	2.517	0.079
200482	60	2.018	1.211	1.211	2.904	0.091
022128	79.8	1.322	1.055	1.055	2.530	0.079
138340	74	1.485	1.099	1.099	2.636	0.083
170274	275	1.668	4.587	4.587	11.003	0.345
169716	80	1.384	1.107	1.107	2.656	0.083
169712	80	6.974	5.579	5.579	13.383	0.419
179866	150	0.867	1.301	1.301	3.119	0.098
187960	165	1.082	1.785	1.785	4.282	0.134
				41.690	100	3.133

7.1.23 Raise Tillery – Badin 115 kV White Line

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)	Cost Allocation Factor (%)	Cost Allocation (MM $)
005703	70.2	27.894	19.582	19.582	48.196	1.510
032986	80	1.304	1.043	1.043	2.568	0.080
016321	70	2.443	1.710	1.710	4.209	0.132
205718	74.9	1.365	1.022	1.022	2.516	0.079
200482	60	1.967	1.180	1.180	2.905	0.091
022128	79.8	1.289	1.029	1.029	2.532	0.079
138340	74	1.447	1.071	1.071	2.636	0.083
170274	275	1.625	4.469	4.469	10.999	0.345
169716	80	1.349	1.079	1.079	2.656	0.083
169712	80	6.797	5.438	5.438	13.384	0.419
179866	150	0.845	1.268	1.268	3.120	0.098
187960	165	1.054	1.739	1.739	4.280	0.134
				40.629	100	3.133

7.1.24 Raise Weatherspoon – Marion 115 kV (Dillon Tap – Marion)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)	Cost Allocation Factor (%)	Cost Allocation (MM $)
010586	70.1	2.551	1.844	1.788	7.519	0.503
017658	80	8.844	7.294	7.075	29.748	1.989
019397	75	4.841	3.743	3.631	15.265	1.021
024078	79.8	1.426	1.173	1.138	4.784	0.320
067146	80	2.036	1.679	1.629	6.848	0.458
179866	150	2.622	4.055	3.933	16.536	1.106
179996	74.9	2.183	1.686	1.635	6.875	0.460
187960	165	1.791	3.047	2.955	12.425	0.831
				23.784	100	6.686

7.2 ERIS Evaluation

The ERIS power-flow study utilizes the Transitional Cluster Study Cases. The new generation economically displaces DEP Balancing Authority Area units. Transmission capacity is available as long as no transmission element is overloaded under N-1 transmission conditions. The thermal evaluation will only consider the Transitional Cluster Study under N-1 transmission contingencies to determine the availability of transmission capacity. ERIS is service using transmission capacity on an "as available" basis; therefore, adverse generation dispatches that could make the transmission capacity unavailable are not used. If the full output of the Customer's generating facility cannot be delivered at the time of the study, the study will identify the maximum allowable output at the time of the study that does not require additional Network Upgrades beyond those necessary to establish the interconnection.

Under the terms of ERIS service, the full output of the following generating facilities **can** be delivered:

ID	MW Deliverable
119004	20
179996	74.9
186310	23.3
191894	30.5

Under the terms of ERIS service, the full output of the following generating facilities **cannot** be delivered:

ID	MW Deliverable[2]
170274	0
179866	0

Delivery of the full output of the preceding generating facilities requires the following Network Upgrades to mitigate thermal loading issues:

Network Upgrade	Mileage	Estimated Cost ($ M)	Estimated Lead Time (months)[3]
Fayetteville – Fay. DuPont 115kV Line (Hope Mills Church Street – Roslin Solar)	3.0	In Transmission Plan	36
Fayetteville – Fay. DuPont 115kV Line (Fayetteville - Hope Mills Church Street)	4.9	12.036	36

For each identified network upgrade, the associated cost allocation is provided.

7.2.1 Reconductor Fayetteville – Fay. DuPont 115 kV (Fayetteville – Hope Mills Church St.)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)	Cost Allocation Factor (%)	Cost Allocation (MM $)
170274	275	0.616	1.424	1.694	8.587	1.034
179866	150	1.662	2.095	2.493	12.638	1.521

[2] The maximum output that can be delivered without requiring Network Upgrades to mitigate thermal loading issues

[3] Unless otherwise noted, the estimated lead time reflects the duration of time required to complete the specific project after the applicable generators have executed an Interconnection Agreement.

7.3 Contingent Facilities

Contingent Facilities shall mean those unbuilt Interconnection Facilities and Network Upgrades upon which the Interconnection Request's costs, timing, and study findings are dependent, and if delayed or not built, could cause a need for Re-Studies of the Interconnection Request or a reassessment of the Interconnection Facilities and/or Network Upgrades and/or costs and timing. The criteria for identifying Contingent Facilities is provided in the joint OATT (LGIP § 4.8).

