Generation Interconnection

Feasibility Study Report

for

Queue Project AF1-068

BOALSBURG-CENTRE HALL 46 KV

12.8 MW Capacity / 20 MW Energy

January 2020

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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 West Penn Power (APS-WPP 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 Centre County, Pennsylvania. The installed facilities will have a total capability of 20 MW with 12.8 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is 01/10/2022. This study does not imply a TO commitment to this in-service date.

Final attachment facilities and local upgrades (if required) along with terms and conditions to interconnect AF1-061 will be specified in a separate two party Interconnection Agreement (IA) between WPP and the Interconnection Customer as this project is considered FERC non-jurisdictional per the PJM Open Access Transmission Tariff (OATT).

Queue Number	**AF1-068**
Project Name	BOALSBURG-CENTRE HALL 46 KV
State	Pennsylvania
County	Centre
Transmission Owner	APS
MFO	20
MWE	20
MWC	12.8
Fuel	Solar
Basecase Study Year	2023

3.1 Point of Interconnection

3.1.1 Primary POI

The interconnection of the project at the Primary POI will be accomplished by tapping the Center Hall - Shingletown 46 kV line (between Centre Hall and Boalsburg substations) and constructing a one span tap. The transmission line tap will be located approximately 0.6 miles from Boalsburg 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 Center Hall and Shingletown substations.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AF1-068 generation project to connect to the FirstEnergy ("FE") transmission system. IC will be responsible for constructing all the facilities on its side of the POI, including the Attachment facilities which connect the generator to the FE transmission system.

3.1.2 Secondary POI

AF1-068 will interconnect with the APS distribution system at the Boalsburg 46 kV substation. A full scope of work or estimated cost is not provided for the proposed Secondary POI.

3.2 Cost Summary

Total estimated cost for the required Interconnection Facilities is **$248,900**. 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.

From the transmission perspective, the network impacts or system reinforcements were identified as detailed in the "Network Impacts" section below.

Description	Total Cost
System Upgrades	**$47,064,500**

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

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 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 required Attachment Facilities and Direct and Non-Direct Connection work for the interconnection of the AF1-068 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 Transmission Owner Scope of Work

The interconnection of the project at the Primary POI will be accomplished by tapping the Center Hall - Shingletown 46 kV line (between Centre Hall and Boalsburg substations) and constructing a one span tap. The transmission line tap will be located approximately 0.6 miles from Boalsburg 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 Center Hall and Shingletown substations.

Description	Total Cost
Install one 46 kV tap switch and construct single span tap to customer's substation. install 46 kV metering in customer's substation.	$36,100
Review drawing and provide nameplates for customer substation.	$63,200
Construct 46 kV tap with two 46 kV line switches.	$72,200
Update relay settings @ Centre Hall	$38,700
Update relay settings @ Shingletown	$38,700
Total Estimated Connection Facility Costs	**$248,900**

5 Schedule

Based on the scope of work for the interconnection facilities, it is expected to take a minimum of **12 months** after the signing of an Interconnection 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 interconnection work, 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.

6 Transmission Owner Analysis

FE performed an analysis of its underlying transmission <100 kV system. The AF1-068 project did not contribute to any overloads on the FE transmission <100 kV system.

7 Interconnection Customer Requirements

10.1 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.

10.2 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 AF1-068 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 AF1-068 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.

10.3 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.

8 Revenue Metering and SCADA Requirements

8.1 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.

1.1.1 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

8.2 FirstEnergy - APS 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

9 Network Impacts – Primary POI

The Queue Project AF1-068 was evaluated as a 20.0 MW (Capacity 12.8 MW) injection tapping the Boalsburg to Centre Hall 46kV line in the APS area. Project AF1-068 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-068 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Load Flow

