Generation Interconnection

Feasibility Study Report

for

Queue Project AG1-144

PHILLIPSBURG 34.5 KV

12 MW Capacity / 20 MW Energy

January 2021

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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) is PENELEC.

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.

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 Clearfield 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 June 01, 2022. This study does not imply a TO commitment to this in-service date.

Queue Number	AG1-144
Project Name	PHILLIPSBURG 34.5 KV
State	Pennsylvania
County	Clearfield
Transmission Owner	PENELEC
MFO	20
MWE	20
MWC	12
Fuel	Solar
Basecase Study Year	2024

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

AG1-144 will interconnect with the PENELEC distribution system at the Phillipsburg 34.5 kV substation. AG1-144 will be required to interconnect via a dedicated developer constructed, owned, and maintained express feeder that will terminate at the 34.5kV #1 bus at the Philipsburg substation. Developer initially requested to interconnect at POI pole F-632222, which is located on the 34.5kV Karthaus feeder at the Philipsburg substation. Due to the existence of previously approved IPP facilities, the addition of AG1-144 would cause this feeder to exceed the threshold for the maximum allowed aggregate generation permitted on a per circuit basis.

These thresholds were adopted as of June 23, 2020 and are now being enforced to limit exposure to the inherent voltage fluctuations the could impact the distribution customers directly sourced from the generation hosting circuit. Having large quantities of generation tied to a given feeder limits the ability of system operators to quickly respond to the switching for planned or emergent events. Having IPP's sourced from a dedicated feeder will offer some level of isolation due to voltage fluctuations stemming from the generator, will provide heightened visibility for the system operators to identify the presence of an IPP and streamline their efforts to isolate the same IPP by opening the substation breaker sourcing the express feeder. Protection coordination between the transmission operator and the IPP will be easier to implement at the substation level.

5 Cost Summary

The AG1-144 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	$4,342,100
Total System Network Upgrade Costs	$56,315,000[1]
Total Costs	$60,657,100

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 2016-36, 2016-25 I.R.B. (6/20/2016). 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.

Cost allocations for any System Upgrades will be provided in the System Impact Study Report.

[1] This project currently causes and/or contributes to overloads of the Transmission System (see Summer Peak Load Flow Analysis section below) and therefore has potential to have cost allocation for the system reinforcements listed in the report. This will be re-evaluated in the System Impact phase. The results may vary with queue customers withdrawing from the queue and other generators deactivating over time. If a customer is the first to cause the need for a project (causes loading to exceed 100% of rating), then the customer is responsible. If a customer contributes to a facility that is already overloaded by a prior queue, then they may receive cost allocation.

6 Transmission Owner Scope of Work

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AG1-144 generation project to connect to the Penelec distribution system. IC will be responsible for constructing all of the facilities on its side of the POI, including the attachment facilities which connect the generator to the Penelec distribution system's direct connection facilities.

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

Description	Total Cost
New 34.5kV substation breaker and bay position at Philipsburg substation	$1,200,000
Install a SCADA controlled 34.5kV recloser to interconnect queue project AG1-144. Install 34.5kV metering in customer's facilities. The customer is responsible to build their own line from their site to Penelec' s existing facilities	$ 102,500
NPs & Cust Dwg Review @ AG1-144	$ 25,200
Philispburg 34.5kV SS. Adjust Remote Relay and Metering Settings.	$ 14,400
Upgrade Philipsburg Substation #1 Transformer	$3,000,000
Total Physical Interconnection Costs	**$4,342,100**

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 18 months after the signing of an Interconnection Construction Service Agreement to complete the installation. 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.

If the customer is ultimately responsible for network upgrades, then the schedule for those upgrades will be refined in future study phases. The customer would need to wait for those upgrades to be completed prior to commercial operation unless determined deliverable by an interim deliverability study. The elapsed time to complete any network upgrades is provided in the System Reinforcements table of this report.[1]

8 Transmission Owner Analysis

The AG1-144 project did cause an overload on the existing Philipsburg substation #1 transformer. The developer will be responsible for the costs to replace this transformer with a larger unit. The cost for this transformer replacement is included in the "Total Physical Connection Costs" above.

