Generation Interconnection

Feasibility Study Report

for

Queue Project AF1-138

HUNTINGDON-WARRIOR RIDGE 46 KV

12 MW Capacity / 20 MW Energy

January, 2020

Table of Contents

1 Introduction

This Feasibility Study has been prepared in accordance with the PJM Open Access Transmission Tariff, 36.2, as well as the Feasibility Study Agreement between, the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) Mid-Atlantic Interstate Transmission (MAIT – Penelec zone).

2 Preface

The intent of the feasibility study is to determine a plan, with ballpark cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the Interconnection Customer. The Interconnection Customer may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: (1) Direct Connections, which are new facilities and/or facilities upgrades needed to connect the generator to the PJM network, and (2) Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system.

In some instances a generator interconnection may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection, may also contribute to the need for the same network reinforcement. Cost allocation rules for network upgrades can be found in PJM Manual 14A, Attachment B. The possibility of sharing the reinforcement costs with other projects may be identified in the feasibility study, but the actual allocation will be deferred until the impact study is performed.

The Interconnection Customer seeking to interconnect a wind or solar generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per Schedule H to the Interconnection Service Agreement and Section 8 of Manual 14D.

PJM utilizes manufacturer models to ensure the performance of turbines is properly captured during the simulations performed for stability verification and, where applicable, for compliance with low voltage ride through requirements. Turbine manufacturers provide such models to their customers. The list of manufacturer models PJM has already validated is contained in Attachment B of Manual 14G. Manufacturer models may be updated from time to time, for various reasons such as to reflect changes to the control systems or to more accurately represent the capabilities turbines and controls which are currently available in the field. Additionally, as new turbine models are developed, turbine manufacturers provide such new models which must be used in the conduct of these studies. PJM needs adequate time to evaluate the new models in order to reduce delays to the System Impact Study process timeline for the Interconnection Customer as well as other Interconnection Customers in the study group. Therefore, PJM will require that any Interconnection Customer with a new manufacturer model must supply that model to PJM, along with a $10,000 fully refundable deposit, no later than three (3) months prior to the starting date of the System Impact Study (See Section 4.3 for starting dates) for the Interconnection Request which shall specify the use of the new model.

The Interconnection Customer will be required to submit a completed dynamic model study request form (Attachment B-1 of Manual 14G) in order to document the request for the study.

The Feasibility Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. The project developer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

3 General

The Interconnection Customer (IC), has proposed a Solar generating facility located in Huntingdon County, Pennsylvania. The installed facilities will have a total capability of 20 MW with 12 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is 04/01/2022. This study does not imply a TO commitment to this in-service date.

Queue Number	AF1-138
Project Name	HUNTINGDON-WARRIOR RIDGE 46 KV
State	Pennsylvania
County	Huntingdon
Transmission Owner	PENELEC
MFO	20
MWE	20
MWC	12
Fuel	Solar
Basecase Study Year	2023

3.1 Point of Interconnection

Primary POI

The interconnection of the project at the primary Point of Interconnection (POI) will be accomplished by tapping the Huntingdon – Warrior Ridge 46 kV line and constructing a one span tap. The transmission line tap will be located approximately 2.1 miles from Huntingdon substation. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection line tap and the associated attachment facilities. The project will also require non-direct connection upgrades at Huntingdon and Warrior Ridge substations.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AF1-138 generation project to connect to the FirstEnergy (“FE”) transmission system. IC will be responsible for constructing the facilities on its side of the POI, including the attachment facilities which connect the generator to the FE transmission system’s direct connection facilities.

Secondary POI

The interconnection of the project at the secondary POI can be accomplished by tapping the Warrior Ridge – Williamsburg 46 kV line and constructing a one span tap. The transmission line tap would be located approximately 1.2 miles from Warrior Ridge substation. A full scope of work or estimated cost is not provided for the proposed Secondary POI.

3.2 Cost Summary

The AF1-138 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 242,700
Direct Connection Network Upgrade	$ 1,619,000
Non-Direct Connection Network Upgrades	$ 583,100
Total Costs	**$ 2,444,800**

In addition, the AF1-138 project may be responsible for a contribution to the following costs:

Description	Total Cost
System Upgrades	**$ 144,017,000**

Cost allocations for these upgrades will be provided in the System Impact Study Report.

The costs provided above exclude the Contribution in Aid of Construction ("CIAC") Federal Income Tax Gross Up charge. If, at a future date, it is determined that the CIAC Federal Income Tax Gross charge is required, the Transmission Owner shall be reimbursed by the Interconnection Customer for such taxes.

The Feasibility Study is used to make a preliminary determination of the type and scope of Attachment Facilities, Local Upgrades, and Network Upgrades that will be necessary to accommodate the Interconnection Request and to provide the Interconnection Customer a preliminary estimate of the time that will be required to construct any necessary facilities and upgrades and the Interconnection Customer's cost responsibility. The System Impact Study provides refined and comprehensive estimates of cost responsibility and construction lead times for new facilities and system upgrades. Facilities Studies will include, commensurate with the degree of engineering specificity as provided in the Facilities Study Agreement, good faith estimates of the cost, determined in accordance with Section 217 of the Tariff,

(a) to be charged to each affected New Service Customer for the Facilities and System Upgrades that are necessary to accommodate this queue project;

(b) the time required to complete detailed design and construction of the facilities and upgrades; and

(c) a description of any site-specific environmental issues or requirements that could reasonably be anticipated to affect the cost or time required to complete construction of such facilities and upgrades.

The required Attachment Facilities and Direct and Non-Direct Connection work for the interconnection of the AF1-138 generation project to the FE Transmission System is detailed in the following sections. The associated one-line with the generation project Attachment Facilities and the Primary Direct and Non-Direct Connection facilities are shown in Attachment 1.

4 Attachment Facilities

The total preliminary cost estimate for the Attachment work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
Construct one span from the new AF1-138 tap to the POI on the WH (Huntingdon-Warrior Ridge) 46kV line to service interconnection customer	$ 242,700
Total Attachment Facility Costs	**$ 242,700**

5 Direct Connection Cost Estimate

The total preliminary cost estimate for the Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
Construct a tap and install switches on the WH (Huntingdon-Warrior Ridge) 46kV line to service interconnection customer AF1-138	$ 1,619,000
Total Direct Connection Facility Costs	**$ 1,619,000**

6 Non-Direct Connection Cost Estimate

The total preliminary cost estimate for the Non-Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
Relay upgrades at Huntingdon	$255,300
Relay upgrades at Warrior Ridge	$255,300
Review nameplates and customer drawings	$72,500
Total Non-Direct Connection Facility Costs	**$ 583,100**

7 Schedule

Based on the scope of work for the Attachment Facilities and the Direct and/or Non-Direct Connection facilities, it is expected to take a minimum of 12 months after the signing of an Interconnection Construction Service Agreement to complete the installation. This includes the requirement for the IC to make a preliminary payment that compensates FE for the first three months of the engineering design work that is related to the construction of the interconnection substation. This assumes that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the defined direct connection and network upgrades, and that all transmission system outages will be allowed when requested.

