Generation Interconnection

System Impact Study Report

for

Queue Project AF2-439

ROXBURY-CARLISLE 115 KV

26 MW Capacity / 50 MW Energy

February 2021

Table of Contents

1 Introduction

This System Impact Study has been prepared in accordance with the PJM Open Access Transmission Tariff, 205, as well as the System Impact Study Agreement between the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is Mid-Atlantic Interstate Transmission, LLC (MAIT, PENELEC zone).

2 Preface

The intent of the System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

In some instances an Interconnection Customer may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection or merchant transmission upgrade, may also contribute to the need for the same network reinforcement. 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 System Impact Study is performed.

The System Impact 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.

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.

3 General

The Interconnection Customer (IC), has proposed a Solar generating facility located in Undetermined County, Undetermined. The installed facilities will have a total capability of 50 MW with 26 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is December 31, 2023. This study does not imply a TO commitment to this in-service date.

Queue Number	**AF2-439**
Project Name	ROXBURY-CARLISLE 115 KV
State	Pennsylvania
County	Franklin
Transmission Owner	MAIT – PENELEC Zone
MFO	50
MWE	50
MWC	26
Fuel	Solar
Basecase Study Year	2023

Any new service customers who can feasibly be commercially operable prior to June 1st of the basecase study year are required to request interim deliverability analysis.

4 Point of Interconnection

4.1 Primary Point of Interconnection

The interconnection of the project at the Primary POI will be accomplished by constructing a new 115 kV three (3) breaker ring bus substation and looping the Carlisle Pike - Roxbury 115 kV line into the new station. The new substation will be located approximately 2.59 miles from Roxbury Substation. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection switching station and the associated facilities. The IC will also be responsible for the rough grade of the property and an access road to the proposed three-breaker ring bus site. The project will also require upgrades at Carlisle Pike Substation, Gardners Substation, and Roxbury Substation.

Attachment 1 shows a one-line diagram of the proposed primary interconnection facilities for the AF2-439 generation project to connect to the FirstEnergy ("FE") Transmission System. The 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 interconnection facilities.

5 Cost Summary

The AF2-439 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	$8,315,800
Total System Network Upgrade Costs (Summer Peak)	$18,212,734
Total System Network Upgrade Costs(Light Load)	$0
Total System Network Upgrade Costs (TO Identified)	$0
Total Costs	**$26,528,534**

*As your project progresses through the study process and other projects modify their request or withdraw, then your cost allocation could change.

This cost excludes a Federal Income Tax Gross Up charges. This tax may or may not be charged based on whether this project meets the eligibility requirements of IRS Notice 88-129. If at a future date it is determined that the Federal Income Tax Gross charge is required, the Transmission Owner shall be reimbursed by the Interconnection Customer for such taxes.

Note 1: PJM Open Access Transmission Tariff (OATT) section 217.3A outline cost allocation rules. The rules are further clarified in PJM Manual 14A Attachment B. The allocation of costs for a network upgrade will start with the first Queue project to cause the need for the upgrade. Later queue projects will receive cost

allocation contingent on their contribution to the violation and are allocated to the queues that have not closed less than 5 years following the execution of the first Interconnection Service Agreement which identifies the need for this upgrade.

Note 2: For customers with System Reinforcements listed: If your present cost allocation to a System Reinforcement indicates $0, then please be aware that as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, reducing in size, etc, the cost responsibilities can change and a cost allocation may be assigned to your project. In addition, although your present cost allocation to a System Reinforcement is presently $0, your project may need this system reinforcement completed to be deliverable to the PJM system. If your project comes into service prior to completion of the system reinforcement, an interim deliverability study for your project will be required.

6 Transmission Owner Scope of Work

The interconnection of the project at the Primary POI will be accomplished by constructing a new 115 kV three (3) breaker ring bus substation and looping the Carlisle Pike - Roxbury 115 kV line into the new station. The new substation will be located approximately 2.59 miles from Roxbury Substation. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection switching station and the associated facilities. The IC will also be responsible for the rough grade of the property and an access road to the proposed three-breaker ring bus site. The project will also require upgrades at Carlisle Pike Substation, Gardners Substation, and Roxbury Substation.