In addition, the developer will be responsible for all costs associated with a new, dedicated 34.5kV substation breaker and bay at Penelec's Philipsburg substation that will source the developer's express feeder to AG1-144.

9 Interconnection Customer Requirements

9.1 System Protection

Proposed single line diagrams show the developer constructing a generation facility (Philipsburg 34.5kV AG1-144) tapping Penelec's 34.5kV #1 bus at Philipsburg substation via a dedicated developer constructed, owned, and maintained express feeder that will terminate to a new substation breaker to be installed at the Philipsburg substation.

The 34.5kV interconnection proposal will require Developer to meet applicable "Technical Requirements" as outlined in First Energy's document titled "Technical Requirements for the Interconnection of Customer-Owned Generation to the FirstEnergy Distribution System". Anti-islanding system shall meet IEEE 1547 and UL 1741 Therefore no Direct Transfer Trip (DTT) will be required.

9.2 General Concerns

It is to be understood, for abnormal operation of the Penelec system, which could cause Developer's generation facility to be electrically isolated from the Penelec system synchronous source via the tripping of a interconnecting primary voltage line or device, Developer will, via Penelec's direction, be required to

disconnect the generation from Penelec's system and remain disconnected (**units are required to be OFF LINE**), until the Penelec system normal circuitry is restored. These abnormal conditions will be reviewed by Penelec system operators as to the need for the generation facility to be disconnected.

9.3 Requirements for Owner's/Developer's generation IPP Facility

The proposed interconnection Owner's/Developer's facilities must be designed in accordance with the document titled *FirstEnergy Distribution Engineering Practices Interconnection of Customer-Owned Generation to the FirstEnergy Distribution System* dated 11/17/14 located at the following link:

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

The document is referred to as engineering practice EP (# 02-280) with section 4, part C specifically referencing the "interconnection technical requirements". Certain protection requirements are shown.

Additionally, Owner/Developer is responsible to provide adequate protection (for their equipment) under any distribution system operating condition' - which includes 'Separation from supply' (i.e. tripping of F.E. circuit breakers) and 'resynchronizing the generation after electric restoration of the supply' (i.e. reclosing of F.E. circuit breakers).

Owner's/Developer's protection must be designed to coordinate with the reclosing practices of FirstEnergy line protective devices. The generator must cease to energize the FirstEnergy circuit to which it is connected prior to reclosing of any (FE) automatic reclosing devices.

Owners/Developer's electrical protection and control schematics shall be provided to FE for consideration. FE may request modifications, if required, to meet the technical requirements.

9.4 Compliance Issues

The Developer will be responsible for meeting a power factor between 0.95 lagging (producing MVARs) to 0.95 leading (absorbing MVARs) and assure that voltage deviation will be less than 1.0 volt as measured at the POI under all Solar Gen operating conditions due to the inherent dynamic reactive power capability of this solar facility.

Generators with no inherent VAR (reactive power) control capability, or those that have a restricted VAR capability less than the defined requirements, must provide dynamic supplementary reactive support located at the generation facility with electrical characteristics equivalent to that provided by a similar sized synchronous generator. A Dynamic Reactive Compensation (either Static VAR Compensator (SVC) or STATCOM) or other method be applied in order to maintain the required specifications at the POI. The Developer is responsible for the installation of equipment on its side of the POI in order to adhere to the criteria stated above by FirstEnergy.

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 - Load Flow Analysis

The Queue Project AG1-144 was evaluated as a 20.0 MW (Capacity 12.0 MW) injection at the Phillipsburg 34.5 kV substation in the PENELEC area. Project AG1-144 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AG1-144 was studied with a commercial probability of 53.0 %. 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)