The schedule for the required Network Impact Reinforcements will be more clearly identified in future study phases. The estimate elapsed time to complete each of the required reinforcements is identified in the "System Reinforcements" section of the report.

8 Transmission Owner Analysis

FE performed an analysis of its underlying transmission < 100 kV system. At the Primary POI, the AF1-138 project contributes to overloads on the FE transmission < 100 kV system as shown below.

The mitigation is to reconductor the Owens Corning to Huntingdon 46 kV circuit (~0.5 miles). The estimated cost of system reinforcements necessary to mitigate these overloads is $892,500.

Contingency Description	Overloaded Element	Rating (MVA)	Final % Loading	AF1-138 MW Contrib.	FE Comments/Reinforcements
Loss of WARRIOR RIDGE - BELLEVILLE 46KV Line	202801 26OC1 TAP 46.0 202735 26HUNTNGDN 46.0 1	SE: 33	113.65	20	Terminal Upgrade

9 Interconnection Customer Requirements

9.1 System Protection

The IC must design its Customer Facilities in accordance with all applicable standards, including the standards in FE's "Requirements for Transmission Connected Facilities" document located at: http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx.

Preliminary Protection requirements will be provided as part of the Facilities Study. Detailed Protection Requirements will be provided once the project enters the construction phase.

The original one-line diagram provided by the IC depicts a non-standard GSU transformer winding configuration. This transformer is in violation of section 14.2.6 of FE's "Requirements for Transmission Connected Facilities" document and will not be accepted. Inverter-based generation that is UL1741 certified for anti-islanding protection connected to the FE Transmission System at <100 kV shall have a delta or

ungrounded wye winding on the transmission (utility) side. The low (generator) side winding is at the discretion of the IC.

9.2 Compliance Issues and Interconnection Customer Requirements

The proposed Customer Facilities must be designed in accordance with FE's "Requirements for Transmission Connected Facilities" document located at: http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx. In particular, the IC is responsible for the following:

1. The purchase and installation of a fully rated 46 kV circuit breaker to protect the AF1-138 generator lead line. A single circuit breaker must be used to protect this line; if the project has several GSU transformers, the individual GSU transformer breakers cannot be used to protect this line.
2. The purchase and installation of the minimum required FE generation interconnection relaying and control facilities. This includes over/under voltage protection, over/under frequency protection, and zero sequence voltage protection relays.
3. The purchase and installation of supervisory control and data acquisition ("SCADA") equipment to provide information in a compatible format to the FE Transmission System Control Center.
4. Compliance with the FE and PJM generator power factor and voltage control requirements.
5. The execution of a back-up service agreement to serve the customer load supplied from the AF1-138 generation project metering point when the units are out-of-service. This assumes the intent of the IC is to net the generation with the load.

The IC will also be required to meet all PJM, ReliabilityFirst, and NERC reliability criteria and operating procedures for standards compliance. For example, the IC will need to properly locate and report the over and under voltage and over and under frequency system protection elements for its units as well as the submission of the generator model and protection data required to satisfy the PJM and ReliabilityFirst audits. Failure to comply with these requirements may result in a disconnection of service if the violation is found to compromise the reliability of the FE system.

9.3 Power Factor Requirements

The IC shall design its solar Customer Facility with the ability to maintain a power factor of at least 0.95 leading (absorbing VARs) to 0.95 lagging (supplying VARs) measured at the high-side of the facility substation transformer(s) connected to the FE transmission system.

10 Revenue Metering and SCADA Requirements

10.1 PJM Requirements

The Interconnection Customer will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Section 8 of Attachment O.

10.1.1 Meteorological Data Reporting Requirement

The solar generation facility shall provide the Transmission Provider with site-specific meteorological data including:

- Temperature (degrees Fahrenheit)
- Atmospheric pressure (hectopascals)
- Irradiance
- Forced outage data

10.2 Penelec Requirements

The IC will be required to comply with all FE revenue metering requirements for generation interconnection customers which can be found in FE's "Requirements for Transmission Connected Facilities" document located at: http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx

11 Network Impacts – Primary Point of Interconnection

The Queue Project AF1-138 was evaluated as a 20.0 MW (Capacity 12.0 MW) injection tapping the Huntington to Warrior Ridge 46 kV line in the Penelec area. Project AF1-138 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-138 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Load Flow

11.1 Generation Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection)

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
42458878	200767	26HOMER CT	230.0	PENELEC	200795	26SHELOCTA	230.0	PENELEC	1	PJM_P1__P1_20A_CONEMAGH-KEYSTONE	single	917.0	99.96	100.16	DC	1.83

11.2 Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
41556354	200519	26REED TAP	115.0	PENELEC	200522	26SHADE GP	115.0	PENELEC	1	PL_P42_100548	breaker	225.0	99.59	100.73	DC	2.57

11.3 Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
41556143	200513	26LEWISTWN	230.0	PENELEC	208005	JUNIBU2	230.0	PPL	1	AP-P2-3-WP-230-446T	breaker	624.0	110.81	112.04	DC	7.71
41810385	200513	26LEWISTWN	230.0	PENELEC	208005	JUNIBU2	230.0	PPL	1	PN-P2-2-PN-115-032	bus	624.0	109.45	110.69	DC	8.03

11.4 Potential Congestion due to Local Energy Deliverability

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which shall study all overload conditions associated with the overloaded element(s) identified.

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
41224731	200513	26LEWISTWN	230.0	PENELEC	208005	JUNI BU2	230.0	PPL	1	Base Case	operation	493.0	113.79	115.22	DC	7.32
41224732	200513	26LEWISTWN	230.0	PENELEC	208005	JUNI BU2	230.0	PPL	1	PN-P1-2-PN-115-094-A	operation	624.0	109.4	110.64	DC	8.03
41224810	200522	26SHADE GP	115.0	PENELEC	938380	AE1-071 TAP	115.0	PENELEC	1	PL_P12_100618	operation	160.0	123.04	124.64	DC	2.56

11.5 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
41810385,41556143	3	26LEWISTWN 230.0 kV - JUNI BU2 230.0 kV Ckt 1	**PENELEC** **PN-AF1-F-0003b : Reconductor Lewistown - Juniata (~24.5 miles).** **Project Type : FAC** **Cost : $102,042,500** **Time Estimate : 6.0 Months** **PPL** **R-PL-0006 : Re-conductor PPL's ~0.9mi LEWI-JUNI 230kV Line** **Project Type : FAC** **Cost : $900,000** **Time Estimate : 24.0 Months**	$102,942,500
41556354	2	26REED TAP 115.0 kV - 26SHADE GP 115.0 kV Ckt 1	**PENELEC** **PN-AF1-F-0004a : Reconductor Reeds Tap - Shade Gap (~22.4 miles).** **Project Type : FAC** **Cost : $39,984,000** **Time Estimate : 6.0 Months**	$39,984,000
42458878	1	26HOMER CT 230.0 kV - 26SHELOCTA 230.0 kV Ckt 1	**PENELEC** **PN-AF1-F-0040a : Replace wave trap at Homer City** **Project Type : FAC** **Cost : $119,000** **Time Estimate : 9.0 Months**	$119,000
AF1-138-L1	N/A	Owens Corning-Huntingdon 46.0 kV Line	**PENELEC** **PN-AF1-F-0083: Reconductor Owens Corning - Huntingdon 46 kV (~0.5 miles)** **Project Type : FAC** **Cost : $892,500** **Time Estimate : 18.0 Months**	$892,500
			TOTAL COST	**$144,017,000**