7.3.1 Prior Interconnection Requests

No Upgrades assigned to Interconnection Customers in Transitional Cluster are dependent upon upgrades associated prior interconnection requests.

7.3.2 Utility Transmission Plan

The outage causing overload of all four sections of the Asheboro East – Biscoe 115 kV Line mentioned below is failure of 230CB25 at Asheboro 230kV Substation, which takes out two of the three 230kV transmission lines at that substation. The solution in progress is moving one of the lines to a new bay, resulting in a double-breaker arrangement. Expected In Service Date (ISD) is 6/2023.

7.3.2.1 Asheboro East – Biscoe 115 kV Line (REMC Ether – Biscoe 115 kV)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)
005703	70.2	6.486	3.076	4.553
170274	275	0.564	1.048	1.551
169712	80	9.371	5.065	7.497
				13.601

7.3.2.2 Asheboro East – Biscoe 115 kV Line (Seagrove – REMC Ether)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)
005703	70.2	6.486	3.076	4.553
170274	275	0.564	1.048	1.551
169712	80	9.371	5.065	7.497
				13.601

7.3.2.3 Asheboro East – Biscoe 115 kV Line (REMC Ulah – Seagrove)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)
005703	70.2	6.486	3.076	4.553
170274	275	0.564	1.048	1.551
169712	80	9.371	5.065	7.497
				13.601

7.3.2.4 Asheboro East – Biscoe 115 kV Line (Asheboro South Tap – REMC Ulah)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)
005703	70.2	6.486	3.299	4.553
170274	275	0.564	1.124	1.551
169712	80	9.371	5.432	7.497
				13.601

The solution to overload of the Hope Mills Church St. – Roslin Solar section of the Fayetteville – Fayetteville DuPont 115 kV Line is reconductoring. Expected ISD is 6/2026.

7.3.2.5 Fayetteville – Fayetteville DuPont 115 kV Line (Hope Mills Church St. – Roslin Solar)

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)
017658	80	2.854	1.919	2.283
019397	75	2.098	1.322	1.574
205718	74.9	2.450	1.542	1.835
067146	80	1.603	1.078	1.282
138340	74	4.775	2.969	3.534
170274	275	0.616	1.424	1.694
179866	150	1.662	2.095	2.493
187960	165	1.511	2.095	2.493
177122	69.9	2.466	1.449	1.724
004538	10	6.201	0.521	0.620
019261	6.201	3.141	0.164	0.195
				19.726

The solution to the overload of the Richmond 500/230kV autotransformers is a tap change on the Current Transformers and adjustment of protection settings. Expected ISD is 12/2022.

7.3.2.6 Richmond 500/230 kV Transformer #1

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)
005703	70.2	6.269	0.552	4.401
016321	70	9.099	0.799	6.369
019397	75	3.309	0.311	2.482
024078	79.8	4.610	0.462	3.679
205718	74.9	8.358	0.785	6.260
200482	60	12.916	0.972	7.750
067146	80	5.200	0.522	4.160
138340	74	7.371	0.684	5.455
170274	275	15.568	5.372	42.812
169712	80	5.389	0.541	4.311
179866	150	3.446	0.649	5.169
179996	74.9	3.491	0.328	2.615
187960	165	5.338	1.105	8.808
177122	69.9	8.542	0.749	5.971
004540	8.8	8.278	0.091	0.728
016328	2	8.278	0.021	0.166
019170	2	8.278	0.021	0.166
016326	2	8.278	0.021	0.166
016327	2	8.278	0.021	0.166
019176	2	8.278	0.021	0.166
019261	6.201	8.542	0.066	0.530
				112.326

7.3.2.7 Richmond 500/230 kV Transformer #2

ID	MW Output (MW)	DFax (%)	Loading Impact (%)	MW Impact (MW)
005703	70.2	6.240	0.550	4.380
016321	70	9.056	0.795	6.339
019397	75	3.293	0.310	2.470
024078	79.8	4.588	0.459	3.661
205718	74.9	8.319	0.782	6.231
200482	60	12.855	0.968	7.713
067146	80	5.175	0.519	4.140
138340	74	7.336	0.681	5.429
170274	275	15.495	5.346	42.611
169712	80	5.363	0.538	4.290
179866	150	3.430	0.646	5.145
179996	74.9	3.474	0.326	2.602
187960	165	5.313	1.100	8.766
177122	69.9	8.502	0.746	5.943
004540	8.8	8.239	0.091	0.725
016328	2	8.239	0.021	0.165
019170	2	8.239	0.021	0.165
016326	2	8.239	0.021	0.165
016327	2	8.239	0.021	0.165
019176	2	8.239	0.021	0.165
019261	6.201	8.502	0.066	0.527
				111.797