None

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	CONTNAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
165742154	200713	26ROCKTON	115.0	PENELEC	200712	26DUBOIS	115.0	PENELEC	1	AP-P2-2-WP-230-001T	bus	190.0	129.16	130.58	DC	2.69
165905811	200713	26ROCKTON	115.0	PENELEC	200712	26DUBOIS	115.0	PENELEC	1	AP-P2-3-WP-230-446T	breaker	190.0	129.17	130.59	DC	2.69
165905812	200713	26ROCKTON	115.0	PENELEC	200712	26DUBOIS	115.0	PENELEC	1	AP-P2-3-WP-230-443T *	breaker	190.0	129.06	130.48	DC	2.69
165742153	200714	26SHAWVL1	115.0	PENELEC	200713	26ROCKTON	115.0	PENELEC	1	AP-P2-2-WP-230-001T	bus	190.0	130.11	131.53	DC	2.69
165905802	200714	26SHAWVL1	115.0	PENELEC	200713	26ROCKTON	115.0	PENELEC	1	AP-P2-3-WP-230-446T	breaker	190.0	130.11	131.53	DC	2.69
165905803	200714	26SHAWVL1	115.0	PENELEC	200713	26ROCKTON	115.0	PENELEC	1	AP-P2-3-WP-230-443T *	breaker	190.0	130.01	131.43	DC	2.69

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
166154179	200714	26SHAWVL 1	115.0	PENELEC	200872	26BIOEN TP	115.0	PENELEC	1	AP-P1-3-WP-230-326T-B	operation	185.0	132.34	133.75	DC	2.6
166154139	200716	26PHILIPSB	115.0	PENELEC	964450	AG1-308 TAP	115.0	PENELEC	1	PN-P1-2-PN-115-052A	operation	202.0	136.93	146.83	DC	20.0
166154208	200716	26PHILIPSB	115.0	PENELEC	200904	26EAGL VAL	115.0	PENELEC	1	AP-P1-3-WP-230-326T-B	operation	244.0	119.62	122.75	DC	7.64
166154204	200727	26SHAW. 2	115.0	PENELEC	200714	26SHAWVL 1	115.0	PENELEC	ZB	PN-P1-2-PN-115-052A	operation	191.0	101.84	109.64	DC	14.89
166154221	200755	26WESTOVER	115.0	PENELEC	200801	26GARMAN	115.0	PENELEC	1	AP-P1-3-WP-230-326T-B	operation	246.0	123.78	124.84	DC	2.6
166154225	200755	26WESTOVER	115.0	PENELEC	200801	26GARMAN	115.0	PENELEC	1	Base Case	operation	193.0	102.62	103.77	DC	2.22
166154144	200904	26EAGL VAL	115.0	PENELEC	200527	26TYRONE N	115.0	PENELEC	1	AP-P1-3-WP-230-326T-B	operation	242.0	155.67	158.83	DC	7.64
166154149	200904	26EAGL VAL	115.0	PENELEC	200527	26TYRONE N	115.0	PENELEC	1	Base Case	operation	200.0	114.14	117.74	DC	7.21
169589725	941420	AE2-139 TAP	230.0	PENELEC	919200	AA1-144 TAP	230.0	PENELEC	1	Base Case	operation	520.0	99.92	100.07	DC	1.7
166154198	944180	AF1-086 TAP	115.0	PENELEC	200755	26WESTOVER	115.0	PENELEC	1	AP-P1-3-WP-230-326T-B	operation	237.0	129.29	130.38	DC	2.6
166154201	944180	AF1-086 TAP	115.0	PENELEC	200755	26WESTOVER	115.0	PENELEC	1	Base Case	operation	175.0	114.26	115.53	DC	2.22

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
166154118	964450	AG1-308 TAP	115.0	PENELEC	200727	26SHAW. 2	115.0	PENELEC	1	PN-P1-2-PN-115-052A	operation	202.0	136.83	146.73	DC	20.0