11.6 Flow Gate Details

The following indices contain additional information about each flowgate presented in the body of the report. For each index, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact. It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

11.6.1 Contingency Descriptions

Contingency Name	Contingency Definition
PN-P1-2-PN-115-094-A	CONTINGENCY 'PN-P1-2-PN-115-094-A' /* ROXBURY - SHADE GAP 115KV DISCONNECT BRANCH FROM BUS 200520 TO BUS 938380 CKT 1 /* 26ROXBURY 115 AE1-071 TAP 115 END
PN-P2-2-PN-115-032	CONTINGENCY 'PN-P2-2-PN-115-032' /* ROXBURY 115KV BUS FAULT DISCONNECT BUS 200520 /* 26ROXBURY 115 END
PL_P42_100548	CONTINGENCY 'PL_P42_100548' /* AT JUNIATA SUB 230KV BUS TIE CB FAILED" DISCONNECT BUS 208005 /* DISCONNECT BUS 208004 /* END
AP-P2-3-WP-230-446T	CONTINGENCY 'AP-P2-3-WP-230-446T' /* ELKO-MOSHANNON STK BKR AT ELKO DISCONNECT BRANCH FROM BUS 200726 TO BUS 235175 CKT 1 /* 26SHAWVL 2 230 01ELKO 230 DISCONNECT BRANCH FROM BUS 235158 TO BUS 235175 CKT 1 /* 01CARB 230 01ELKO 230 DISCONNECT BRANCH FROM BUS 235175 TO BUS 235236 CKT 1 /* 01ELKO 230 01QUEHAN 230 DISCONNECT BRANCH FROM BUS 235220 TO BUS 235236 CKT 1 /* 01MOSHAN 230 01QUEHAN 230 DISCONNECT BRANCH FROM BUS 235236 TO BUS 236732 CKT 81 /* 01QUEHAN 230 01QUEHANNA 46 END
PL_P12_100618	CONTINGENCY 'PL_P12_100618' /* JUNIATA 230/69KV TR4 OUT" DISCONNECT BRANCH FROM BUS 208005 TO BUS 209997 CKT 4 /* DISCONNECT BRANCH FROM BUS 208005 TO BUS 207955 CKT 1 /* DISCONNECT BRANCH FROM BUS 208005 TO BUS 200009 CKT 2 /* DISCONNECT BRANCH FROM BUS 208005 TO BUS 208006 CKT 1 /* DISCONNECT BRANCH FROM BUS 208005 TO BUS 208004 CKT 1 /* DISCONNECT BRANCH FROM BUS 208005 TO BUS 200513 CKT 1 /* END
Base Case	
PJM_P1__P1_20A_CONEMAGH-KEYSTONE	CONTINGENCY 'PJM_P1__P1_20A_CONEMAGH-KEYSTONE' DISCONNECT BRANCH FROM BUS 200005 TO BUS 200011 CKT 1 /* CONEMAGH KEYSTONE 500 500 END

11.6.2 Index 1

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
4245887 8	20076 7	26HOME R CT	PENELE C	20079 5	26SHELOCT A	PENELE C	1	PJM_P1__P1_20A_CONEMA GH-KEYSTONE	singl e	917.0	99.96	100.16	DC	1.83

Bus #	Bus	MW Impact
200503	**26C.SLOPE (Deativation : 06/07/19)**	**20.6684**
200642	26SENECA#1	4.6296
200643	26SENECA#2	4.3724
200644	26SENECA#3	0.4371
200794	26CONEMAGH	0.3174
200809	26SITHE	1.8324
200812	26ALY HYDR	0.4467
200830	26HNSMLK 3	1.0537
200831	26HNSMLK 4	1.0537
200832	26HNSMLK 5	1.0537
200833	26SEWRDB34	19.0081
200834	26SW_E13_K22	0.0532
200835	26DSGENWIN	0.2564
200837	26HOMER C1	31.5573
200838	26HOMER C2	25.9880
200839	26HOMER C3	27.5117
200846	26FORWARD	0.1912
200852	26WARR RDG	0.1276
200886	26ARWF_N39	0.5148
200887	26ARMNA MT	0.4439
200888	26HIGHLAND	0.4125
200889	26STNY CRK	0.3179
200890	26BF_G21_K23	0.1257
200891	26CSLMN_L13	0.1972
200892	26LOOKOUT	0.1873
200898	26AA1-106	2.2768
200905	26Q36	0.2325
200915	26CHSTN_FL	0.2162
200925	26R32	0.4760
200945	26CT_V3-030	0.1089
201144	W3-099 C OP1	1.0456
201477	26Y2-055	3.1550
202225	26SCI_S29B	0.0828
203034	26NA_O38_P22	0.4505
203261	26BLOSSBCT	0.4152
203349	26Z1-069 C	0.3252
203350	26MILZ1-092	0.4108
203909	26Z1-038	1.7279
203910	26Z1-091	2.1436
919201	AA1-144 OP	17.1622
919491	AA2-000	48.0210

Bus #	Bus	MW Impact
920341	AA2-132	2.3388
922932	AB1-082 OP	3.5520
923442	AB1-160 C	0.0929
930511	AB1-092	1.7632
935061	AD1-142	0.0227
936421	AD2-055	3.6301
936991	AD2-133 C	2.9979
938351	AE1-053	1.7660
938881	AE1-116	0.9531
938951	AE1-123	1.4636
938991	AE1-128 C	16.0812
939171	AE1-147 C	1.1360
939291	AE1-160 C	1.0478
939381	AE1-169 C O1	4.2349
940201	AE2-001 C	1.1350
940681	AE2-055 C	1.1184
940861	AE2-074 C	2.6970
941191	AE2-113 C	10.0955
941231	AE2-117 C	1.8288
941241	AE2-118 C	1.8288
941251	**AE2-119 C (Withdrawn : 12/16/2019)**	**1.3083**
941261	AE2-120 C	1.1343
941271	AE2-121 C	0.6050
941321	AE2-126 C	1.3586
941331	AE2-129 C	1.7927
941351	AE2-131 C	1.7927
941421	AE2-139 C	6.3536
942121	AE2-224 C	15.6510
942351	AE2-248 C	0.9002
942361	AE2-249 C	1.8091
942491	AE2-262 C	4.9615
942501	AE2-263 C	4.6638
942511	AE2-264 C	8.5925
942811	AE2-299 C	2.6085
942961	AE2-316 C	4.2079
943711	AF1-039 C O1	0.5386
943751	AF1-043	5.7719
943871	AF1-055 C O1	2.0683
944001	AF1-068 C O1	0.6350
944181	AF1-086 C O1	0.9378
944261	AF1-094 C	0.4997
944281	AF1-096 C	0.5247
944301	AF1-098 C	2.1163
944311	AF1-099 C	3.9917
944321	AF1-100 C O1	8.2110
944381	AF1-103 O1	1.1526
944411	AF1-106 O1	2.9582
944471	AF1-112 C	0.5974
944671	AF1-132 C O1	0.5947
944691	AF1-134 C O1	0.5086
944701	AF1-135 C	0.6103
944731	AF1-138 C O1	1.8288