8.0 Reactive Power Capability

For transmission-connected generators in DEP, the reactive capability requirement at the Point of Interconnection (POI) is the Mvar required to achieve 0.95 lagging power factor to 0.95 leading power factor at the maximum requested MW output of the plant. The calculated Mvar capability, shown in the table below, is required at all plant MW output levels.

Reactive Capability will be evaluated in Phase 2 by modeling a Customer's generating facility at various taps and system voltage conditions. The reactive capability of the facility can be affected by many factors including but not limited to generator/inverter capability limits, transformer impedances, and bus voltage limits. The evaluation determines whether sufficient reactive support will be available at the Point of Interconnection based on the requirements set forth in **DEP's Facility Interconnection Requirements** (FIR) for generation connected to the Transmission System. For more information on reactive requirements for generation, reference the FIR on the **DEP** OASIS site[4].

The MW value included in the Interconnection Agreement shall not exceed a MW value higher than that at which the Customer's generating facility meets the reactive capability requirements. Additionally, batteries, if any, must be operated in a manner that does not restrict the ability of the Customer's generating facility to supply or absorb reactive power within the appropriate reactive power range.

For projects that cannot meet the reactive capability requirements at their requested MW output, two mitigation options will be offered: 1) MW reduction or 2) capacitor addition. If a capacitor bank is installed at the Customer's generating facility, it may be used only to compensate for plant reactive power losses. If the capacitor bank is capable of providing compensation beyond the plant losses, that additional compensation shall not be factored into the determination of whether or not the Customer's generating facility meets the reactive capability requirements. If a capacitor bank is installed but is not capable of being placed into service, the MW output of the Customer's generating facility may be restricted. Any capacitor installed to meet the power factor requirement shall be automatically switched by the power plant controller as needed to meet the voltage, power factor, or reactive power schedule provided by the utility.

[4] = http://www.oatioasis.com/cpl/index.html

ID	Requested MW	MVAR Capability Required	
		Lagging	Leading
005703	70.2	23.0	-23.0
032986	80	26.2	-26.2
010586	70.1	23.0	-23.0
016321	70	23.0	-23.0
017658	80	26.2	-26.2
019397	75	24.6	-24.6
024078	79.8	26.2	-26.2
021764	8	2.6	-2.6
021772	8	2.6	-2.6
030708	78.32	25.7	-25.7
205718	74.9	24.6	-24.6
200482	60	19.7	-19.7
022128	79.8	26.2	-26.2
126008	75	24.6	-24.6
067146	80	26.2	-26.2
119904	18.4	6.0	-6.0
138340	74	24.3	-24.3
170274	275	90.4	-90.4
169716	80	26.2	-26.2
169712	80	26.2	-26.2
179866	150	49.3	-49.3
179996	74.9	24.6	-24.6
186310	23.3	7.6	-7.6
187960	165	54.2	-54.2
177122	69.9	22.9	-22.9
191894	30.5	10.0	-10.0

9.0 Affected Systems

Generator interconnections to the DEP system may have an adverse impact on neighboring systems. As such, additional studies may be required by neighboring systems, which may result in increased cost of interconnection. DEP screened requests in the Transitional Cluster against all tie lines with neighboring utilities using a 5% DFax to determine which requests to notify potential Affected Systems about. In addition, requests that have less than 5% DFax but are close to a potential Affected System based on engineering judgement were added to the notification list. Distribution requests are not included in the potential Affected System lists due to their significantly smaller impact. The potential Affected System will determine if they need to perform an Affected System Study.