11.5 System Reinforcements - Summer Peak Load Flow - Primary POI

ID	Idx	Facility	Upgrade Description	Cost
165905811,165905812,165742154	1	26ROCKTON 115.0 kV - 26DUBOIS 115.0 kV Ckt 1	**PENELEC** **PN-AF2-F-0054A (1472) : Replace line trap at Dubois.** **Project Type : FAC** **Cost : $200,000** **Time Estimate : 12.0 Months** **PN-AF2-F-0054B (1473) : Reconductor 11.67 miles of line.** **Project Type : FAC** **Cost : $28,640,000** **Time Estimate : 48.0 Months** **PN-AF2-F-0054C (1474) : Adjust CT ratios at Dubois.** **Project Type : FAC** **Cost : $800,000** **Time Estimate : 12.0 Months**	$29,640,000
165742153,165905803,165905802	2	26SHAWVL 1 115.0 kV - 26ROCKTON 115.0 kV Ckt 1	**PENELEC** **PN-AF2-F-0050A (1432) : Replace line trap at Shawville.** **Project Type : FAC** **Cost : $200,000** **Time Estimate : 12.0 Months** **PN-AF2-F-0050B (1433) : Reconductor 8.63 miles of line. Replace line drops at Shawville.** **Project Type : FAC** **Cost : $26,475,000** **Time Estimate : 48.0 Months**	$26,675,000
			TOTAL COST	**$56,315,000**[1]

11.6 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".

11.6.1 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
165905812	200713	26ROCKTON	PENELEC	200712	26DUBOIS	PENELEC	1	AP-P2-3-WP-230-443T *	breaker	190.0	129.06	130.48	DC	2.69

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
200665	26SHAWVL 3	3.0960	50/50	3.0960
200666	26SHAWVL 4	3.0432	50/50	3.0432
200715	26SHAWVL 1	2.7655	50/50	2.7655
200722	26SHAWVL 2	2.8293	50/50	2.8293
200905	26Q36	0.1317	50/50	0.1317
200913	26SHAW-D	0.1681	50/50	0.1681
235003	AC1-025 E	0.0980	Adder	0.12
236828	01GRAYMONT	0.2686	Adder	0.32
290086	Q-036 E	4.0236	50/50	4.0236
921642	AA2-000	26.3797	Adder	31.03
930511	AB2-092	0.9686	Adder	1.14
936421	AD2-055	1.9941	Adder	2.35
936991	AD2-133 C	1.8106	50/50	1.8106
936992	AD2-133 E	8.2816	50/50	8.2816
939171	AE1-147 C	0.8091	Adder	0.95
939172	AE1-147 E	0.5394	Adder	0.63
940201	AE2-001 C	0.8071	Adder	0.95
940202	AE2-001 E	0.5381	Adder	0.63
940681	**AE2-055 C (Suspended)**	**0.7776**	**Adder**	**0.91**
940682	**AE2-055 E (Suspended)**	**0.5184**	**Adder**	**0.61**
941261	AE2-120 C	0.8061	Adder	0.95
941262	AE2-120 E	0.5374	Adder	0.63
941271	AE2-121 C	0.4319	Adder	0.51
941272	AE2-121 E	0.2884	Adder	0.34
941331	AE2-129 C	1.6170	50/50	1.6170
941332	AE2-129 E	1.0780	50/50	1.0780
941351	**AE2-131 C (Suspended)**	**1.6170**	**50/50**	**1.6170**
941352	**AE2-131 E (Suspended)**	**1.0780**	**50/50**	**1.0780**
942351	AE2-248 C	0.6320	Adder	0.74
942352	AE2-248 E	0.4213	Adder	0.5
942491	AE2-262 C	3.7795	Adder	4.45
942492	AE2-262 E	2.5398	Adder	2.99
942501	AE2-263 C	3.5528	Adder	4.18
942502	AE2-263 E	2.3720	Adder	2.79
943751	AF1-043	5.9824	Adder	7.04
944001	**AF1-068 C O1 (Withdrawn : 12/15/2020)**	**0.8386**	**Adder**	**0.99**
944002	**AF1-068 E O1 (Withdrawn : 12/15/2020)**	**0.4717**	**Adder**	**0.55**
944181	AF1-086 C O1	1.0997	Adder	1.29