Bus #	Bus	MW Impact
944741	AF1-139 C O1	0.7475
944751	AF1-140 C	2.1269
944771	AF1-142 C	6.3867
944781	AF1-143 C	10.5960
944841	AF1-149 C	1.1342
944881	AF1-153 C O1	0.6577
944901	AF1-155 C	0.6568
945021	AF1-167 C	0.3921
945071	AF1-172 C	8.2131
945121	AF1-177	0.2881
945161	AF1-181	0.0438
945171	AF1-182	0.2190
945181	AF1-183	0.0562
945331	AF1-198	0.3914
945481	AF1-213 C	4.9361
945491	AF1-214 C	0.6012
945551	AF1-220 C	5.6012
945671	AF1-232 C O1	22.4318
945771	AF1-242 C	0.6568
945901	AF1-255 C	1.2536
946081	AF1-273 C O1	12.9414
946091	AF1-274 C	3.0831
946131	AF1-278	33.2466
946191	AF1-284 C O1	0.5393
946211	AF1-286 C O1	1.1981
946221	AF1-287 C	0.4905
946241	AF1-289 C O1	5.2342
946381	AF1-302 C	0.9739
946401	AF1-304 C	2.6500
946421	AF1-306 C	3.3071
946431	AF1-307 C	8.2785
946571	AF1-321 C O1	2.8732
946771	AF1-217 C O1	0.4905
DUCKCREEK	DUCKCREEK	2.4412
NEWTON	NEWTON	2.2769
FARMERCITY	FARMERCITY	0.1171
G-007A	G-007A	5.2194
VFT	VFT	14.2610
PRAIRIE	PRAIRIE	5.4011
COFFEEN	COFFEEN	1.1178
EDWARDS	EDWARDS	0.7430
CHEOAH	CHEOAH	0.9795
TILTON	TILTON	1.3451
MADISON	MADISON	0.1855
GIBSON	GIBSON	1.1663
CALDERWOOD	CALDERWOOD	0.9756
BLUEG	BLUEG	3.7376
TRIMBLE	TRIMBLE	1.1998
CATAWBA	CATAWBA	0.6244

11.6.3 Index 2

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
41556354	200519	26REED TAP	PENELEC	200522	26SHADE GP	PENELEC	1	PL_P42_100548	breaker	225.0	99.59	100.73	DC	2.57

Bus #	Bus	MW Impact
200812	26ALY HYDR	0.3760
200852	26WARR RDG	0.1074
235003	AC1-025 E	0.1809
236828	01GRAYMONT	0.4655
290086	Q-036 E	2.0611
293301	N-039 E	3.5812
294515	O38_P22	3.1335
919491	AA2-000	26.2577
930511	AB1-092	0.9641
936421	AD2-055	1.9849
936991	AD2-133 C	0.9275
936992	AD2-133 E	4.2422
939171	AE1-147 C	1.3885
939172	AE1-147 E	0.9257
940201	AE2-001 C	1.3931
940202	AE2-001 E	0.9287
940681	AE2-055 C	1.4624
940682	AE2-055 E	0.9750
941231	AE2-117 C	1.5395
941232	AE2-117 E	1.0263
941241	AE2-118 C	1.5395
941242	AE2-118 E	1.0263
941251	**AE2-119 C (Withdrawn : 12/16/2019)**	**0.7308**
941252	**AE2-119 E (Withdrawn : 12/16/2019)**	**0.4872**
941261	AE2-120 C	1.3956
941262	AE2-120 E	0.9304
941271	AE2-121 C	0.7340
941272	AE2-121 E	0.4901
941321	AE2-126 C	0.6666
941322	AE2-126 E	0.4444
941331	AE2-129 C	0.6690
941332	AE2-129 E	0.4460
941351	AE2-131 C	0.6690
941352	AE2-131 E	0.4460
942031	AE2-215 C	13.2746
942032	AE2-215 E	8.8498
942351	AE2-248 C	1.1468
942352	AE2-248 E	0.7645
942491	AE2-262 C	4.1025
942492	AE2-262 E	2.7569
942501	AE2-263 C	3.8564
942502	AE2-263 E	2.5747

Bus #	Bus	MW Impact
942511	AE2-264 C	5.0630
942512	AE2-264 E	3.3754
943751	AF1-043	3.1560
944001	AF1-068 C O1	1.5383
944002	AF1-068 E O1	0.8653
944311	AF1-099 C	3.3006
944312	AF1-099 E	2.2004
944321	AF1-100 C O1	5.6135
944322	AF1-100 E O1	3.7423
944471	AF1-112 C	1.4258
944472	AF1-112 E	0.9506
944671	AF1-132 C O1	1.4471
944672	AF1-132 E O1	0.9647
944691	AF1-134 C O1	0.2510
944692	AF1-134 E O1	0.2510
944701	AF1-135 C	0.3012
944702	AF1-135 E	0.2008
944731	AF1-138 C O1	1.5395
944732	AF1-138 E O1	1.0263
944771	AF1-142 C	5.2810
944772	AF1-142 E	3.5207
944841	AF1-149 C	1.3958
944842	AF1-149 E	0.9306
944881	AF1-153 C O1	0.3383
944882	AF1-153 E O1	0.2255
944901	AF1-155 C	0.3363
944902	AF1-155 E	0.2242
945071	AF1-172 C	4.9350
945072	AF1-172 E	3.2900
945161	AF1-181	0.0299
945171	AF1-182	0.1497
945181	AF1-183	0.0349
945481	AF1-213 C	2.6018
945482	AF1-213 E	1.7345
945491	AF1-214 C	1.3954
945492	AF1-214 E	0.9302
945551	AF1-220 C	2.5011
945552	AF1-220 E	1.6683
945771	AF1-242 C	0.3363
945772	AF1-242 E	0.2242
946091	AF1-274 C	1.4725
946092	AF1-274 E	0.9817
946311	AF1-295	4.4249
946421	AF1-306 C	1.7269
946422	AF1-306 E	6.9075
LGEE	LGEE	0.0650
WEC	WEC	0.0435
CBM-W2	CBM-W2	0.5897
CBM-W1	CBM-W1	2.0892
TVA	TVA	0.0364
O-066	O-066	1.5456
CHEOAH	CHEOAH	0.0070

Bus #	Bus	MW Impact
CBM-S1	CBM-S1	0.3578
G-007	G-007	0.2735
MEC	MEC	0.1796
CALDERWOOD	CALDERWOOD	0.0050
CATAWBA	CATAWBA	0.0399

11.6.4 Index 3

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
41556143	200513	26LEWISTWN	PENELEC	208005	JUNI BU2	PPL	1	AP-P2-3-WP-230-446T	breaker	624.0	110.81	112.04	DC	7.71