At the time of this Transitional Cluster Phase 1 study, the following potential Affected Systems have been identified for the listed projects:

- **American Electric Power (AEP)**
  - None
- **Dominion Energy South Carolina (DESC/SCEG)**
  - 067146
  - 179996
  - 187960
- **Duke Energy Carolinas (DEC)**
  - 005703
  - 019397
  - 024078
  - 169712
  - 170274
  - 179866
  - 179996
  - 186310
  - 200482
- **South Carolina Public Service Authority (SCPSA/Santee Cooper)**
  - 010586
  - 016321
  - 017658
  - 019397
  - 024078
  - 032986
  - 067146
  - 177122
  - 179866
  - 179996
  - 187960
  - 205718

- **Dominion Virginia Power (DVP)**
  - 021764
  - 021772
  - 022128
  - 030708
  - 126008
  - 186310
- **Tennessee Valley Authority (TVA)**
  - None
- **Cube Hydro (YAD/Yadkin)**
  - 005703
  - 169712

Report Prepared By:

William Quaintance, PE, Principal Engineer, DEP

Kyle Hord, PE, Senior Engineer, DEP

Duke Energy Progress, LLC

Distribution Phase 1 Power Flow

Transitional Cluster Report

Prepared By:

Distributed Energy Group

2/28/2022

1 Preface

The distribution Phase 1 Power Flow study is designed to identify the electric system impacts, from a voltage and thermal perspective, associated with interconnecting the proposed Transitional Cluster Study Generation Facilities and to identify System Upgrades required to correct any system violations identified within this phase of the Transitional Cluster study process. Protection related System Upgrades that do not require study to identify are also included due to the significant impact the upgrades could have on the System Upgrade cost estimates. The Interconnection Facilities required to interconnect the Facilities to the Duke Energy distribution system are also detailed. The study is based on the point of interconnections proposed by the Interconnection Customers and on technical information provided in the Interconnection Requests.

In addition to detailing the required Interconnection Facilities and System Upgrades, the study provides a ***preliminary, non-binding*** estimate of the cost of the System Upgrades. The cost estimate provided in this report is a Class 5 estimate (under the Association for the Advancement of Cost Engineering standards) and therefore has a maximum expected accuracy range of -50% to +100%.

2 Cost Allocation Summary

As a result of the power flow analysis performed within Phase 1, System Upgrades were identified for the distribution system to accommodate the Generating Facilities. System Upgrades were localized to the individual circuits and/or substations, as detailed in Section 5 below. Therefore, only impacting projects were assigned allocated costs for each of the System Upgrades identified. The total allocated distribution costs for each project is detailed in the table below. The assigned costs for the Transmission impacts are included below and can be found within the Transmission.

Table 1 – Cost Allocations Per Project

ID	Distribution Allocation	Transmission Allocation	Interconnection Facilities	Total Cost
#004484	$0[5]	$0[6]	$125,000	$125,000
#004538	$0[5]	$1,151,000	$125,000	$1,276,000
#016257	$0[5]	$0[6]	$125,000	$125,000
#016227	$0	$0[6]	$125,000	$125,000
#019261	$572,000	$1,209,000	$125,000	$1,906,000
#016327	$581,000	$314,000	$125,000	$1,020,000
#016326	$581,000	$314,000	$125,000	$1,020,000
#019170	$581,000	$314,000	$125,000	$1,020,000
#004540	$2,007,000	$1,383,000	$125,000	$3,515,000
#016328	$637,000	$314,000	$125,000	$1,076,000
#019176	$637,000	$314,000	$125,000	$1,076,000
#019139	$541,000	$0[6]	$125,000	$666,000
#020832	$541,000	$0[6]	$125,000	$666,000
#021892	$2,400	$0[6]	$125,000	$127,400
#008286	$1,412,000	$0[6]	$125,000	$1,537,000
#002115	$366,000[5]	$0[6]	$125,000	$491,000
#002156	$366,000[5]	$0[6]	$125,000	$491,000
#005037	$0	$0[6]	$125,000	$125,000

[5] Allocation does not factor in costs to construct new customer-owned distribution facilities along new right-of-way to relocate POIs. The costs and construction of these new lines are solely the responsibility of the individual Interconnection Customers. Reference the results in Section 5 for further details.

[6] Attachment D projects under the Interconnection Settlement Agreement, as filed in North Carolina Utilities Commission in Docket No. E-100, Sub 101 on September 3, 2020 and filed with the Public Service Commission of South Carolina on September 4, 2020 in Docket No. 2015-362-E. Attachment D projects are subject to Transmission Contingency Violation Curtailment as defined in the Settlement and have not been assigned transmission network upgrades.

For Distribution-level Interconnection Customers determined through Transitional Cluster Phase 1 not to cause or contribute to the need for Network Upgrades requiring further study in Phase 2, DEP shall complete a distribution level System Impact Study if the Interconnection Customer elects to continue through the System Impact Study process. (NCIP 4.4.6, 4.4.7.1; SC GIP Appendix Duke CS 5.3.6; 5.3.7.1).

3 Queue Summary

The table below represents an overview of all Generating Facilities proposed to interconnect to the Duke Energy distribution system within the Transitional Cluster. These Generating Facilities have been grouped together by substation and feeder to detail the grouping of Facilities that will be responsible for circuit, and substation, level System Upgrades that may be required.