The total physical interconnection costs is given in the table below:

Description	**Total Cost**
Construct a new three breaker 115 kV ring bus interconnection substation.	$6,268,400
Loop the Carlisle Pike – Roxbury 115 kV Line into the new interconnection substation.	$919,600
Upgrade relaying at Roxbury Substation	$333,100
Upgrade relaying at Carlisle Pike Substation	$350,600
Upgrade relaying at Gardners Substation	$411,500
Review drawings, nameplated, and relay settings at IC's substation.	$32,600
Total Physical Interconnection Costs	$8,315,800

7 Schedule

Based on the scope of work for the interconnection facilities, it is expected to take a minimum of **33 months** (populate with TO schedule) after the signing of an Interconnection Construction Service Agreement and construction kickoff call to complete the installation of the physical connection work. 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 interconnection work, and that all system outages will be allowed when requested.

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

8 Transmission Owner Analysis

8.1 Power Flow Analysis

FE performed an analysis of its underlying transmission <100 kV system. The AF2-439 project did not contribute to any overloads on the FE Transmission <100 kV System.

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.

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 115 kV circuit breaker to protect the AF2-439 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 AF2-439 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 Transmission System.

9.3 Power Factor Requirements

The IC shall design its non-synchronous 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.

10.2 Meteorological Data Reporting Requirements

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

- Back Panel temperature (Fahrenheit) - (Required for plants with Maximum Facility Output of 3 MW or higher)
- Irradiance (Watts/meter2) - (Required for plants with Maximum Facility Output of 3 MW or higher)
- Ambient air temperature (Fahrenheit) - (Accepted, not required)
- Wind speed (meters/second) - (Accepted, not required)

- Wind direction (decimal degrees from true north) - (Accepted, not required)

10.3 Interconnected Transmission Owner Requirements

The IC will be required to comply with all Interconnected Transmission Owner's revenue metering requirements for generation interconnection customers located at the following link:

http://www.pjm.com/planning/design-engineering/to-tech-standards/

11 Summer Peak Analysis

The Queue Project AF2-439 was evaluated as a 50.0 MW (Capacity 26.0 MW) injection tapping the Roxbury to Carlisle 115 kV line in the PENELEC area. Project AF2-439 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF2-439 was studied with a commercial probability of 100.0 %. Potential network impacts were as follows:

11.1 Generation Deliverability

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

None

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
160667838	235136	01ANTRIM	138.0	AP	235503	01REID	138.0	AP	1	AP-P2-3-PE-138-089-A	breaker	332.0	96.91	100.29	AC	11.54

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
160667738	235189	01GUILFD	138.0	AP	235136	01ANTRIM	138.0	AP	1	AP-P2-3-PE-138-089-A	breaker	306.0	110.75	114.42	AC	11.54
101484078	961480	AF2-439 TAP	115.0	PENELEC	200504	26CARLISLE	115.0	PENELEC	1	ME_P4-500-002F	breaker	159.0	100.25	109.4	AC	15.05

11.4 Steady-State Voltage Requirements

To be determined

11.5 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
99798971	200513	26LEWISTWN	230.0	PENELEC	208005	JUNI BU2	230.0	PPL	1	Base Case	operation	493.0	160.58	161.78	AC	6.12
160668036	235136	01ANTRIM	138.0	AP	235503	01REID	138.0	AP	1	AP-P1-2-WP-138-112-A	operation	332.0	96.84	100.23	AC	11.56
100866914	235187	01GRANDP	138.0	AP	235180	01FAYETT	138.0	AP	1	AP-P1-2-WP-138-109	operation	228.0	98.39	104.15	AC	13.26
160667971	235189	01GUILFD	138.0	AP	235136	01ANTRIM	138.0	AP	1	AP-P1-2-WP-138-112-A	operation	306.0	110.68	114.36	AC	11.56
100866878	936470	AD2-062 TAP	138.0	AP	235188	01GREENE	138.0	AP	1	TS P1-2_#1	operation	206.0	96.53	107.31	AC	22.37
100866882	936470	AD2-062 TAP	138.0	AP	235188	01GREENE	138.0	AP	1	Base Case	operation	164.0	90.79	104.36	AC	22.64
101484439	961480	AF2-439 TAP	115.0	PENELEC	200504	26CARLISLE	115.0	PENELEC	1	235188 01GREENE 138 936470 AD2-062 TAP 138 1	operation	159.0	92.94	108.98	AC	26.45
101484441	961480	AF2-439 TAP	115.0	PENELEC	200504	26CARLISLE	115.0	PENELEC	1	Base Case	operation	133.0	96.04	107.04	AC	15.22