Bus #	Bus	MW Impact
200665	26SHAWVL 3	7.7967
200666	26SHAWVL 4	7.6716
200715	26SHAWVL 1	4.9146
200722	26SHAWVL 2	5.0397
200812	26ALY HYDR	1.1301
200852	26WARR RDG	0.3229
200883	Q-053 E	6.8957
200886	26ARWF_N39	0.4288
200894	26K02	9.1554
200898	26AA1-106	1.9579
200905	26Q36	0.2813
200913	26SHAW-D	0.2124
200915	26CHSTN_FL	0.1524
203034	26NA_O38_P22	0.3752
203905	26W1-045 C	0.6853
235003	AC1-025 E	0.6133
236828	01GRAYMONT	1.5971
290086	Q-036 E	8.0600
293301	N-039 E	12.2874
293393	V3-030E	2.7472
294515	O38_P22	10.7514
901242	W1-045 E OP1	1.1181
919491	AA2-000	117.3103
930511	AB1-092	4.3073
936421	AD2-055	8.8679
936471	AD2-062 C O1	5.0032
936472	AD2-062 E O1	2.5063
936991	AD2-133 C	3.6270
936992	AD2-133 E	16.5895
938381	AE1-071 C	13.1348
938382	AE1-071 E	8.0374
939171	AE1-147 C	4.7732
939172	AE1-147 E	3.1822
940201	AE2-001 C	4.7834
940202	AE2-001 E	3.1890
940681	AE2-055 C	4.9397
940682	AE2-055 E	3.2931
941231	AE2-117 C	4.6266
941232	AE2-117 E	3.0844
941241	AE2-118 C	4.6266
941242	AE2-118 E	3.0844

Bus #	Bus	MW Impact
941251	AE2-119 C (Withdrawn : 12/16/2019)	3.0438
941252	AE2-119 E (Withdrawn : 12/16/2019)	2.0292
941261	AE2-120 C	4.7891
941262	AE2-120 E	3.1927
941271	AE2-121 C	2.5283
941272	AE2-121 E	1.6882
941321	AE2-126 C	2.1067
941322	AE2-126 E	1.4045
941331	AE2-129 C	2.7008
941332	AE2-129 E	1.8006
941351	AE2-131 C	2.7008
941352	AE2-131 E	1.8006
941421	AE2-139 C	5.5361
941422	AE2-139 E	3.6907
942031	AE2-215 C	14.8871
942032	AE2-215 E	9.9247
942121	AE2-224 C	7.2840
942122	AE2-224 E	4.8560
942351	AE2-248 C	3.8996
942352	AE2-248 E	2.5997
942491	AE2-262 C	17.7280
942492	AE2-262 E	11.9132
942501	AE2-263 C	16.6643
942502	AE2-263 E	11.1261
942511	AE2-264 C	15.1296
942512	AE2-264 E	10.0864
943751	AF1-043	26.6038
944001	AF1-068 C O1	5.2205
944002	AF1-068 E O1	2.9365
944181	AF1-086 C O1	2.8312
944182	AF1-086 E O1	12.3174
944311	AF1-099 C	26.9111
944312	AF1-099 E	17.9407
944321	AF1-100 C O1	48.2115
944322	AF1-100 E O1	32.1410
944471	AF1-112 C	4.8575
944472	AF1-112 E	3.2383
944671	AF1-132 C O1	4.9052
944672	AF1-132 E O1	3.2702
944691	AF1-134 C O1	1.8754
944692	AF1-134 E O1	1.8754
944701	AF1-135 C	2.2505
944702	AF1-135 E	1.5003
944731	AF1-138 C O1	4.6266
944732	AF1-138 E O1	3.0844
944751	AF1-140 C	1.1435
944752	AF1-140 E	0.7623
944771	AF1-142 C	43.0578
944772	AF1-142 E	28.7052
944841	AF1-149 C	4.7897
944842	AF1-149 E	3.1931
945071	AF1-172 C	42.2760

Bus #	Bus	MW Impact
945072	AF1-172 E	28.1840
945161	AF1-181	0.2565
945171	AF1-182	1.2856
945181	AF1-183	0.2886
945481	AF1-213 C	19.9893
945482	AF1-213 E	13.3262
945491	AF1-214 C	4.7887
945492	AF1-214 E	3.1925
945551	AF1-220 C	11.0811
945552	AF1-220 E	7.3914
945901	AF1-255 C	0.2695
945902	AF1-255 E	0.3722
946091	AF1-274 C	8.1585
946092	AF1-274 E	5.4390
946241	AF1-289 C O1	1.2428
946242	AF1-289 E O1	0.8286
946311	AF1-295	4.9624
LGEE	LGEE	0.5465
CPLE	CPLE	0.3744
WEC	WEC	0.3115
CBM-W2	CBM-W2	7.4120
CBM-W1	CBM-W1	12.8478
TVA	TVA	1.1872
O-066	O-066	18.8832
CBM-S2	CBM-S2	3.7743
CBM-S1	CBM-S1	7.3954
G-007	G-007	2.9432
MEC	MEC	1.5207

Short Circuit

11.7 Short Circuit

The following Breakers are overdutied:

None

12 Network Impacts – Secondary Point of Interconnection

The Queue Project AF1-138 was evaluated as a 20.0 MW (Capacity 12.0 MW) injection tapping the Warrior Ridge to ABW Tap 46 kV line in the Penelec area. Project AF1-138 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-138 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Load Flow

12.1 Generation Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection)

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
42458878	200767	26HOMER CT	230.0	PENELEC	200795	26SHELOCTA	230.0	PENELEC	1	PJM_P1__P1_20A_CONEMAGH-KEYSTONE	single	917.0	99.91	100.11	DC	1.83

12.2 Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
41556354	200519	26REED TAP	115.0	PENELEC	200522	26SHADE GP	115.0	PENELEC	1	PL_P42_100548	breaker	225.0	99.52	100.66	DC	2.57

12.3 Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
41556143	200513	26LEWISTWN	230.0	PENELEC	208005	JUNIBU2	230.0	PPL	1	AP-P2-3-WP-230-446T	breaker	624.0	110.71	111.95	DC	7.71
41556144	200513	26LEWISTWN	230.0	PENELEC	208005	JUNIBU2	230.0	PPL	1	AP-P2-3-WP-230-443T *	breaker	624.0	110.62	111.85	DC	7.71
41556145	200513	26LEWISTWN	230.0	PENELEC	208005	JUNIBU2	230.0	PPL	1	AP-P2-2-WP-230-001T	breaker	624.0	110.62	111.85	DC	7.71
41810385	200513	26LEWISTWN	230.0	PENELEC	208005	JUNIBU2	230.0	PPL	1	PN-P2-2-PN-115-032	bus	624.0	109.32	110.55	DC	8.03
41810386	200513	26LEWISTWN	230.0	PENELEC	208005	JUNIBU2	230.0	PPL	1	AP-P2-2-WP-230-001T	bus	624.0	110.62	111.85	DC	7.71

12.4 Potential Congestion due to Local Energy Deliverability

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed

with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which shall study all overload conditions associated with the overloaded element(s) identified.