Table 2 – Transitional Cluster Proposed Projects

Substation	Page #	Feeder	ID	Requested Capacity (kW)
DILLON 115KV	Page #6	T2750B04	#004484	2,000
			#004538	10,000
HARTSVILLE SEGARS MILL 230KV	Page #7	T3665B04	#016257	1,980
		T3665B05	#016227	1,980
LAURINBURG 230KV	Page #8	T2200B23	#019261	6,201
MCCOLL 230KV	Page #9	T3760B01	#016327	2,000
			#016326	2,000
			#019170	2,000
		T3760B02	#004540	8,000
			#016328	2,000
			#019176	2,000
MULLINS 115KV	Page #10	T3030B01	#019139	2,000
			#020832	2,000
		T3030B04	#021892	2,000
WADESBORO BOWMAN SCHOOL 230KV	Page #11	T1672B03	#008286	4,992
WEATHERSPOON 230KV	Page #12	T2631B03	#002115	4,998
			#002156	4,999
WHITEVILLE 115KV	Page #12	T6670B03	#005037	1,998

The table below details the aggregate generation capacity and groups together by substation and circuit. The "Existing DER" represent Facilities that are currently connected, or have committed to connecting, prior to the introduction of the Facilities proposed as part of the Transitional Cluster. The "Total DER" represent the aggregate of the Existing DER and the Generating Facilities proposed within Transitional Cluster. Capacity violations, in accordance with the Method of Service Guidelines, that will require

remediation are detailed in red below. Further details regarding the remediation of these violations can be found in the Section 5 below.

Table 3 - Aggregate Queue State

Substation	Feeder	Existing DER on Circuit (MW)	Total DER on Circuit (MW)	Existing DER on Substation (MW)	Total DER on Substation (MW)
DILLON 115KV	T2750B04	6.2	18.2	6.2	18.2
HARTSVILLE SEGARS MILL 230KV	T3665B04	8.9	10.88	10.9	14.86
	T3665B05	0	1.98		
LAURINBURG 230KV	T2200B23	6.999	13.2	6.999	13.2
MCCOLL 230KV	T3760B01	0	6	10	**28**
	T3760B02	10	**22**		
MULLINS 115KV	T3030B01	2	6	2	8
	T3030B04	0	2		
WADESBORO BOWMAN	T1672B03	7.192	12.19	12.198	17.19
WEATHERSPOON 230KV	T2631B03	6.997	16.994	26.288	36.285
WHITEVILLE 115KV	T6670B03	6.997	8.995	16.947	18.945

4 Interconnection Facilities

The Interconnection Facilities for each of the Generating Facilities within the Transitional Cluster will be as per Figure 71B of the Requirements for Electric Service and Meter Installations manual, link provided below.

https://www.duke-energy.com/_/media/pdfs/partner-with-us/service-requirements-manual.pdf

The requirements for the Generating Facility are as follows, as per Figure 75C:

a) Interconnection protection will be owned and operated by DEP and is to include a recloser, relaying (control), and remote communications for monitoring and operations.
    i. Protection will utilize overcurrent, under/over voltage, and under/over frequency relaying.
b) Duke Energy Progress shall provide a manual load-break rated disconnect switch to serve as a clear visible indication of switch position between the utility and the Interconnection Customer. The switch must be readily accessible to Duke Energy personnel.
c) Interconnection Customer's inverters are required to be tested and listed for compliance with the latest published edition of Underwriter Laboratories Inc., UL 1741 for utility interactive inverters.
d) Interconnection Customer shall comply with the latest edition of IEEE 1547 and applicable series standards.

These requirements and the interconnection Figure are subject to change at any time.

A power quality (PQ) meter will also be installed with the Interconnection Facilities to continuously monitor the power quality impacts of the Generating Facility to the DEP system.

The Generating Facility is to be operated such that unity power factor is continuously maintained at the Point of Interconnection (where utility-owned metering is located).

5 Distribution Impacts Summary

The proposed Generating Facilities were evaluated for adverse impacts on the distribution system based on each substation and circuit being proposed to interconnect to. Each of the impacted substations and circuits are detailed below summarizing the impacts from the relevant Generating Facilities.