11.6 System Reinforcements

<table>
<tr><th>ID</th><th>Idx</th><th>Facility</th><th>Upgrade Description</th><th>Cost</th><th>Cost Allocated to AF2-439</th><th>Upgrade Number</th></tr>
<tr>
<td>101484078</td>
<td>3</td>
<td>AF2-439 TAP 115.0 kV - 26CARLISLE 115.0 kV Ckt 1</td>
<td><u>PENELEC</u>
ProjectId : n7119.1 (PN-AG1-F-0020A)
Description : Upgrade relaying at Carlisle Pike
Type : FAC
Total Cost : $800,000
Time Estimate : 12.0 Months
Ratings : 133.0/160.0/180.0
<table>
<tr><th>Queue</th><th>MW</th><th>Cost %</th><th>Cost $</th></tr>
<tr><td>AF2-268</td><td>0.12</td><td>0.79%</td><td>$6,328</td></tr>
<tr><td>AF2-439</td><td>15.05</td><td>99.21%</td><td>$793,672</td></tr>
</table>
ProjectId : n7119.2 (PN-AG1-F-0020B)
Description : Reconductor 6.82 miles of line. Replace line drops at Carlisle Pike substation.
Type : FAC
Total Cost : $16,840,000
Time Estimate : 42.0 Months
Ratings : 176.0/199.0/219.0
<table>
<tr><th>Queue</th><th>MW</th><th>Cost %</th><th>Cost $</th></tr>
<tr><td>AF2-439</td><td>15.05</td><td>100.00%</td><td>$16,840,000</td></tr>
</table>
</td>
<td>$17,640,000</td>
<td>$17,633,672</td>
<td>n7119.1, n7119.2</td>
</tr>
<tr>
<td>160667838</td>
<td>1</td>
<td>01ANTRIM 138.0 kV - 01REID 138.0 kV Ckt 1</td>
<td><u>APS</u>
ProjectId : n7117 (PE-AF2-S-0025)
Description : Replace 1200 A wave trap at Reid.
Type : FAC
Total Cost : $130,000
Time Estimate : 12.0 Months
Ratings : 295.0/358.0/358.0
<table>
<tr><th>Queue</th><th>MW</th><th>Cost %</th><th>Cost $</th></tr>
<tr><td>AF2-439</td><td>11.54</td><td>100.00%</td><td>$130,000</td></tr>
</table>
</td>
<td>$130,000</td>
<td>$130,000</td>
<td>n7117</td>
</tr>
</table>

<table>
<tr><th>ID</th><th>Idx</th><th>Facility</th><th>Upgrade Description</th><th>Cost</th><th>Cost Allocated to AF2-439</th><th>Upgrade Number</th></tr>
<tr><td>160667738</td><td>2</td><td>01GUILFD 138.0 kV - 01ANTRIM 138.0 kV Ckt 1</td><td><u>APS</u>
ProjectId : n7118.1 (WP-AG1-F-0020A)
Description : Replace RT (KC-4 & ITH) for breaker failure & fault detector at Guilford substation.
Type : FAC
Total Cost : $781,515
Time Estimate : 12.0 Months
Ratings : 293.0/343.0/343.0
<table><tr><th>Queue</th><th>MW</th><th>Cost %</th><th>Cost $</th></tr><tr><td>AF2-117</td><td>36.29</td><td>75.87%</td><td>$592,958</td></tr><tr><td>AF2-439</td><td>11.54</td><td>24.13%</td><td>$188,557</td></tr></table>
ProjectId : n7118.2 (WP-AG1-F-0020B)
Description : Replace 1200 A WT at Guilford substation.
Type : FAC
Total Cost : $130,252
Time Estimate : 12.0 Months
Ratings : 294.0/350.0/350.0
<table><tr><th>Queue</th><th>MW</th><th>Cost %</th><th>Cost $</th></tr><tr><td>AF2-439</td><td>11.54</td><td>100.00%</td><td>$130,252</td></tr></table>
ProjectId : n7118.3 (WP-AG1-F-0020C)
Description : Replace 954 ACSR 45/7 SCCIR (disconnect leads) at Guilford substation.
Type : FAC
Total Cost : $130,252
Time Estimate : 12.0 Months
Ratings : 299.0/358.0/358.0
<table><tr><th>Queue</th><th>MW</th><th>Cost %</th><th>Cost $</th></tr><tr><td>AF2-439</td><td>11.54</td><td>100.00%</td><td>$130,252</td></tr></table></td><td>$1,042,020</td><td>$449,062</td><td>n7118.1, n7118.2, n7118.3</td></tr>
<tr><td></td><td></td><td></td><td>TOTAL COST</td><td>$18,812,000</td><td>$18,212,734</td><td></td></tr>
</table>

Note : For customers with System Reinforcements listed: If your present cost allocation to a System Reinforcement indicates $0, then please be aware that as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, reducing in size, etc, the cost responsibilities can change and a cost allocation may be assigned to your project. In addition, although your present cost allocation to a System Reinforcement is presently $0, your project may need this system reinforcement completed to be deliverable to the PJM system. If your project comes into service prior to completion of the system reinforcement, an interim deliverability study for your project will be required.