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
944182	AF1-086 E O1	4.7845	Adder	5.63
944311	AF1-099 C	5.7373	Adder	6.75
944312	AF1-099 E	3.8249	Adder	4.5
944321	AF1-100 C	16.2855	50/50	16.2855
944322	AF1-100 E	10.8570	50/50	10.8570
944382	AF1-103 BAT	1.3910	Merchant Transmission	1.3910
944471	AF1-112 C	0.7932	Adder	0.93
944472	AF1-112 E	0.5288	Adder	0.62
944671	**AF1-132 C O1 (Withdrawn : 12/15/2020)**	**0.7842**	**Adder**	**0.92**
944672	**AF1-132 E O1 (Withdrawn : 12/15/2020)**	**0.5228**	**Adder**	**0.62**
944691	AF1-134 C	1.3462	50/50	1.3462
944692	AF1-134 E	0.8974	50/50	0.8974
944771	AF1-142 C	9.1797	Adder	10.8
944772	AF1-142 E	6.1198	Adder	7.2
944901	AF1-155 C	-1.0979	Adder	-1.29
945161	AF1-181	0.0142	50/50	0.0142
945171	AF1-182	0.0712	50/50	0.0712
945181	AF1-183	0.0227	50/50	0.0227
945491	**AF1-214 C (Withdrawn : 12/03/2020)**	**0.8062**	**Adder**	**0.95**
945492	**AF1-214 E (Withdrawn : 12/03/2020)**	**0.5375**	**Adder**	**0.63**
946423	AF1-306 BAT	32.6563	50/50	32.6563
957451	AF2-039 C	1.4369	50/50	1.4369
957452	AF2-039 E	0.9579	50/50	0.9579
957941	AF2-088 C	0.6918	50/50	0.6918
957942	AF2-088 E	0.4612	50/50	0.4612
958271	AF2-121 C	1.6170	50/50	1.6170
958272	AF2-121 E	1.0780	50/50	1.0780
959802	AF2-271 E	0.1375	Adder	0.16
960022	AF2-293 E	0.0787	Adder	0.09
960051	AF2-296 C	1.3462	50/50	1.3462
960052	AF2-296 E	0.8974	50/50	0.8974
962411	AG1-090 C O1	8.0850	50/50	8.0850
962412	AG1-090 E O1	5.3900	50/50	5.3900
962951	AG1-144 C	1.6170	50/50	1.6170
962952	AG1-144 E	1.0780	50/50	1.0780
963891	AG1-242 C	0.7292	50/50	0.7292
963892	AG1-242 E	0.3926	50/50	0.3926
964031	AG1-257 C	0.2917	Adder	0.65
964032	AG1-257 E	0.4077	Adder	0.9
964041	AG1-258 C	0.2917	Adder	0.65
964042	AG1-258 E	0.4077	Adder	0.9
964451	AG1-308 C O1	1.2243	50/50	1.2243
964452	AG1-308 E O1	1.7111	50/50	1.7111
965121	AG1-377 C O1	1.6170	50/50	1.6170
965122	AG1-377 E O1	1.0780	50/50	1.0780
965131	AG1-378 C O1	1.6170	50/50	1.6170
965132	AG1-378 E O1	1.0780	50/50	1.0780
965203	AG1-385 BAT	0.9227	50/50	0.9227

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
965301	AG1-395 C	2.0778	50/50	2.0778
965302	AG1-395 E	0.6172	50/50	0.6172
966041	AG1-473 C	0.8280	Adder	1.84
966042	AG1-473 E	0.5520	Adder	1.23
966122	AG1-481 BAT	0.5640	Merchant Transmission	0.5640
G-007A	G-007A	1.2563	Confirmed LTF	1.2563
VFT	VFT	3.4120	Confirmed LTF	3.4120
CALDERWOOD	CALDERWOOD	0.1123	Confirmed LTF	0.1123
NY	NY	0.0265	Confirmed LTF	0.0265
PRAIRIE	PRAIRIE	0.7258	Confirmed LTF	0.7258
CHEOAH	CHEOAH	0.1121	Confirmed LTF	0.1121
CBM-N	CBM-N	0.6456	Confirmed LTF	0.6456
COTTONWOOD	COTTONWOOD	0.5271	Confirmed LTF	0.5271
HAMLET	HAMLET	0.0872	Confirmed LTF	0.0872
GIBSON	GIBSON	0.1605	Confirmed LTF	0.1605
BLUEG	BLUEG	0.5052	Confirmed LTF	0.5052
TRIMBLE	TRIMBLE	0.1625	Confirmed LTF	0.1625
CATAWBA	CATAWBA	0.0613	Confirmed LTF	0.0613