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
41224731	200513	26LEWISTWN	230.0	PENELEC	208005	JUNIBU2	230.0	PPL	1	Base Case	operation	493.0	115.83	117.26	DC	7.32
41224732	200513	26LEWISTWN	230.0	PENELEC	208005	JUNIBU2	230.0	PPL	1	PN-P1-2-PN-115-094-A	operation	624.0	109.27	110.5	DC	8.03
41224810	200522	26SHADEGP	115.0	PENELEC	938380	AE1-071TAP	115.0	PENELEC	1	PL_P12_100618	operation	160.0	122.94	124.55	DC	2.56

12.5 Flow Gate Details

The following indices contain additional information about each flowgate presented in the body of the report. For each index, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact. It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

12.5.1 Contingency Descriptions

Contingency Name	Contingency Definition
PN-P1-2-PN-115-094-A	CONTINGENCY 'PN-P1-2-PN-115-094-A' /* ROXBURY - SHADE GAP 115KV DISCONNECT BRANCH FROM BUS 200520 TO BUS 938380 CKT 1 /* 26ROXBURY 115 AE1-071 TAP 115 END
AP-P2-3-WP-230-443T *	CONTINGENCY 'AP-P2-3-WP-230-443T *' / UPDATED CON AJK 3-31-16 DISCONNECT BRANCH FROM BUS 200726 TO BUS 235175 CKT 1 DISCONNECT BRANCH FROM BUS 235175 TO BUS 235236 CKT 1 DISCONNECT BUS 235158 END

Contingency Name	Contingency Definition
PL_P42_100548	CONTINGENCY 'PL_P42_100548' /* AT JUNIATA SUB 230KV BUS TIE CB FAILED" DISCONNECT BUS 208005 /* DISCONNECT BUS 208004 /* END
AP-P2-3-WP-230-446T	CONTINGENCY 'AP-P2-3-WP-230-446T' /* ELKO-MOSHANNON STK BKR AT ELKO DISCONNECT BRANCH FROM BUS 200726 TO BUS 235175 CKT 1 /* 26SHAWVL 2 230 01ELKO 230 DISCONNECT BRANCH FROM BUS 235158 TO BUS 235175 CKT 1 /* 01CARB 230 01ELKO 230 DISCONNECT BRANCH FROM BUS 235175 TO BUS 235236 CKT 1 /* 01ELKO 230 01QUEHAN 230 DISCONNECT BRANCH FROM BUS 235220 TO BUS 235236 CKT 1 /* 01MOSHAN 230 01QUEHAN 230 DISCONNECT BRANCH FROM BUS 235236 TO BUS 236732 CKT 81 /* 01QUEHAN 230 01QUEHANNA 46 END
PL_P12_100618	CONTINGENCY 'PL_P12_100618' /* JUNIATA 230/69KV TR4 OUT" DISCONNECT BRANCH FROM BUS 208005 TO BUS 209997 CKT 4 /* DISCONNECT BRANCH FROM BUS 208005 TO BUS 207955 CKT 1 /* DISCONNECT BRANCH FROM BUS 208005 TO BUS 200009 CKT 2 /* DISCONNECT BRANCH FROM BUS 208005 TO BUS 208006 CKT 1 /* DISCONNECT BRANCH FROM BUS 208005 TO BUS 208004 CKT 1 /* DISCONNECT BRANCH FROM BUS 208005 TO BUS 200513 CKT 1 /* END
Base Case	
PJM_P1__P1_20A_CONEMAGH-KEYSTONE	CONTINGENCY 'PJM_P1__P1_20A_CONEMAGH-KEYSTONE' DISCONNECT BRANCH FROM BUS 200005 TO BUS 200011 CKT 1 /* CONEMAGH KEYSTONE 500 500 END
AP-P2-2-WP-230-001T	CONTINGENCY 'AP-P2-2-WP-230-001T' /* ELKO #2 230KV BUS DISCONNECT BRANCH FROM BUS 235175 TO BUS 235158 CKT 1 /* 01ELKO 230 01CARB 230 DISCONNECT BRANCH FROM BUS 235175 TO BUS 235236 CKT 1 /* 01ELKO 230 01QUEHAN 230 DISCONNECT BRANCH FROM BUS 235175 TO BUS 200726 CKT 1 /* 01ELKO 230 26SHAWVL 2 230 REDUCE BUS 237007 SHUNT BY 100 PERCENT /* 01ELKO CAP 138 DISCONNECT BUS 237007 /* 01ELKO CAP 138 END
PN-P2-2-PN-115-032	CONTINGENCY 'PN-P2-2-PN-115-032' /* ROXBURY 115KV BUS FAULT DISCONNECT BUS 200520 /* 26ROXBURY 115 END

12.5.2 Index 1

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
4245887 8	20076 7	26HOME R CT	PENELE C	20079 5	26SHELOCT A	PENELE C	1	PJM_P1__P1_20A_CONEMA GH-KEYSTONE	singl e	917.0	99.91	100.11	DC	1.83

Bus #	Bus	MW Impact
200503	**26C.SLOPE (Deativation : 06/07/19)**	**20.6684**
200642	26SENECA#1	4.6296
200643	26SENECA#2	4.3724
200644	26SENECA#3	0.4371
200794	26CONEMAGH	0.3174
200809	26SITHE	1.8324
200812	26ALY HYDR	0.4467
200830	26HNSMLK 3	1.0537
200831	26HNSMLK 4	1.0537
200832	26HNSMLK 5	1.0537
200833	26SEWRDB34	19.0081
200834	26SW_E13_K22	0.0532
200835	26DSGENWIN	0.2564
200837	26HOMER C1	31.5573
200838	26HOMER C2	25.9880
200839	26HOMER C3	27.5117
200846	26FORWARD	0.1912
200852	26WARR RDG	0.1276
200886	26ARWF_N39	0.5148
200887	26ARMNA MT	0.4439
200888	26HIGHLAND	0.4125
200889	26STNY CRK	0.3179
200890	26BF_G21_K23	0.1257
200891	26CSLMN_L13	0.1972
200892	26LOOKOUT	0.1873
200898	26AA1-106	2.2768
200905	26Q36	0.2325
200915	26CHSTN_FL	0.2162
200925	26R32	0.4760
200945	26CT_V3-030	0.1089
201144	W3-099 C OP1	1.0456
201477	26Y2-055	3.1550
202225	26SCI_S29B	0.0828
203034	26NA_O38_P22	0.4505
203261	26BLOSSBCT	0.4152
203349	26Z1-069 C	0.3252
203350	26MILZ1-092	0.4108
203909	26Z1-038	1.7279
203910	26Z1-091	2.1436
919201	AA1-144 OP	17.1622
919491	AA2-000	48.0210