11.7 Flow Gate Details

The following indices contain additional information about each facility presented in the body of the report. For each index, a description of the flowgate and its contingency was included for convenience. The intent of the indices is to provide more details on which projects/generators have contributions to the flowgate in question. All New Service Queue Requests, through the end of the Queue under study, that are contributors to a flowgate will be listed in the indices. Please note that there may be contributors that are subsequently queued after the queue under study that are not listed in the indices. Although this information is not used "as is" for cost allocation purposes, it can be used to gage the impact of other projects/generators. It should be noted the project/generator MW contributions presented in the body of the report are Full MW Impact contributions which are also noted in the indices column named "Full MW Impact", whereas the loading percentages reported in the body of the report, take into consideration the PJM Generator Deliverability Test rules such as commercial probability of each project as well as the ramping impact of "Adder" contributions. The MW Impact found and used in the analysis is shown in the indices column named "Gendeliv MW Impact".

11.7.1 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
160667838	235136	01ANTRIM	AP	235503	01REID	AP	1	AP-P2-3-PE-138-089-A	breaker	332.0	96.91	100.29	AC	11.54

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
200870	26C_T85_W218	0.1809	50/50	0.1809
203905	26W1-045 C	1.1946	50/50	1.1946
235040	01AB1-127	3.1247	50/50	3.1247
235041	AB1-128 C	3.1247	50/50	3.1247
235723	01GUILF1	4.0711	50/50	4.0711
235724	01GUILF2	4.0711	50/50	4.0711
237329	01CHBRG_I12	1.9311	50/50	1.9311
237577	01ROUTE 16	0.4891	50/50	0.4891
901242	W1-045 E OP1	1.9491	50/50	1.9491
930822	AB1-127 E	5.0981	50/50	5.0981
930832	AB1-128 E	5.0981	50/50	5.0981
934361	AD1-060 C	1.1061	50/50	1.1061
934362	AD1-060 E	1.8047	50/50	1.8047
934371	AD1-061 C	2.9528	50/50	2.9528
934372	AD1-061 E	4.8176	50/50	4.8176
936061	AD2-009 C	24.9384	50/50	24.9384
936062	AD2-009 E	11.3545	50/50	11.3545
936471	AD2-062 C O1	16.2934	50/50	16.2934
936472	AD2-062 E O1	8.1619	50/50	8.1619
936871	AD2-110	6.6073	50/50	6.6073
938381	AE1-071 C	12.9609	50/50	12.9609
938382	AE1-071 E	7.9310	50/50	7.9310
938751	AE1-101 C	53.4650	50/50	53.4650
938752	AE1-101 E	26.3335	50/50	26.3335
939031	AE1-132 C O1	26.4420	50/50	26.4420
939032	AE1-132 E O1	17.6280	50/50	17.6280
939591	AE1-188 C	4.0082	50/50	4.0082
939592	AE1-188 E	2.3540	50/50	2.3540
940671	**AE2-054 C (Suspended)**	**4.5446**	**50/50**	**4.5446**
940672	**AE2-054 E (Suspended)**	**3.0298**	**50/50**	**3.0298**
945011	AF1-166 C	3.9450	50/50	3.9450
945012	AF1-166 E	2.6300	50/50	2.6300
945441	AF1-209 C O1	3.9204	50/50	3.9204
945442	AF1-209 E O1	2.6136	50/50	2.6136
945591	AF1-224 C	2.5131	50/50	2.5131
945592	AF1-224 E	1.2724	50/50	1.2724
945601	AF1-225 C O1	0.6500	Adder	0.76
945602	AF1-225 E O1	0.8977	Adder	1.06
945891	AF1-254 C O1	0.8940	Adder	1.05
945892	AF1-254 E O1	0.5960	Adder	0.7
958221	AF2-116 C	6.8957	50/50	6.8957