5.1 Substation: Dillon 115kV

Feeder: T2750B04

The interconnection of ID #004484 and #004538 results in steady state voltage violations that cannot be remediated with System Upgrades. The existing Generating Facilities increase the circuit voltages to their limit during peak and valley loading periods. The addition of the proposed Facilities increases the voltages beyond the limit. Modifying the distribution system to the largest standard equipment does not remediate these violations. To accommodate the proposed generation capacities, both Facilities are required to construct, own, and maintain new distribution facilities along new right-of-way for each installation to bring the Point of Interconnections (POIs) to near DIS# A2BP (34.432001°, -79.354923°), just outside of the substation. Interconnection Facilities for each project would extend off this location and each Interconnection Customer's new lines would connect to the Point of Deliveries (POD).

High Level Scope of Work:

1. New Line Construction:
   a. ID #004484 must obtain, build, and maintain new right-of-way and distribution facilities from the project site to the POI. The new POI for this project is located near DIS# A2BP (34.432001°, -79.354923°), approximately 5.1 miles from the project site assuming DOT roadways are followed (actual distance may vary depending on the path chosen by the Interconnection Customer). The costs for this work are outside of Duke Energy's area of responsibility. Cost allocations do not include the cost to perform this work.
   b. ID #004538 must obtain, build, and maintain new right-of-way and distribution facilities from the project site to the POI. The new POI for this project is located near DIS# A2BP (34.432001°, -79.354923°), approximately 3 miles from the project site assuming DOT roadways are followed (actual distance may vary depending on the path chosen by the Interconnection Customer). The costs for this work are outside of Duke Energy's area of responsibility. Cost allocations do not include the cost to perform this work.

5.2 Substation: Hartsville Segars Mill 230kV

Feeder: T3665B04

The interconnection of ID #016257 results in steady state voltage violations that cannot be remediated with System Upgrades due to the existing distribution facilities already being their largest standard size. The existing Generating Facilities increase the circuit voltages to the limit during valley loading periods. The addition of the proposed Facility increases the voltages over the limit. To accommodate the proposed generation capacity, the Facility is required to construct, own, and maintain new distribution facilities along new right-of-way to bring the Point of Interconnection (POI) to near DIS# HE85BW (34.381249°, -80.146551°) just outside of the substation. The Interconnection Facilities would extend off of this location and the Interconnection Customer's new lines would connect to the Point of Delivery (POD).

High Level Scope of Work:

1. New Line Construction:
    a. ID #016257 must obtain, build, and maintain new right-of-way and distribution facilities from the project site to the POI. The new POI for this project is located near DIS# HE85BW (34.381249°, -80.146551°), approximately 3.5 miles from the project site assuming DOT roadways are followed (actual distance may vary depending on the path chosen by the Interconnection Customer). The costs for this work are outside of Duke Energy's area of responsibility. Cost allocations do not include the cost to perform this work.

Feeder: T3665B05

The interconnection of ID #016227 did not result in any steady state voltage or rapid voltage change violations on the circuit. No power flow related System Upgrades have been identified at this time.

5.3 Substation: Laurinburg 230kV

Feeder: 01522408

The interconnection of ID #019261 results in steady state voltage violations on the distribution system. Reconductoring existing line sections between the substation and the Point of Interconnection (POI) to remediate these violations is required. Additionally, certain protective devices that lie between the substation and the POI required alternation to maintain proper protection/coordination on the circuit with the addition of the Facility.

High Level Scope of Work:

1. Distribution Line System Upgrades:
   a. Upgrade existing 3 -336 ACSR circuit with 3-477 AAC circuit from DIS# PC134 to DIS# T93AH (approximately 0.0248 miles). The circuit should be built to High Capacity Standards, which typically includes 4/0 Neutral, 84" Primary to Neutral spacing, 280 ft. maximum spans, etc.
   b. Upgrade existing 3 – 1/0 ACSR circuit with 3 - 477 AAC circuit from DIS# T93AH to DIS# U10AH (approximately 0.254 miles). The circuit should be built to High Capacity Standards, which typically includes 4/0 Neutral, 84" Primary to Neutral spacing, 280 ft. maximum spans, etc.
   c. Replace existing 3 – 1/0 ACSR circuit with 3-477 AAC circuit from DIS# U10AH to DIS# A002AH (approximately 0.497 miles). The existing neutral should be replaced with a 4/0 AAAC neutral.
   d. Replace existing 3 -336 ACSR circuit with 3-477 AAC circuit from DIS# T93AH to DIS# A022AH (approximately 0. 0439 miles). The existing neutral should be replaced with a 4/0 AAAC neutral
2. Protection/Sectionalization System Upgrades:
   a. Replace 65A Fuse with G&W Viper recloser at DIS# T96AH
   b. Move 25A fuse at DIS #A005AH to within line section A002AH_A003AH