11.6.2 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
165905803	200714	26SHAWVL 1	PENELEC	200713	26ROCKTON	PENELEC	1	AP-P2-3-WP-230-443T *	breaker	190.0	130.01	131.43	DC	2.69

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
200665	26SHAWVL 3	3.0960	50/50	3.0960
200666	26SHAWVL 4	3.0432	50/50	3.0432
200715	26SHAWVL 1	2.7655	50/50	2.7655
200722	26SHAWVL 2	2.8293	50/50	2.8293
200905	26Q36	0.1317	50/50	0.1317
200913	26SHAW-D	0.1681	50/50	0.1681
235003	AC1-025 E	0.0980	Adder	0.12
236828	01GRAYMONT	0.2686	Adder	0.32
290086	Q-036 E	4.0236	50/50	4.0236
921642	AA2-000	26.3797	Adder	31.03
930511	AB2-092	0.9686	Adder	1.14
936421	AD2-055	1.9941	Adder	2.35
936991	AD2-133 C	1.8106	50/50	1.8106
936992	AD2-133 E	8.2816	50/50	8.2816
939171	AE1-147 C	0.8091	Adder	0.95
939172	AE1-147 E	0.5394	Adder	0.63
940201	AE2-001 C	0.8071	Adder	0.95
940202	AE2-001 E	0.5381	Adder	0.63
940681	**AE2-055 C (Suspended)**	**0.7776**	**Adder**	**0.91**
940682	**AE2-055 E (Suspended)**	**0.5184**	**Adder**	**0.61**
941261	AE2-120 C	0.8061	Adder	0.95
941262	AE2-120 E	0.5374	Adder	0.63
941271	AE2-121 C	0.4319	Adder	0.51
941272	AE2-121 E	0.2884	Adder	0.34
941331	AE2-129 C	1.6170	50/50	1.6170
941332	AE2-129 E	1.0780	50/50	1.0780
941351	**AE2-131 C (Suspended)**	**1.6170**	**50/50**	**1.6170**
941352	**AE2-131 E (Suspended)**	**1.0780**	**50/50**	**1.0780**
942351	AE2-248 C	0.6320	Adder	0.74
942352	AE2-248 E	0.4213	Adder	0.5
942491	AE2-262 C	3.7795	Adder	4.45
942492	AE2-262 E	2.5398	Adder	2.99
942501	AE2-263 C	3.5528	Adder	4.18
942502	AE2-263 E	2.3720	Adder	2.79
943751	AF1-043	5.9824	Adder	7.04
944001	**AF1-068 C O1 (Withdrawn : 12/15/2020)**	**0.8386**	**Adder**	**0.99**
944002	**AF1-068 E O1 (Withdrawn : 12/15/2020)**	**0.4717**	**Adder**	**0.55**
944181	AF1-086 C O1	1.0997	Adder	1.29