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
958222	AF2-116 E	3.4737	50/50	3.4737
958231	AF2-117 C	24.1965	50/50	24.1965
958232	AF2-117 E	12.0957	50/50	12.0957
958551	AF2-146 C	2.0102	50/50	2.0102
958552	AF2-146 E	1.3402	50/50	1.3402
958571	AF2-148 C	1.3569	50/50	1.3569
958572	AF2-148 E	0.9046	50/50	0.9046
958871	AF2-178	0.9082	50/50	0.9082
958881	AF2-179	2.3846	50/50	2.3846
958891	AF2-180	2.3846	50/50	2.3846
958931	AF2-184	2.2534	50/50	2.2534
958941	AF2-185	0.8538	50/50	0.8538
959241	AF2-215 C	1.2089	50/50	1.2089
959242	AF2-215 E	0.8060	50/50	0.8060
959381	AF2-229 C	2.5383	50/50	2.5383
959382	AF2-229 E	2.1191	50/50	2.1191
959842	AF2-275 E	1.2334	50/50	1.2334
959852	AF2-276 E	1.2334	50/50	1.2334
961481	AF2-439 C	6.0003	50/50	6.0003
961482	AF2-439 E	5.5387	50/50	5.5387
NEWTON	NEWTON	0.3331	Confirmed LTF	0.3331
FARMERCITY	FARMERCITY	0.0176	Confirmed LTF	0.0176
G-007A	G-007A	1.4049	Confirmed LTF	1.4049
VFT	VFT	3.8506	Confirmed LTF	3.8506
GIBSON	GIBSON	0.1682	Confirmed LTF	0.1682
PRAIRIE	PRAIRIE	0.8188	Confirmed LTF	0.8188
COFFEEN	COFFEEN	0.0618	Confirmed LTF	0.0618
CHEOAH	CHEOAH	0.1792	Confirmed LTF	0.1792
EDWARDS	EDWARDS	0.1057	Confirmed LTF	0.1057
TILTON	TILTON	0.1915	Confirmed LTF	0.1915
CALDERWOOD	CALDERWOOD	0.1774	Confirmed LTF	0.1774
BLUEG	BLUEG	0.5364	Confirmed LTF	0.5364
TRIMBLE	TRIMBLE	0.1720	Confirmed LTF	0.1720
CATAWBA	CATAWBA	0.1382	Confirmed LTF	0.1382

11.7.2 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
160667738	235189	01GUILFD	AP	235136	01ANTRIM	AP	1	AP-P2-3-PE-138-089-A	breaker	306.0	110.75	114.42	AC	11.54

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
200870	26C_T85_W218	0.1809	50/50	0.1809
203905	26W1-045 C	1.1946	50/50	1.1946
235040	01AB1-127	3.1247	50/50	3.1247
235041	AB1-128 C	3.1247	50/50	3.1247
235723	01GUILF1	4.0711	50/50	4.0711
235724	01GUILF2	4.0711	50/50	4.0711
237329	01CHBRG_I12	1.9311	50/50	1.9311
237577	01ROUTE 16	0.4891	50/50	0.4891
901242	W1-045 E OP1	1.9491	50/50	1.9491
930822	AB1-127 E	5.0981	50/50	5.0981
930832	AB1-128 E	5.0981	50/50	5.0981
934361	AD1-060 C	1.1061	50/50	1.1061
934362	AD1-060 E	1.8047	50/50	1.8047
934371	AD1-061 C	2.9528	50/50	2.9528
934372	AD1-061 E	4.8176	50/50	4.8176
936061	AD2-009 C	24.9384	50/50	24.9384
936062	AD2-009 E	11.3545	50/50	11.3545
936471	AD2-062 C O1	16.2934	50/50	16.2934
936472	AD2-062 E O1	8.1619	50/50	8.1619
936871	AD2-110	6.6073	50/50	6.6073
938381	AE1-071 C	12.9609	50/50	12.9609
938382	AE1-071 E	7.9310	50/50	7.9310
938751	AE1-101 C	53.4650	50/50	53.4650
938752	AE1-101 E	26.3335	50/50	26.3335
939031	AE1-132 C O1	26.4420	50/50	26.4420
939032	AE1-132 E O1	17.6280	50/50	17.6280
939591	AE1-188 C	4.0082	50/50	4.0082
939592	AE1-188 E	2.3540	50/50	2.3540
940671	**AE2-054 C (Suspended)**	**4.5446**	**50/50**	**4.5446**
940672	**AE2-054 E (Suspended)**	**3.0298**	**50/50**	**3.0298**
945011	AF1-166 C	3.9450	50/50	3.9450
945012	AF1-166 E	2.6300	50/50	2.6300
945441	AF1-209 C O1	3.9204	50/50	3.9204
945442	AF1-209 E O1	2.6136	50/50	2.6136
945591	AF1-224 C	2.5131	50/50	2.5131
945592	AF1-224 E	1.2724	50/50	1.2724
945601	AF1-225 C O1	0.6500	Adder	0.76
945602	AF1-225 E O1	0.8977	Adder	1.06
945891	AF1-254 C O1	0.8940	Adder	1.05
945892	AF1-254 E O1	0.5960	Adder	0.7
958221	AF2-116 C	6.8957	50/50	6.8957