9.1 Generation Deliverability

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

None

9.2 Multiple Facility Contingency

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

None

9.3 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
41774102	200904	26EAGLVAL	115.0	PENELEC	200527	26TYRONEN	115.0	PENELEC	1	AP-P2-2-WP-230-005T	bus	191.0	113.23	113.68	DC	1.92
41495814	235248	01SHINGL	230.0	AP	200513	26LEWISTWN	230.0	PENELEC	1	AP-P2-3-WP-230-446T	breaker	570.0	116.77	118.91	DC	12.21
41495815	235248	01SHINGL	230.0	AP	200513	26LEWISTWN	230.0	PENELEC	1	AP-P2-3-WP-230-443T *	breaker	570.0	116.63	118.77	DC	12.21
41495816	235248	01SHINGL	230.0	AP	200513	26LEWISTWN	230.0	PENELEC	1	AP-P2-2-WP-230-001T	breaker	570.0	116.63	118.77	DC	12.21
41774015	235248	01SHINGL	230.0	AP	200513	26LEWISTWN	230.0	PENELEC	1	AP-P2-2-WP-230-001T	bus	570.0	116.63	118.77	DC	12.21

9.4 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
41154626	200522	26SHADE GP	115.0	PENELEC	938380	AE1-071 TAP	115.0	PENELEC	1	PL_P12_100618	operation	160.0	108.64	110.14	DC	2.4
41154423	235248	01SHINGL	230.0	AP	200513	26LEWISTWN	230.0	PENELEC	1	Base Case	operation	491.0	110.99	112.98	DC	10.09
41154426	235248	01SHINGL	230.0	AP	200513	26LEWISTWN	230.0	PENELEC	1	AP-P1-2-WP-230-324T_FSA_B	operation	570.0	103.01	104.87	DC	10.94
49426214	235248	01SHINGL	230.0	AP	200513	26LEWISTWN	230.0	PENELEC	1	200909 26LOBO+ 230 919490 AA2-000 TAP 230 1	operation	570.0	103.01	104.87	DC	10.94

9.5 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
41495814,41495815, 41495816,41774015	2	01SHINGL 230.0 kV - 26LEWISTWN 230.0 kV Ckt 1	**PENELEC** **PN-AF1-F-0061a : Replace substation conductor at Shingletown** **Project Type : FAC** **Cost : $238,000** **Time Estimate : 6.0 Months** **PN-AF1-F-0061b : Replace substation conductor at Shingletown. Replace disconnect switches at Shingletown Reconductor Shingletown - Lewistown 115 kV (~26 miles)** **Project Type : FAC** **Cost : $46,826,500** **Time Estimate : 9.0 Months**	$47,064,500
41774102	1	26EAGL VAL 115.0 kV - 26TYRONE N 115.0 kV Ckt 1	**PENELEC** **s1776.1: Supplemental upgrade s1776.1: Tyrone North - Construct a four breaker 115 kV ring bus. The supplemental project has a projected in-service date of 12/31/2020.** **Project Type: CON** **Cost : $0** **s1776.2: Supplemental upgrade s1776.2: Replace the Tyrone North #2 115/46 kV 45/60/75 MVA transformer. The supplemental project has a projected in-service date of 12/31/2020.** **Project Type: CON** **Cost : $0** **s1776.3: Supplemental upgrade s1776.3: Install a 46 kV 1200 A bypass switch between the Tipton and Warrior Ridge 46 kV lines. The supplemental project has a projected in-service date of 12/31/2020.** **Project Type: CON** **Cost : $0**	$0
			TOTAL COST	**$47,064,500**

9.6 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.

9.6.1 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
41774102	200904	26EAGL VAL	PENELEC	200527	26TYRONE N	PENELEC	1	AP-P2-2-WP-230-005T	bus	191.0	113.23	113.68	DC	1.92

Bus #	Bus	MW Impact
200665	26SHAWVL 3	2.5507
200666	26SHAWVL 4	2.5057
200715	26SHAWVL 1	2.2589
200722	26SHAWVL 2	2.3221
200905	26Q36	0.7172
200913	26SHAW-D	0.1365
235003	AC1-025 E	0.1219
236828	01GRAYMONT	0.3194
290086	Q-036 E	20.5528
919491	AA2-000	28.5206
930511	AB1-092	1.0472
936421	AD2-055	2.1560
936991	AD2-133 C	9.2488
936992	AD2-133 E	42.3028
939171	AE1-147 C	0.9548
939172	AE1-147 E	0.6365
940201	AE2-001 C	0.9570
940202	AE2-001 E	0.6380
940681	AE2-055 C	0.9910
940682	AE2-055 E	0.6607
941191	AE2-113 C	2.9319
941192	AE2-113 E	3.1567
941251	**AE2-119 C (Withdrawn : 12/16/2019)**	**1.9591**
941252	**AE2-119 E (Withdrawn : 12/16/2019)**	**1.3061**
941261	AE2-120 C	0.9578
941262	AE2-120 E	0.6385
941271	AE2-121 C	0.5067
941272	AE2-121 E	0.3383
941321	AE2-126 C	1.4356
941322	AE2-126 E	0.9570
941331	AE2-129 C	4.2805
941332	AE2-129 E	2.8537
941351	AE2-131 C	4.2805
941352	AE2-131 E	2.8537
942351	AE2-248 C	0.7794
942352	AE2-248 E	0.5196
942491	AE2-262 C	3.9032
942492	AE2-262 E	2.6230
942501	AE2-263 C	3.6690
942502	AE2-263 E	2.4496
943751	AF1-043	3.4280