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
944182	AF1-086 E O1	4.7845	Adder	5.63
944311	AF1-099 C	5.7373	Adder	6.75
944312	AF1-099 E	3.8249	Adder	4.5
944321	AF1-100 C	16.2855	50/50	16.2855
944322	AF1-100 E	10.8570	50/50	10.8570
944382	AF1-103 BAT	1.3910	Merchant Transmission	1.3910
944471	AF1-112 C	0.7932	Adder	0.93
944472	AF1-112 E	0.5288	Adder	0.62
944671	**AF1-132 C O1 (Withdrawn : 12/15/2020)**	**0.7842**	**Adder**	**0.92**
944672	**AF1-132 E O1 (Withdrawn : 12/15/2020)**	**0.5228**	**Adder**	**0.62**
944691	AF1-134 C	1.3462	50/50	1.3462
944692	AF1-134 E	0.8974	50/50	0.8974
944771	AF1-142 C	9.1797	Adder	10.8
944772	AF1-142 E	6.1198	Adder	7.2
944901	AF1-155 C	-1.0979	Adder	-1.29
945161	AF1-181	0.0142	50/50	0.0142
945171	AF1-182	0.0712	50/50	0.0712
945181	AF1-183	0.0227	50/50	0.0227
945491	**AF1-214 C (Withdrawn : 12/03/2020)**	**0.8062**	**Adder**	**0.95**
945492	**AF1-214 E (Withdrawn : 12/03/2020)**	**0.5375**	**Adder**	**0.63**
946423	AF1-306 BAT	32.6563	50/50	32.6563
957451	AF2-039 C	1.4369	50/50	1.4369
957452	AF2-039 E	0.9579	50/50	0.9579
957941	AF2-088 C	0.6918	50/50	0.6918
957942	AF2-088 E	0.4612	50/50	0.4612
958271	AF2-121 C	1.6170	50/50	1.6170
958272	AF2-121 E	1.0780	50/50	1.0780
959802	AF2-271 E	0.1375	Adder	0.16
960022	AF2-293 E	0.0787	Adder	0.09
960051	AF2-296 C	1.3462	50/50	1.3462
960052	AF2-296 E	0.8974	50/50	0.8974
962411	AG1-090 C O1	8.0850	50/50	8.0850
962412	AG1-090 E O1	5.3900	50/50	5.3900
962951	AG1-144 C	1.6170	50/50	1.6170
962952	AG1-144 E	1.0780	50/50	1.0780
963891	AG1-242 C	0.7292	50/50	0.7292
963892	AG1-242 E	0.3926	50/50	0.3926
964031	AG1-257 C	0.2917	Adder	0.65
964032	AG1-257 E	0.4077	Adder	0.9
964041	AG1-258 C	0.2917	Adder	0.65
964042	AG1-258 E	0.4077	Adder	0.9
964451	AG1-308 C O1	1.2243	50/50	1.2243
964452	AG1-308 E O1	1.7111	50/50	1.7111
965121	AG1-377 C O1	1.6170	50/50	1.6170
965122	AG1-377 E O1	1.0780	50/50	1.0780
965131	AG1-378 C O1	1.6170	50/50	1.6170
965132	AG1-378 E O1	1.0780	50/50	1.0780
965203	AG1-385 BAT	0.9227	50/50	0.9227

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
965301	AG1-395 C	2.0778	50/50	2.0778
965302	AG1-395 E	0.6172	50/50	0.6172
966041	AG1-473 C	0.8280	Adder	1.84
966042	AG1-473 E	0.5520	Adder	1.23
966122	AG1-481 BAT	0.5640	Merchant Transmission	0.5640
G-007A	G-007A	1.2563	Confirmed LTF	1.2563
VFT	VFT	3.4120	Confirmed LTF	3.4120
CALDERWOOD	CALDERWOOD	0.1123	Confirmed LTF	0.1123
NY	NY	0.0265	Confirmed LTF	0.0265
PRAIRIE	PRAIRIE	0.7258	Confirmed LTF	0.7258
CHEOAH	CHEOAH	0.1121	Confirmed LTF	0.1121
CBM-N	CBM-N	0.6456	Confirmed LTF	0.6456
COTTONWOOD	COTTONWOOD	0.5271	Confirmed LTF	0.5271
HAMLET	HAMLET	0.0872	Confirmed LTF	0.0872
GIBSON	GIBSON	0.1605	Confirmed LTF	0.1605
BLUEG	BLUEG	0.5052	Confirmed LTF	0.5052
TRIMBLE	TRIMBLE	0.1625	Confirmed LTF	0.1625
CATAWBA	CATAWBA	0.0613	Confirmed LTF	0.0613