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
958222	AF2-116 E	3.4737	50/50	3.4737
958231	AF2-117 C	24.1965	50/50	24.1965
958232	AF2-117 E	12.0957	50/50	12.0957
958551	AF2-146 C	2.0102	50/50	2.0102
958552	AF2-146 E	1.3402	50/50	1.3402
958571	AF2-148 C	1.3569	50/50	1.3569
958572	AF2-148 E	0.9046	50/50	0.9046
958871	AF2-178	0.9082	50/50	0.9082
958881	AF2-179	2.3846	50/50	2.3846
958891	AF2-180	2.3846	50/50	2.3846
958931	AF2-184	2.2534	50/50	2.2534
958941	AF2-185	0.8538	50/50	0.8538
959241	AF2-215 C	1.2089	50/50	1.2089
959242	AF2-215 E	0.8060	50/50	0.8060
959381	AF2-229 C	2.5383	50/50	2.5383
959382	AF2-229 E	2.1191	50/50	2.1191
959842	AF2-275 E	1.2334	50/50	1.2334
959852	AF2-276 E	1.2334	50/50	1.2334
961481	AF2-439 C	6.0003	50/50	6.0003
961482	AF2-439 E	5.5387	50/50	5.5387
NEWTON	NEWTON	0.3331	Confirmed LTF	0.3331
FARMERCITY	FARMERCITY	0.0176	Confirmed LTF	0.0176
G-007A	G-007A	1.4049	Confirmed LTF	1.4049
VFT	VFT	3.8506	Confirmed LTF	3.8506
GIBSON	GIBSON	0.1682	Confirmed LTF	0.1682
PRAIRIE	PRAIRIE	0.8188	Confirmed LTF	0.8188
COFFEEN	COFFEEN	0.0618	Confirmed LTF	0.0618
CHEOAH	CHEOAH	0.1792	Confirmed LTF	0.1792
EDWARDS	EDWARDS	0.1057	Confirmed LTF	0.1057
TILTON	TILTON	0.1915	Confirmed LTF	0.1915
CALDERWOOD	CALDERWOOD	0.1774	Confirmed LTF	0.1774
BLUEG	BLUEG	0.5364	Confirmed LTF	0.5364
TRIMBLE	TRIMBLE	0.1720	Confirmed LTF	0.1720
CATAWBA	CATAWBA	0.1382	Confirmed LTF	0.1382

11.7.3 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
101484078	961480	AF2-439 TAP	PENELEC	200504	26CARLISLE	PENELEC	1	ME_P4-500-002F	breaker	159.0	100.25	109.4	AC	15.05

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
203905	26W1-045 C	0.2528	Adder	0.3
235040	01AB1-127	0.4378	Adder	0.52
235041	AB1-128 C	0.4378	Adder	0.52
237329	01CHBRG_I12	0.5344	50/50	0.5344
901242	W1-045 E OP1	0.4124	Adder	0.49
930822	AB1-127 E	0.7143	Adder	0.84
930832	AB1-128 E	0.7143	Adder	0.84
933971	**AD1-020 C (Suspended)**	**-3.5701**	**Adder**	**-4.2**
933973	**AD1-020 BAT (Suspended)**	**1.5672**	**Merchant Transmission**	**1.5672**
934371	AD1-061 C	0.3610	Adder	0.42
934372	AD1-061 E	0.5891	Adder	0.69
936061	AD2-009 C	2.4335	Adder	2.86
936062	AD2-009 E	1.1080	Adder	1.3
936471	AD2-062 C O1	10.4266	50/50	10.4266
936472	AD2-062 E O1	5.2231	50/50	5.2231
936871	AD2-110	0.7994	Adder	0.94
938381	AE1-071 C	13.1801	50/50	13.1801
938382	AE1-071 E	8.0651	50/50	8.0651
938751	AE1-101 C	5.7619	Adder	6.78
938752	AE1-101 E	2.8380	Adder	3.34
939031	AE1-132 C O1	2.5802	Adder	3.04
939032	AE1-132 E O1	1.7201	Adder	2.02
939591	AE1-188 C	0.6699	Adder	0.79
939592	AE1-188 E	0.3934	Adder	0.46
940671	**AE2-054 C (Suspended)**	**0.5666**	**Adder**	**0.67**
940672	**AE2-054 E (Suspended)**	**0.3777**	**Adder**	**0.44**
945011	AF1-166 C	0.5529	Adder	0.65
945012	AF1-166 E	0.3686	Adder	0.43
945441	AF1-209 C O1	0.5495	Adder	0.65
945442	AF1-209 E O1	0.3663	Adder	0.43
945591	AF1-224 C	0.4200	Adder	0.49
945592	AF1-224 E	0.2127	Adder	0.25
958071	AF2-101 C	-0.2707	Adder	-0.32
958221	AF2-116 C	0.6729	Adder	0.79
958222	AF2-116 E	0.3390	Adder	0.4
958231	AF2-117 C	2.1541	Adder	2.53
958232	AF2-117 E	1.0768	Adder	1.27
958551	AF2-146 C	2.0183	50/50	2.0183
958552	AF2-146 E	1.3455	50/50	1.3455
958571	AF2-148 C	1.3623	50/50	1.3623
958572	AF2-148 E	0.9082	50/50	0.9082