Bus #	Bus	MW Impact
944001	AF1-068 C O1	0.5542
944002	AF1-068 E O1	0.3117
944181	AF1-086 C O1	0.4667
944182	AF1-086 E O1	2.0305
944311	AF1-099 C	3.1403
944312	AF1-099 E	2.0935
944321	AF1-100 C O1	15.7470
944322	AF1-100 E O1	10.4980
944471	AF1-112 C	0.5150
944472	AF1-112 E	0.3433
944671	AF1-132 C O1	0.5210
944672	AF1-132 E O1	0.3473
944691	AF1-134 C O1	0.4449
944692	AF1-134 E O1	0.4449
944701	AF1-135 C	0.5338
944702	AF1-135 E	0.3559
944771	AF1-142 C	5.0244
944772	AF1-142 E	3.3496
944841	AF1-149 C	0.9578
944842	AF1-149 E	0.6385
944881	AF1-153 C O1	0.3827
944882	AF1-153 E O1	0.2552
944901	AF1-155 C	0.3798
944902	AF1-155 E	0.2532
945071	AF1-172 C	5.4317
945072	AF1-172 E	3.6211
945161	AF1-181	0.0839
945171	AF1-182	0.4199
945181	AF1-183	0.1327
945481	AF1-213 C	11.8213
945482	AF1-213 E	7.8808
945491	AF1-214 C	0.5076
945492	AF1-214 E	0.3384
945551	AF1-220 C	3.6798
945552	AF1-220 E	2.4545
945771	AF1-242 C	0.3798
945772	AF1-242 E	0.2532
946091	AF1-274 C	5.6595
946092	AF1-274 E	3.7730
946421	AF1-306 C	2.0125
946422	AF1-306 E	8.0498
DUCKCREEK	DUCKCREEK	0.0115
NEWTON	NEWTON	0.0161
FARMERCITY	FARMERCITY	0.0009
CBM-W1	CBM-W1	0.0375
PRAIRIE	PRAIRIE	0.0465
O-066	O-066	0.3494
COFFEEN	COFFEEN	0.0074
EDWARDS	EDWARDS	0.0032
CHEOAH	CHEOAH	0.0205
TILTON	TILTON	0.0069
G-007	G-007	0.0686

Bus #	Bus	MW Impact
GIBSON	GIBSON	0.0082
CALDERWOOD	CALDERWOOD	0.0199
BLUEG	BLUEG	0.0278
TRIMBLE	TRIMBLE	0.0089
CATAWBA	CATAWBA	0.0203

9.6.2 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
41774015	235248	01SHINGL	AP	200513	26LEWISTWN	PENELEC	1	AP-P2-2-WP-230-001T	bus	570.0	116.63	118.77	DC	12.21