Bus #	Bus	MW Impact
920341	AA2-132	2.3388
922932	AB1-082 OP	3.5520
923442	AB1-160 C	0.0929
930511	AB1-092	1.7632
935061	AD1-142	0.0227
936421	AD2-055	3.6301
936991	AD2-133 C	2.9979
938351	AE1-053	1.7660
938881	AE1-116	0.9531
938951	AE1-123	1.4636
938991	AE1-128 C	16.0812
939171	AE1-147 C	1.1360
939291	AE1-160 C	1.0478
939381	AE1-169 C O1	4.2349
940201	AE2-001 C	1.1350
940681	AE2-055 C	1.1184
940861	AE2-074 C	2.6970
941191	AE2-113 C	10.0955
941231	AE2-117 C	1.8288
941241	AE2-118 C	1.8288
941251	**AE2-119 C (Withdrawn : 12/16/2019)**	**1.3083**
941261	AE2-120 C	1.1343
941271	AE2-121 C	0.6050
941321	AE2-126 C	1.3586
941331	AE2-129 C	1.7927
941351	AE2-131 C	1.7927
941421	AE2-139 C	6.3536
942121	AE2-224 C	15.6510
942351	AE2-248 C	0.9002
942361	AE2-249 C	1.8091
942491	AE2-262 C	4.9615
942501	AE2-263 C	4.6638
942511	AE2-264 C	8.5925
942811	AE2-299 C	2.6085
942961	AE2-316 C	4.2079
943711	AF1-039 C O2	0.4577
943751	AF1-043	5.7719
943871	AF1-055 C O2	2.1634
944001	AF1-068 C O2	0.6347
944181	AF1-086 C O2	0.9348
944261	AF1-094 C	0.4997
944281	AF1-096 C	0.5247
944301	AF1-098 C	2.1163
944311	AF1-099 C	3.9917
944321	AF1-100 C O2	8.2023
944381	AF1-103 O2	1.1526
944411	AF1-106 O2	2.9582
944471	AF1-112 C	0.5974
944671	AF1-132 C O2	0.5950
944691	AF1-134 C O1	0.5086
944701	AF1-135 C	0.6103
944731	AF1-138 C O2	1.8288

Bus #	Bus	MW Impact
944741	AF1-139 C O1	0.7475
944751	AF1-140 C	2.1269
944771	AF1-142 C	6.3867
944781	AF1-143 C	10.5960
944841	AF1-149 C	1.1342
944881	AF1-153 C O2	0.6577
944901	AF1-155 C	0.6568
945071	AF1-172 C	8.2131
945121	AF1-177	0.2881
945161	AF1-181	0.0438
945171	AF1-182	0.2190
945181	AF1-183	0.0562
945331	AF1-198	0.3914
945481	AF1-213 C	4.9361
945491	AF1-214 C	0.6012
945551	AF1-220 C	5.6012
945671	AF1-232 C O2	22.3714
945771	AF1-242 C	0.6568
945901	AF1-255 C	1.2536
946081	AF1-273 C O2	12.8610
946091	AF1-274 C	3.0831
946131	AF1-278	33.2466
946191	AF1-284 C O2	0.6357
946211	AF1-286 C O2	1.1981
946241	AF1-289 C O2	5.2291
946381	AF1-302 C	0.9739
946401	AF1-304 C	2.6500
946421	AF1-306 C	3.3071
946431	AF1-307 C O2	11.6360
946571	AF1-321 C O2	3.5905
DUCKCREEK	DUCKCREEK	2.4412
NEWTON	NEWTON	2.2769
FARMERCITY	FARMERCITY	0.1171
G-007A	G-007A	5.2194
VFT	VFT	14.2610
PRAIRIE	PRAIRIE	5.4011
COFFEEN	COFFEEN	1.1178
EDWARDS	EDWARDS	0.7430
CHEOAH	CHEOAH	0.9795
TILTON	TILTON	1.3451
MADISON	MADISON	0.1855
GIBSON	GIBSON	1.1663
CALDERWOOD	CALDERWOOD	0.9756
BLUEG	BLUEG	3.7376
TRIMBLE	TRIMBLE	1.1998
CATAWBA	CATAWBA	0.6244

12.5.3 Index 2

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
41556354	200519	26REED TAP	PENELEC	200522	26SHADE GP	PENELEC	1	PL_P42_100548	breaker	225.0	99.52	100.66	DC	2.57

Bus #	Bus	MW Impact
200812	26ALY HYDR	0.3760
200852	26WARR RDG	0.1074
235003	AC1-025 E	0.1809
236828	01GRAYMONT	0.4655
290086	Q-036 E	2.0611
293301	N-039 E	3.5812
294515	O38_P22	3.1335
919491	AA2-000	26.2577
930511	AB1-092	0.9641
936421	AD2-055	1.9849
936991	AD2-133 C	0.9275
936992	AD2-133 E	4.2422
939171	AE1-147 C	1.3885
939172	AE1-147 E	0.9257
940201	AE2-001 C	1.3931
940202	AE2-001 E	0.9287
940681	AE2-055 C	1.4624
940682	AE2-055 E	0.9750
941231	AE2-117 C	1.5395
941232	AE2-117 E	1.0263
941241	AE2-118 C	1.5395
941242	AE2-118 E	1.0263
941251	**AE2-119 C (Withdrawn : 12/16/2019)**	**0.7308**
941252	**AE2-119 E (Withdrawn : 12/16/2019)**	**0.4872**
941261	AE2-120 C	1.3956
941262	AE2-120 E	0.9304
941271	AE2-121 C	0.7340
941272	AE2-121 E	0.4901
941321	AE2-126 C	0.6666
941322	AE2-126 E	0.4444
941331	AE2-129 C	0.6690
941332	AE2-129 E	0.4460
941351	AE2-131 C	0.6690
941352	AE2-131 E	0.4460
942031	AE2-215 C	13.2746
942032	AE2-215 E	8.8498
942351	AE2-248 C	1.1468
942352	AE2-248 E	0.7645
942491	AE2-262 C	4.1025
942492	AE2-262 E	2.7569
942501	AE2-263 C	3.8564
942502	AE2-263 E	2.5747

Bus #	Bus	MW Impact
942511	AE2-264 C	5.0630
942512	AE2-264 E	3.3754
943751	AF1-043	3.1560
944001	AF1-068 C O2	1.5407
944002	AF1-068 E O2	0.8667
944311	AF1-099 C	3.3006
944312	AF1-099 E	2.2004
944321	AF1-100 C O2	5.5810
944322	AF1-100 E O2	3.7207
944471	AF1-112 C	1.4257
944472	AF1-112 E	0.9505
944671	AF1-132 C O2	1.4444
944672	AF1-132 E O2	0.9630
944691	AF1-134 C O1	0.2510
944692	AF1-134 E O1	0.2510
944701	AF1-135 C	0.3012
944702	AF1-135 E	0.2008
944731	AF1-138 C O2	1.5395
944732	AF1-138 E O2	1.0263
944771	AF1-142 C	5.2810
944772	AF1-142 E	3.5207
944841	AF1-149 C	1.3958
944842	AF1-149 E	0.9306
944881	AF1-153 C O2	0.3383
944882	AF1-153 E O2	0.2255
944901	AF1-155 C	0.3363
944902	AF1-155 E	0.2242
945071	AF1-172 C	4.9350
945072	AF1-172 E	3.2900
945161	AF1-181	0.0299
945171	AF1-182	0.1497
945181	AF1-183	0.0349
945481	AF1-213 C	2.6018
945482	AF1-213 E	1.7345
945491	AF1-214 C	1.3954
945492	AF1-214 E	0.9302
945551	AF1-220 C	2.5011
945552	AF1-220 E	1.6683
945771	AF1-242 C	0.3363
945772	AF1-242 E	0.2242
946091	AF1-274 C	1.4725
946092	AF1-274 E	0.9817
946311	AF1-295	4.4249
946421	AF1-306 C	1.7269
946422	AF1-306 E	6.9075
LGEE	LGEE	0.0650
WEC	WEC	0.0435
CBM-W2	CBM-W2	0.5897
CBM-W1	CBM-W1	2.0892
TVA	TVA	0.0364
O-066	O-066	1.5456
CHEOAH	CHEOAH	0.0070