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
958871	AF2-178	0.1922	Adder	0.23
958881	AF2-179	0.3341	Adder	0.39
958891	AF2-180	0.3341	Adder	0.39
958931	AF2-184	0.2755	Adder	0.32
959223	AF2-213 BAT	4.6869	Merchant Transmission	4.6869
959241	AF2-215 C	0.1549	Adder	0.18
959242	AF2-215 E	0.1033	Adder	0.12
959381	AF2-229 C	0.5371	Adder	0.63
959382	AF2-229 E	0.4484	Adder	0.53
959773	AF2-268 BAT	0.1178	Merchant Transmission	0.1178
959842	AF2-275 E	0.1728	Adder	0.2
959852	AF2-276 E	0.1728	Adder	0.2
961481	AF2-439 C	7.8239	50/50	7.8239
961482	AF2-439 E	7.2221	50/50	7.2221
WEC	WEC	0.1191	Confirmed LTF	0.1191
LGEE	LGEE	0.2156	Confirmed LTF	0.2156
CPLE	CPLE	0.2335	Confirmed LTF	0.2335
CBM-W2	CBM-W2	3.0631	Confirmed LTF	3.0631
NY	NY	0.2649	Confirmed LTF	0.2649
TVA	TVA	0.5208	Confirmed LTF	0.5208
O-066	O-066	5.6986	Confirmed LTF	5.6986
CBM-S2	CBM-S2	2.0750	Confirmed LTF	2.0750
CBM-S1	CBM-S1	3.1780	Confirmed LTF	3.1780
G-007	G-007	0.8861	Confirmed LTF	0.8861
MEC	MEC	0.5991	Confirmed LTF	0.5991
CBM-W1	CBM-W1	4.7288	Confirmed LTF	4.7288

11.8 Queue Dependencies

The Queue Projects below are listed in one or more indices for the overloads identified in your report. These projects contribute to the loading of the overloaded facilities identified in your report. The percent overload of a facility and cost allocation you may have towards a particular reinforcement could vary depending on the action of these earlier projects. The status of each project at the time of the analysis is presented in the table. This list may change as earlier projects withdraw or modify their requests.