Bus #	Bus	MW Impact
200665	26SHAWVL 3	11.2213
200666	26SHAWVL 4	11.0429
200715	26SHAWVL 1	6.8508
200722	26SHAWVL 2	7.0237
200894	26K02	13.1208
200898	26AA1-106	2.6976
200905	26Q36	0.2708
200913	26SHAW-D	0.2828
203352	26CANZ2-011	0.4430
235003	AC1-025 E	0.9180
236828	01GRAYMONT	2.3847
290086	Q-036 E	7.7608
919491	AA2-000	169.8793
930511	AB1-092	6.2375
936421	AD2-055	12.8419
936991	AD2-133 C	3.4924
936992	AD2-133 E	15.9737
939171	AE1-147 C	7.1243
939172	AE1-147 E	4.7495
940201	AE2-001 C	7.1412
940202	AE2-001 E	4.7608
940681	AE2-055 C	7.3998
940682	AE2-055 E	4.9332
941251	**AE2-119 C (Withdrawn : 12/16/2019)**	**4.0520**
941252	**AE2-119 E (Withdrawn : 12/16/2019)**	**2.7014**
941261	AE2-120 C	7.1504
941262	AE2-120 E	4.7670
941271	AE2-121 C	3.7720
941272	AE2-121 E	2.5186
941321	AE2-126 C	2.6525
941322	AE2-126 E	1.7683
941331	AE2-129 C	3.1049
941332	AE2-129 E	2.0699
941351	AE2-131 C	3.1049
941352	AE2-131 E	2.0699
941421	AE2-139 C	7.8236
941422	AE2-139 E	5.2157
942351	AE2-248 C	5.8335
942352	AE2-248 E	3.8890
942491	AE2-262 C	26.1095
942492	AE2-262 E	17.5456

Bus #	Bus	MW Impact
942501	AE2-263 C	24.5429
942502	AE2-263 E	16.3863
943751	AF1-043	38.5255
944001	AF1-068 C O1	7.8127
944002	AF1-068 E O1	4.3947
944181	AF1-086 C O1	1.2931
944182	AF1-086 E O1	5.6255
944311	AF1-099 C	39.6342
944312	AF1-099 E	26.4228
944321	AF1-100 C O1	69.3975
944322	AF1-100 E O1	46.2650
944471	AF1-112 C	7.2636
944472	AF1-112 E	4.8424
944671	AF1-132 C O1	7.3427
944672	AF1-132 E O1	4.8951
944691	AF1-134 C O1	2.2470
944692	AF1-134 E O1	2.2470
944701	AF1-135 C	2.6964
944702	AF1-135 E	1.7976
944771	AF1-142 C	63.4148
944772	AF1-142 E	42.2765
944841	AF1-149 C	7.1515
944842	AF1-149 E	4.7677
945071	AF1-172 C	61.3380
945072	AF1-172 E	40.8920
945161	AF1-181	0.3692
945171	AF1-182	1.8506
945181	AF1-183	0.4023
945481	AF1-213 C	25.4386
945482	AF1-213 E	16.9591
945491	AF1-214 C	7.1500
945492	AF1-214 E	4.7666
945551	AF1-220 C	5.7668
945552	AF1-220 E	3.8467
946091	AF1-274 C	10.0853
946092	AF1-274 E	6.7235
946312	AF1-295 BAT	1.5296
LGEE	LGEE	0.0673
WEC	WEC	0.0444
CBM-W2	CBM-W2	0.6962
CBM-W1	CBM-W1	2.1267
TVA	TVA	0.0672
O-066	O-066	5.0266
CBM-S1	CBM-S1	0.5197
G-007	G-007	0.8403
MEC	MEC	0.1907
CATAWBA	CATAWBA	0.0231

Affected Systems

9.7 Affected Systems

9.7.1 LG&E

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

9.7.2 MISO

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

9.7.3 TVA

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

9.7.4 Duke Energy Progress

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

9.7.5 NYISO

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

9.8 Contingency Definitions

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-P2-2-WP-230-005T	CONTINGENCY 'AP-P2-2-WP-230-005T' /* SHINGLETOWN #2 230KV BUS DISCONNECT BRANCH FROM BUS 235248 TO BUS 235970 CKT 1 /* 01SHINGL 230 01DALE 230 DISCONNECT BRANCH FROM BUS 235248 TO BUS 200513 CKT 1 /* 01SHINGL 230 26LEWISTWN 230 DISCONNECT BRANCH FROM BUS 235248 TO BUS 236711 CKT 82 /* 01SHINGL 230 01SHINGLTN 46 DISCONNECT BUS 237058 /*SHINGLETOWN 230 KV CAPACITOR 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
AP-P1-2-WP-230-324T_FSA_B	CONTINGENCY 'AP-P1-2-WP-230-324T_FSA_B' /* MOSHANNON-MARSHALL 230KV APS-PN TIE DISCONNECT BRANCH FROM BUS 919490 TO BUS 200909 CKT 1 /* AA2-000 TAP 230 26LOBO+ 230 DISCONNECT BRANCH FROM BUS 200857 TO BUS 200909 CKT 1 /* 26MARSHALL 230 26LOBO+ 230 DISCONNECT BRANCH FROM BUS 236829 TO BUS 200909 CKT 81 /* 01LOBO 46 46 26LOBO+ 230 REMOVE LOAD 1 FROM BUS 236829 /* 01LOBO 46 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	
200909 26LOBO+ 230 919490 AA2-000 TAP 230 1	CONTINGENCY '200909 26LOBO+ 230 919490 AA2-000 TAP 230 1' OPEN BRANCH FROM BUS 200909 TO BUS 919490 CKT 1 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