5.4 Substation: McColl 230kV

McColl 230kV BK1

The interconnection of ID #016327, #016326, #019170, #004540, #016328, and #019176 results in the aggregate generation capacity on this substation to exceed the substation transformer capacity, which requires the capacity to be increased. A new transformer is to be added in parallel with the existing transformer to increase the total capacity of the substation transformer bank to a large enough size to accommodate all the proposed Facilities. Additionally, the aggregate generation proposed on the T3760B02 feeder exceeds the loading limit. A new 24kV feeder breaker position is to be added off the 24kV unregulated bus along with a set of feeder voltage regulators to create a new feeder. With this new breaker position, the T3760B02 feeder will be reconfigured to move portions of the existing feeder to this new feeder. Reconfiguring portions of the existing feeder to this new breaker will relocate some of the Facilities to this feeder, which will remediate the overloads on feeder T3760B02.

High Level Scope of Work:

1. Substation Transformer System Upgrades
   a. Install one 3Ø 230kV/24kV 15MVA ONAN transformer in parallel with the existing 3Ø 230kV/24kV 15MVA ONAN transformer.
2. 24kV Unregulated Bus System Upgrades
   a. Install additional 24kV feeder breaker position; including one 24kV circuit breaker, associated relaying equipment, and three single-phase voltage regulators.

Feeder: T3760B01

Portions of the existing distribution circuit between the substation and the point of interconnections (POIs) exceed their capacity limits with the combined generation capacity of ID #016327, #016326, and #019170. Reconductoring these line sections to heavy conductors is required to increase the capacity to an amount that can accommodate these Facilities.

High Level Scope of Work:

1. Distribution Line System Upgrades:
   a. Replace existing conductors with 3Ø 477 AAC conductor with a 4/0 ACSR neutral from DIS# GE09BV to DIS# GK50BV; approximately 1.11 miles.

Feeder: T3760B02

Portions of the existing distribution circuit do not have the capacity to accommodate the combined generation capacity of ID #019176 and #016328. Therefore, reconductoring of these line sections is to be performed to increase the capacity. Additionally, certain protective devices that lie between the substation and the POI required alternation to maintain proper protection and coordination on the circuit with the addition of the Facilities.

High Level Scope of Work:

1. Distribution Line System Upgrades:
   a. Replace existing conductors with 3Ø 1/0 ACSR conductors keeping existing neutral from DIS# GC33BV to DIS# SXB60; approximately 0.45 miles

b. Verify line sections are built to High Capacity Standards, and rebuild as necessary, from the T3760B02 feeder exit to DIS# FA03BV (approximately 0.09 miles), which typically includes 4/0 Neutral, 84" Primary to Neutral spacing, 280 ft. maximum spans, etc.

2. Protection/Sectionalization System Upgrades:
   c. Replace 3Ø fuse with G&W Viper recloser at DIS #GC33BV.
   d. Relocate 3Ø fuse at DIS #GC33BV to section downstream of the ID # 016328 point of interconnection.

Feeder: T3760B## (New Position Number To Be Assigned)

To relieve the overload that occurs on feeder T3760B02 as a result of the aggregate generation capacity, a new feeder is being created out of the McColl 230kV substation. Feeder T3750B02 is then going to be reconfigured just outside of the substation to bring the southbound portions of the circuit to this new feeder. This reconfiguration will transfer ID #004540 to this new feeder.

High Level Scope of Work:

1. Distribution Line System Upgrades:
   a. Construct new 3Ø 477 AAC lines with a 4/0 ACSR neutral from the new feeder breaker position to near DIS# FA01BV; approximately 100 ft.
   b. Transfer sections of the T3760B02 feeder starting at ID #421611618 to the end of the new lines constructed for the new feeder breaker position.

5.5 Substation: Mullins 115kV

Feeder: T3030B01

The interconnection of ID#019139 and #020832 results in steady state voltage violations on the circuit. To remediate these violations, portions of the circuit were reconductored to heavy conductors. All violations were remediated on the circuit when this change is made.

High Level Scope of Work

1. Distribution Line System Upgrades:
   a. Replace existing 3Ø #2 ACSR circuit with 3Ø 477 AAC circuit from DIS#AT80BS to DIS#AU92BS (approximately 1.185 miles). The existing neutral should be replaced with a 4/0 AAAC neutral.
   b. Replace existing 3Ø #2 ACSR circuit with 3Ø 477 AAC circuit from DIS# AU92BS to DIS#AV3BS (approximately 0.619 miles). The existing neutral should be replaced with a 4/0 AAAC neutral.