11.7 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
AA2-000	N/A	N/A
AB2-092	Bergen 138kV	Partially in Service - Under Construction
AC1-025	Dale Summit	In Service
AD2-055	Moshannon-East Towanda 230 kV	Active
AD2-133	Eagle Valley 115kV	Active
AE1-147	Bellefonte 46 kV	Engineering and Procurement
AE2-001	Nittany-Zion 46 kV	Active
AE2-055	Shingletown-Boalsburg 46 kV	Suspended
AE2-120	Graymont-Zion 46 kV	Active
AE2-121	Milesburg-Tanney Junction 46 kV	Active
AE2-129	Philipsburg-Clarence 34.5 kV	Engineering and Procurement
AE2-131	Philipsburg-Karthaus 34.5	Suspended
AE2-248	Fillmore-Thompson Farm 46 kV	Active
AE2-262	Moshannon-Milesburg 230 kV	Active
AE2-263	Moshannon-Milesburg 230 kV	Active
AF1-043	Moshannon-East Towanda 230 kV	Active
AF1-068	Boalsburg-Centre Hall 46 kV	Withdrawn
AF1-086	Madera-Westover South 115 kV	Active
AF1-099	Moshannon-Milesburg 230 kV	Active
AF1-100	Shawville-Moshannon 230 kV	Active
AF1-103	Warren 34.5 kV	Active
AF1-112	Centre Hall-Boalsburg 46 kV	Active
AF1-132	Shingletown-Boalsburg 46 kV	Withdrawn
AF1-134	Philipsburg-Madera 34.5 kV	Active
AF1-142	Moshannon-Milesburg 230 kV	Active
AF1-155	Paper City-Wilcox 46 kV	Engineering and Procurement
AF1-181	Shawville 3 230 kV	Partially in Service - Under Construction
AF1-182	Shawville 4 230 kV	Partially in Service - Under Construction
AF1-183	Shawville 1 230 kV	Partially in Service - Under Construction
AF1-214	Nittany-Zion 46 kV	Withdrawn
AF1-306	Squab Hollow 230 kV	Active
AF2-039	Shawville-Clearfield 34.5 kV	Active
AF2-088	Shawville-Clearfield 34.5 kV II	Active
AF2-121	Philipsburg-Shawville 34.5 kV	Active
AF2-271	Pemberton-Sinking Valley 12.47 kV	Engineering and Procurement
AF2-293	Beech Creek 12.47 kV	Active
AF2-296	Madera 34.5 kV	Active
AG1-090	Philipsburg 115 kV	Active
AG1-144	Phillipsburg 34.5 kV	Active

Queue Number	Project Name	Status
AG1-242	Beccaria 34.5 kV	Active
AG1-257	Madisonburg Jct-Millheim 46 kV	Active
AG1-258	Madisonburg Jct-Millheim 46 kV	Active
AG1-308	Shawville-Philipsburg 115 kV	Active
AG1-377	Philipsburg 115 kV	Active
AG1-378	Philipsburg 115 kV	Active
AG1-385	Motion-Ridgeway 46 kV	Active
AG1-395	Philipsburg-Karthaus 34.5 kV 2	Active
AG1-473	Shingletown-Lewistown 230 kV	Active
AG1-481	Warren 34.5 kV	Active

11.8 Contingency Descriptions

Contingency Name	Contingency Definition
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
AP-P1-3-WP-230-326T-B	CONTINGENCY 'AP-P1-3-WP-230-326T-B' /* SHINGLETOWN #82 230/46KV XFMR DISCONNECT BRANCH FROM BUS 966040 TO BUS 200513 CKT 1 /* AG1-473 TAP 230 26LEWISTWN 230 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 END
Base Case	
PN-P1-2-PN-115-052A	CONTINGENCY 'PN-P1-2-PN-115-052A' /* EAGLE VALLEY - TYRONE NORTH 115KV DISCONNECT BRANCH FROM BUS 200904 TO BUS 200527 CKT 1 /* 26EAGL VAL 115 26TYRONE N 115 END
AP-P2-3-WP-230-446T	CONTINGENCY 'AP-P2-3-WP-230-446T' DISCONNECT BRANCH FROM BUS 200726 TO BUS 235175 CKT 1 DISCONNECT BRANCH FROM BUS 235158 TO BUS 235175 CKT 1 DISCONNECT BRANCH FROM BUS 235175 TO BUS 235236 CKT 1 DISCONNECT BRANCH FROM BUS 235220 TO BUS 235236 CKT 1 DISCONNECT BRANCH FROM BUS 235236 TO BUS 236732 CKT 81 OPEN BUS 235158 END

12 Short Circuit Analysis

The following Breakers are overdutied:

None

12.1 System Reinforcements - Short Circuit

None

13 Affected Systems

13.1 NYISO

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