Short Circuit

9.9 Short Circuit

The following Breakers are overduty:

None.

10 Network Impacts – Secondary POI

The Queue Project AF1-068 was evaluated as a 20.0 MW (Capacity 12.8 MW) injection at the Boalsburg 46 kV substation in the APS area. Project AF1-068 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-068 was studied with a commercial probability of 0.53. Potential network impacts were as follows:

Summer Peak Load Flow

10.1 Generation Deliverability

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

None

10.2 Multiple Facility Contingency

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

None

10.3 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
41495814	235248	01SHING L	230.0	AP	200513	26LEWISTWN	230.0	PENELEC	1	AP-P2-3-WP-230-446T	breaker	570.0	116.74	118.88	DC	12.22
41495815	235248	01SHING L	230.0	AP	200513	26LEWISTWN	230.0	PENELEC	1	AP-P2-3-WP-230-443T *	breaker	570.0	116.6	118.74	DC	12.22
41774015	235248	01SHING L	230.0	AP	200513	26LEWISTWN	230.0	PENELEC	1	AP-P2-2-WP-230-001T	bus	570.0	116.58	118.72	DC	12.22

10.4 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
41154626	200522	26SHADE GP	115.0	PENELEC	938380	AE1-071 TAP	115.0	PENELEC	1	PL_P12_100618	operation	160.0	108.58	110.08	DC	2.41

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
41154579	200904	26EAGLVAL	115.0	PENELEC	200527	26TYRONEN	115.0	PENELEC	1	AP-P1-2-WP-230-323T	operation	191.0	113.26	113.72	DC	1.93
41154423	235248	01SHINGL	230.0	AP	200513	26LEWISTWN	230.0	PENELEC	1	Base Case	operation	491.0	110.95	112.95	DC	10.11
41154426	235248	01SHINGL	230.0	AP	200513	26LEWISTWN	230.0	PENELEC	1	AP-P1-2-WP-230-324T_FSA_B	operation	570.0	102.97	104.84	DC	10.95
49426214	235248	01SHINGL	230.0	AP	200513	26LEWISTWN	230.0	PENELEC	1	200909 26LOBO+ 230 919490 AA2-000 TAP 230 1	operation	570.0	102.97	104.84	DC	10.95

10.5 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.

10.5.1 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
41774015	235248	01SHINGL	AP	200513	26LEWISTWN	PENELEC	1	AP-P2-2-WP-230-001T	bus	570.0	116.58	118.72	DC	12.22

Bus #	Bus	MW Impact
200665	26SHAWVL 3	11.2213
200666	26SHAWVL 4	11.0429
200715	26SHAWVL 1	6.8508
200722	26SHAWVL 2	7.0238
200894	26K02	13.1208
200898	26AA1-106	2.6976
200905	26Q36	0.2708
200913	26SHAW-D	0.2828
203352	26CANZ2-011	0.4430
235003	AC1-025 E	0.9180
236828	01GRAYMONT	2.3847
290086	Q-036 E	7.7608
919491	AA2-000	169.8793
930511	AB1-092	6.2375
936421	AD2-055	12.8419
936991	AD2-133 C	3.4924
936992	AD2-133 E	15.9737
939171	AE1-147 C	7.1243
939172	AE1-147 E	4.7495
940201	AE2-001 C	7.1412
940202	AE2-001 E	4.7608
940681	AE2-055 C	7.3998
940682	AE2-055 E	4.9332
941251	**AE2-119 C (Withdrawn : 12/16/2019)**	**4.0520**
941252	**AE2-119 E (Withdrawn : 12/16/2019)**	**2.7014**
941261	AE2-120 C	7.1504
941262	AE2-120 E	4.7670
941271	AE2-121 C	3.7720
941272	AE2-121 E	2.5186
941321	AE2-126 C	2.6525
941322	AE2-126 E	1.7683
941331	AE2-129 C	3.1049
941332	AE2-129 E	2.0699
941351	AE2-131 C	3.1049
941352	AE2-131 E	2.0699
941421	AE2-139 C	7.8236
941422	AE2-139 E	5.2157
942351	AE2-248 C	5.8335
942352	AE2-248 E	3.8890
942491	AE2-262 C	26.1095
942492	AE2-262 E	17.5456