Queue Number	Project Name	Status
AB1-127	St. Thomas-Guilford 34.5kV	In Service
AB1-128	St. Thomas-Mercersburg 34.5kV	In Service
AD1-020	Hunterstown-Lincoln 115 kV	Suspended
AD1-060	Mercersburg-Milnor 34 kV	In Service
AD1-061	McConnelsburg-Mercersburg 34 kV	Active
AD2-009	McConnellsburg 138 kV	Active
AD2-062	Roxbury-Greene 138 kV	Active
AD2-110	Guilford 138kV	Partially in Service - Under Construction
AE1-071	Shade Gap-Roxbury 115 kV	Active
AE1-101	McConnellsburg-Texas Eastern 138 kV	Active
AE1-132	McConnellsburg 138 kV	Active
AE1-188	Fayetteville 34.5 kV	Engineering and Procurement
AE2-054	Warfordsburg 34 kV	Suspended
AF1-166	Target-Chambers No.5 34.5 kV	Engineering and Procurement
AF1-209	Guilford 34.5 kV	Active
AF1-224	Fayetteville 34.5 kV	Engineering and Procurement
AF1-225	Milnor 34.5 kV	Active
AF1-254	Milnor-Huyetts 34.5 kV	Active
AF2-101	Allen 13.2 kV	Engineering and Procurement
AF2-116	McConnellsburg 138 kV	Active
AF2-117	Warfordsburg-McConnellsburg 138 kV	Active
AF2-146	Hill Valley-Valley REC 46 kV	Active
AF2-148	Shade Gap-Three Springs KTS 23 kV	Active
AF2-178	Roxbury 23 kV II	In Service
AF2-179	St. Thomas-Mercersburg 34.5 kV II	In Service
AF2-180	St. Thomas-Guilford 34.5 kV II	In Service
AF2-184	McConnelsburg-Mercersburg 34 kV II	Active
AF2-185	Mercersburg-Minor 34 kV II	In Service
AF2-213	Zions View-Smith Street 115 kV	Active
AF2-215	Saint Thomas-LeMasters Junction 34.5 kV	Engineering and Procurement
AF2-229	Roxbury 23 kV	Active
AF2-268	Orrtanna 13.2 kV	Engineering and Procurement
AF2-275	Guilford 12.47 kV	Active
AF2-276	Guilford 12.47 kV	Active
AF2-439	Roxbury-Carlisle 115 kV	Active
W1-045	Roxbury 23 kV	In Service

11.9 Contingency Descriptions

Contingency Name	Contingency Definition
AP-P2-3-PE-138-089-A	CONTINGENCY 'AP-P2-3-PE-138-089-A' /* 293 DISCONNECT BRANCH FROM BUS 235453 TO BUS 235490 CKT 1 /* 01CHERYR 138 01MORGAN 138 DISCONNECT BRANCH FROM BUS 958230 TO BUS 235267 CKT 1 /* AF2-117 TAP 138 01WARFOR 138 DISCONNECT BRANCH FROM BUS 235267 TO BUS 235453 CKT 1 /* 01WARFOR 138 01CHERYR 138 DISCONNECT BRANCH FROM BUS 236686 TO BUS 235267 CKT 2 /* 01WARFORDS 35 01WARFOR 138 END
ME_P4-500-002F	CONTINGENCY 'ME_P4-500-002F' /* HUNTERSTOWN 500 KV STUCK CB - CB500692 DISCONNECT BRANCH FROM BUS 200026 TO BUS 270070 CKT 1 /* HUNTERTN 500 CONEM-GH 500 / PJM FIXED DISCONNECT BRANCH FROM BUS 200026 TO BUS 204501 CKT 1 /* HUNTERTN 500 27HUNTRSTN 230 END
235188 01GREENE 138 936470 AD2-062 TAP 138 1	CONTINGENCY '235188 01GREENE 138 936470 AD2-062 TAP 138 1' OPEN BRANCH FROM BUS 235188 TO BUS 936470 CKT 1 END
AP-P1-2-WP-138-109	CONTINGENCY 'AP-P1-2-WP-138-109' /* GUILFORD - REID 138KV DISCONNECT BRANCH FROM BUS 235189 TO BUS 235136 CKT 1 /* 01GUILFD 138 01ANTRIM 138 DISCONNECT BRANCH FROM BUS 235136 TO BUS 235503 CKT 1 /* 01ANTRIM 138 01REID 138 REMOVE LOAD 1 FROM BUS 235136 /* 01ANTRIM 138 END
AP-P1-2-WP-138-112-A	CONTINGENCY 'AP-P1-2-WP-138-112-A' /* CHERRY RUN - AF2-117 TAP 138KV DISCONNECT BRANCH FROM BUS 958230 TO BUS 235267 CKT 1 /* AF2-117 TAP 138 01WARFOR 138 DISCONNECT BRANCH FROM BUS 235267 TO BUS 235453 CKT 1 /* 01WARFOR 138 01CHERYR 138 DISCONNECT BRANCH FROM BUS 235267 TO BUS 236686 CKT 2 /* 01WARFOR 138 01WARFORDS 35 END
Base Case	

Contingency Name	Contingency Definition
TS P1-2_#1	CONTINGENCY 'TS P1-2_#1' OPEN BRANCH FROM BUS 270071 TO BUS 235506 CKT 1 / 270071 RICE_230 230 TO 235506 01RINGLD 230 1 END

12 Light Load Analysis

Light load analysis not required for solar projects.

13 Short Circuit Analysis

None.

13.1 System Reinforcements - Short Circuit

None.

14 Stability and Reactive Power

To be determined in the Facilities Study Phase.

15 Affected Systems

15.1 NYISO

None

16 Attachment 1: One Line Diagram