Feeder: T3030B04

With the existing circuit conditions, a Section 3.2.2 line voltage regulator, in accordance with the Method of Service Guidelines, would be needed between the substation and the point of interconnection for ID#021892. To remediate the impact this device would have on the Facility, load is to be reconfigured so that more balanced conditions are achieved on the circuit which in turn reduces the voltage drop on the circuit. The circuit does not experience any steady state voltage or rapid voltage change violations with the addition of the Facility once this change is made.

High Level Scope of Work

1. Circuit Reconfiguration:
   a. Rephase 1Ø C phase tap line at DIS #6AR99 to B phase

5.6 Substation: Wadesboro Bowman School 230kV

Feeder: T1672B03

The interconnection of ID #008286 is proposed at the end of a single phase tap line off of the existing distribution system. In order to accommodate the proposed Facility, this 2.22 mile long tap line would need to be converted to three phase. Additionally, certain protective devices that lie between the substation and the POI required alternation to maintain proper protection/coordination on the circuit with the addition of the Facility. Once these System Upgrades are performed, the interconnection of the Facility does not result in any steady state voltage or rapid voltage change violations on the circuit.

High Level Scope of Work

1. Distribution Line System Upgrades:
   a. Reconductor existing 1 – 1/0 ACSR circuit with 3-477 AAC circuit from DIS# BC20AL to DIS# BC23AL (approximately 0.1 miles). The existing neutral should be replaced with a 4/0 AAAC neutral due to single phase path to POI.
   b. Reconductor existing 1 – 2 ACSR circuit with 3-477 AAC circuit from DIS# BC23AL to DIS# BC09AL (approximately 0.3 miles). The existing neutral should be replaced with a 4/0 AAAC neutral due to single phase path to POI.
   c. Reconductor existing 1 – 1/0 ACSR circuit with 3-477 AAC circuit from DIS# BC09AL to DIS# BB78AL (approximately 1.21 miles). The existing neutral should be replaced with a 4/0 AAAC neutral due to single phase path to POI.
   d. Reconductor existing 1 – 2 AAAC circuit with 3-477 AAC circuit from DIS# BB78AL to DIS# BS40AL (approximately 0.61miles). The existing neutral should be replaced with a 4/0 AAAC neutral due to single phase path to POI.
2. Protection/Sectionalization System Upgrades:
   a. Replace 1Ø 100A TripSaver at DIS# BC20AL with G&W Viper.
   b. Remove 1Ø 25KS fuse at DIS# BB78AL and replace with solid blades.

5.7 Substation: Weatherspoon 230kV

Feeder: T2631B03

The interconnection of ID #002115 and #002156 results in steady state voltage violations that can only be partially remediated with System Upgrades. The existing Generating Facilities increase the circuit voltages to the limit during peak and valley loading periods and the addition of the proposed Facilities increase the voltages beyond the limit. Modifying the distribution to the largest standard equipment does not completely remediate these violations. The remainder of the remediation requires relocation of the Point of Interconnections (POIs) for both Generating Facilities. To accommodate the proposed generation capacities, both Facilities are required to construct, own, and maintain new distribution facilities along new right-of-way for each installation to bring the Point of Interconnections (POIs) to near DIS# 9LL07 (34.597245°, -78.961050°). The Interconnection Facilities for each project would extend off this location and each Interconnection Customer's new lines would connect to the Point of Deliveries (POD).

High Level Scope of Work

1. New Line Construction:
   a. ID #002115 must obtain, build, and maintain new right-of-way and distribution facilities from the project site to the POI. The studied POI for this project is located near DIS# 9LL07 (34.597245°, -78.961050°), approximately 2.2 miles from the project site assuming DOT roadways are followed (actual distance may vary depending on the path chosen by the Interconnection Customer).
   b. ID #002156 must obtain, build, and maintain new right-of-way and distribution facilities from the project site to the POI. The studied POI for this project is located near DIS# 9LL07 (34.597245°, -78.961050°), approximately 3 miles from the project site assuming DOT roadways are followed (actual distance may vary depending on the path chosen by the Interconnection Customer).
2. Distribution Line System Upgrades:
   a. Verify line sections are built to High Capacity Standards, and rebuild as necessary, from the T2631B03 feeder exit to DIS# 9LL07 (approximately 1.22 miles), which typically includes 4/0 Neutral, 84" Primary to Neutral spacing, 280 ft. maximum spans, etc.

5.8 Substation: Whiteville 115kV

Feeder: T6670B03

The interconnection of ID #005037 did not result in any steady state voltage or rapid voltage change violations on the circuit. No power flow related System Upgrades have been identified at this time.