Bus #	Bus	MW Impact
942501	AE2-263 C	24.5429
942502	AE2-263 E	16.3863
943751	AF1-043	38.5255
944001	AF1-068 C O2	7.8216
944002	AF1-068 E O2	4.3996
944181	AF1-086 C O2	1.2704
944182	AF1-086 E O2	5.5268
944311	AF1-099 C	39.6342
944312	AF1-099 E	26.4228
944321	AF1-100 C O2	69.4320
944322	AF1-100 E O2	46.2880
944471	AF1-112 C	7.2631
944472	AF1-112 E	4.8421
944671	AF1-132 C O2	7.3327
944672	AF1-132 E O2	4.8885
944691	AF1-134 C O1	2.2470
944692	AF1-134 E O1	2.2470
944701	AF1-135 C	2.6964
944702	AF1-135 E	1.7976
944771	AF1-142 C	63.4148
944772	AF1-142 E	42.2765
944841	AF1-149 C	7.1515
944842	AF1-149 E	4.7677
945071	AF1-172 C	61.3380
945072	AF1-172 E	40.8920
945161	AF1-181	0.3692
945171	AF1-182	1.8506
945181	AF1-183	0.4023
945481	AF1-213 C	25.4386
945482	AF1-213 E	16.9591
945491	AF1-214 C	7.1500
945492	AF1-214 E	4.7666
945551	AF1-220 C	5.7668
945552	AF1-220 E	3.8467
946091	AF1-274 C	10.0853
946092	AF1-274 E	6.7235
946312	AF1-295 BAT	1.5296
LGEE	LGEE	0.0673
WEC	WEC	0.0444
CBM-W2	CBM-W2	0.6962
CBM-W1	CBM-W1	2.1267
TVA	TVA	0.0672
O-066	O-066	5.0266
CBM-S1	CBM-S1	0.5197
G-007	G-007	0.8403
MEC	MEC	0.1907
CATAWBA	CATAWBA	0.0231

Affected Systems

10.6 Affected Systems

10.6.1 LG&E

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

10.6.2 MISO

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

10.6.3 TVA

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

10.6.4 Duke Energy Progress

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

10.6.5 NYISO

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

10.7 Contingency Definitions

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-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
AP-P1-2-WP-230-324T_FSA_B	CONTINGENCY 'AP-P1-2-WP-230-324T_FSA_B' /* MOSHANNON-MARSHALL 230KV APS-PN TIE DISCONNECT BRANCH FROM BUS 919490 TO BUS 200909 CKT 1 /* AA2-000 TAP 230 26LOBO+ 230 DISCONNECT BRANCH FROM BUS 200857 TO BUS 200909 CKT 1 /* 26MARSHALL 230 26LOBO+ 230 DISCONNECT BRANCH FROM BUS 236829 TO BUS 200909 CKT 81 /* 01LOBO 46 46 26LOBO+ 230 REMOVE LOAD 1 FROM BUS 236829 /* 01LOBO 46 46 END
AP-P1-2-WP-230-323T	CONTINGENCY 'AP-P1-2-WP-230-323T' /* SHINGLETOWN-LEWISTOWN 230KV APS-PN TIE DISCONNECT BRANCH FROM BUS 235248 TO BUS 200513 CKT 1 /* 01SHINGL 230 26LEWISTWN 230 END
Base Case	
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
200909 26LOBO+ 230 919490 AA2-000 TAP 230 1	CONTINGENCY '200909 26LOBO+ 230 919490 AA2-000 TAP 230 1' OPEN BRANCH FROM BUS 200909 TO BUS 919490 CKT 1 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

Short Circuit

10.8 Short Circuit

The following Breakers are overduty:

None.

11 Attachment 1 – One Line