Bus #	Bus	MW Impact
CBM-S1	CBM-S1	0.3578
G-007	G-007	0.2735
MEC	MEC	0.1796
CALDERWOOD	CALDERWOOD	0.0050
CATAWBA	CATAWBA	0.0399

12.5.4 Index 3

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
41810386	200513	26LEWISTWN	PENELEC	208005	JUNI BU2	PPL	1	AP-P2-2-WP-230-001T	bus	624.0	110.62	111.85	DC	7.71

Bus #	Bus	MW Impact
200665	26SHAWVL 3	7.7967
200666	26SHAWVL 4	7.6716
200715	26SHAWVL 1	4.9146
200722	26SHAWVL 2	5.0397
200812	26ALY HYDR	1.1301
200852	26WARR RDG	0.3229
200883	Q-053 E	6.8957
200886	26ARWF_N39	0.4288
200894	26K02	9.1554
200898	26AA1-106	1.9579
200905	26Q36	0.2813
200913	26SHAW-D	0.2124
200915	26CHSTN_FL	0.1524
203034	26NA_O38_P22	0.3752
203905	26W1-045 C	0.6853
235003	AC1-025 E	0.6133
236828	01GRAYMONT	1.5971
290086	Q-036 E	8.0600
293301	N-039 E	12.2874
293393	V3-030E	2.7472
294515	O38_P22	10.7514
901242	W1-045 E OP1	1.1181
919491	AA2-000	117.3103
930511	AB1-092	4.3073
936421	AD2-055	8.8679
936471	AD2-062 C O1	5.0032
936472	AD2-062 E O1	2.5063
936991	AD2-133 C	3.6270
936992	AD2-133 E	16.5895
938381	AE1-071 C	13.1348
938382	AE1-071 E	8.0374
939171	AE1-147 C	4.7732
939172	AE1-147 E	3.1822
940201	AE2-001 C	4.7834
940202	AE2-001 E	3.1890
940681	AE2-055 C	4.9397
940682	AE2-055 E	3.2931
941231	AE2-117 C	4.6266
941232	AE2-117 E	3.0844
941241	AE2-118 C	4.6266
941242	AE2-118 E	3.0844

Bus #	Bus	MW Impact
941251	AE2-119 C (Withdrawn : 12/16/2019)	3.0438
941252	AE2-119 E (Withdrawn : 12/16/2019)	2.0292
941261	AE2-120 C	4.7891
941262	AE2-120 E	3.1927
941271	AE2-121 C	2.5283
941272	AE2-121 E	1.6882
941321	AE2-126 C	2.1067
941322	AE2-126 E	1.4045
941331	AE2-129 C	2.7008
941332	AE2-129 E	1.8006
941351	AE2-131 C	2.7008
941352	AE2-131 E	1.8006
941421	AE2-139 C	5.5361
941422	AE2-139 E	3.6907
942031	AE2-215 C	14.8871
942032	AE2-215 E	9.9247
942121	AE2-224 C	7.2840
942122	AE2-224 E	4.8560
942351	AE2-248 C	3.8996
942352	AE2-248 E	2.5997
942491	AE2-262 C	17.7280
942492	AE2-262 E	11.9132
942501	AE2-263 C	16.6643
942502	AE2-263 E	11.1261
942511	AE2-264 C	15.1296
942512	AE2-264 E	10.0864
943751	AF1-043	26.6038
944001	AF1-068 C O2	5.2259
944002	AF1-068 E O2	2.9395
944181	AF1-086 C O2	2.8019
944182	AF1-086 E O2	12.1896
944311	AF1-099 C	26.9111
944312	AF1-099 E	17.9407
944321	AF1-100 C O2	48.1185
944322	AF1-100 E O2	32.0790
944471	AF1-112 C	4.8571
944472	AF1-112 E	3.2381
944671	AF1-132 C O2	4.8992
944672	AF1-132 E O2	3.2662
944691	AF1-134 C O1	1.8754
944692	AF1-134 E O1	1.8754
944701	AF1-135 C	2.2505
944702	AF1-135 E	1.5003
944731	AF1-138 C O2	4.6266
944732	AF1-138 E O2	3.0844
944751	AF1-140 C	1.1435
944752	AF1-140 E	0.7623
944771	AF1-142 C	43.0578
944772	AF1-142 E	28.7052
944841	AF1-149 C	4.7897
944842	AF1-149 E	3.1931
945071	AF1-172 C	42.2760

Bus #	Bus	MW Impact
945072	AF1-172 E	28.1840
945161	AF1-181	0.2565
945171	AF1-182	1.2856
945181	AF1-183	0.2886
945481	AF1-213 C	19.9893
945482	AF1-213 E	13.3262
945491	AF1-214 C	4.7887
945492	AF1-214 E	3.1925
945551	AF1-220 C	11.0811
945552	AF1-220 E	7.3914
945901	AF1-255 C	0.2695
945902	AF1-255 E	0.3722
946091	AF1-274 C	8.1585
946092	AF1-274 E	5.4390
946241	AF1-289 C O2	1.2500
946242	AF1-289 E O2	0.8333
946311	AF1-295	4.9624
LGEE	LGEE	0.5465
CPLE	CPLE	0.3744
WEC	WEC	0.3115
CBM-W2	CBM-W2	7.4120
CBM-W1	CBM-W1	12.8478
TVA	TVA	1.1872
O-066	O-066	18.8832
CBM-S2	CBM-S2	3.7743
CBM-S1	CBM-S1	7.3954
G-007	G-007	2.9432
MEC	MEC	1.5207

Short Circuit

12.6 Short Circuit

The following Breakers are overdutied:

None

Affected Systems

13 Affected Systems

13.1 LG&E

LG&E Impacts to be determined during later study phases (as applicable).

13.2 MISO

MISO Impacts to be determined during later study phases (as applicable).

13.3 TVA

TVA Impacts to be determined during later study phases (as applicable).

13.4 Duke Energy Progress

Duke Energy Progress Impacts to be determined during later study phases (as applicable).

13.5 NYISO

NYISO Impacts to be determined during later study phases (as applicable).

Attachment 1

System Configuration