Generation Interconnection

Feasibility Study Report

for

Queue Project AF1-278

LEWIS RUN-PIERCE BROOK 3 230 KV

53.44 MW Capacity / 80 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 Mid-Atlantic Interstate Transmission (MAIT - PENELEC zone).

2 Preface

The intent of the feasibility study is to determine a plan, with estimated 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.

An Interconnection Customer with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

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 McKean County, Pennsylvania. The installed facilities will have a capability of 80 MW with 53.44 of new request MW of this output being recognized by PJM as capacity. Note that this project is an increase to the Interconnection Customer's AF1-276 and AF1-277 projects, which will share the same property and connection point. The conduct of light load analysis as required under the PJM planning process is not performed during the Generation Interconnection Feasibility Study phase of the PJM study process. Additional reinforcement requirements for this Interconnection Request may be defined during the conduct of the light load analysis which shall be performed following execution of the System Impact Study agreement. The proposed in-service date for this project is 06/29/2024. This study does not imply a TO commitment to this in-service date.

Queue Number	**AF1-278**
Project Name	LEWIS RUN-PIERCE BROOK 3 230 KV
State	PA
County	McKean
Transmission Owner	MAIT - PENELEC
MFO	280
MWE	80
MWC	53.44
Fuel	Solar
Basecase Study Year	2023

3.1 Point of Interconnection

AF1-278 will interconnect with the MAIT - PENELEC transmission system as an uprate to AF1-276 and AF1-277 tapping the Lewis Run to Pierce Brook 230 kV line.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AF1-278 generation project to connect to the FirstEnergy ("FE") transmission system.

3.2 Cost Summary

AF1-278 does not currently have cost responsibility for the Interconnection work. The Interconnection Facilities to be constructed assumes a prior Queue position, AF1-276, has cost responsibility for the construction of a new 230 kV three (3) breaker ring bus substation and looping the Lewis Run – Pierce Brook 230 kV line into the new station. The new substation will be located approximately 5.4 miles from Lewis Run 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.

AF1-278 cost responsibility may change if earlier Queue positions are no longer responsible for the costs of Attachment Facilities, Direct, Non-Direct and System Upgrades.

The AF1-278 project may be responsible for a contribution to the following costs:

Description	Total Cost
System Upgrades	**$280,459,000**

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.

4 Transmission Owner Scope of Work

AF1-278 will interconnect with the MAIT - PENELEC transmission system as an uprate to AF1-276 and AF1-277 using the AF1-276 interconnection facilities.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AF1-278 generation project to connect to the FirstEnergy (“FE”) transmission system.

5 Attachment Facilities

Attachment Facilities scope of work not required. This scope is included in project AF1-276.

6 Direct Connection Cost Estimate

Direct Connection scope of work not required. This scope is included in project AF1-276.

7 Non-Direct Connection Cost Estimate

Non-Direct Connection scope of work not required. This scope is included in project AF1-276.

8 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 includes the requirement for the IC to make a preliminary payment that compensates FE for the first three months of the engineering design work that is related to the construction of the interconnection substation. This assumes that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the defined direct connection and network upgrades, and that all transmission system outages will be allowed when requested.

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

9 Transmission Owner Analysis

Power Flow Analysis

FE performed an analysis of its underlying transmission <100 kV system. The AF1-278 project did not contribute to any overloads on the FE transmission <100 kV system.

10 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.

The IC has requested a non-standard GSU transformer winding configuration. This transformer is in violation of section 14.2.6 of FE's "Requirements for Transmission Connected Facilities" document and will not be accepted. The GSU transformer must have a grounded wye connection on the high (utility) side and a delta connection on the low (generator) side.

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 230 kV circuit breaker to protect the AF1-278 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 AF1-278 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.

11 Revenue Metering and SCADA Requirements

11.1 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.

11.1.1 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

11.2 PENELEC – FirstEnergy 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.

12 Network Impacts

The Queue Project AF1-278 was evaluated as an 80.0 MW (Capacity 53.44 MW) injection as an uprate to AF1-277 tapping the Lewis Run to Pierce Brook 230 kV line in the MAIT - PENELEC area. Project AF1-278 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-277 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Load Flow

12.1 Generation Deliverability

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

ID	FROM BUS#	FROM BUS	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
3293028	200513	26LEWISTWN	PENELEC	208005	JUNI BU2	PPL	1	Base Case	single	493.0	101.2	102.29	DC	5.45
2758143	235248	01SHINGL	AP	200513	26LEWISTWN	PENELEC	1	Base Case	single	491.0	149.81	150.98	DC	5.95
2758144	235248	01SHINGL	AP	200513	26LEWISTWN	PENELEC	1	PN-P1-2-PN-230-004	single	570.0	146.88	148.22	DC	7.66
3292890	235248	01SHINGL	AP	200513	26LEWISTWN	PENELEC	1	Base Case	single	491.0	149.81	150.98	DC	5.95
3292891	235248	01SHINGL	AP	200513	26LEWISTWN	PENELEC	1	PN-P1-2-PN-230-004	single	570.0	146.88	148.22	DC	7.66
3293337	944300	AF1-098 TAP	PENELEC	200927	26FOURMILE	PENELEC	1	PN-P1-2-PN-230-003	single	245.0	100.38	102.33	DC	4.78

12.2 Multiple Facility Contingency

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

ID	FROM BUS#	FROM BUS	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
3292470	200711	26WHETSTON	PENELEC	200720	26HARVY.RU	PENELEC	1	AP-P2-3-WP-230-708C	breaker	172.0	108.95	110.16	DC	4.62
3292472	200711	26WHETSTON	PENELEC	200720	26HARVY.RU	PENELEC	1	AP-P2-3-WP-230-708DT	breaker	172.0	108.9	110.11	DC	4.62
3292231	200712	26DUBOIS	PENELEC	200713	26ROCKTON	PENELEC	1	PN-P2-2-PN-230-012T	bus	190.0	107.93	108.72	DC	3.36
3292582	200712	26DUBOIS	PENELEC	200713	26ROCKTON	PENELEC	1	PN-P2-3-PN-230-7AT	breaker	190.0	107.93	108.72	DC	3.36
3292234	200713	26ROCKTON	PENELEC	200714	26SHAWVL1	PENELEC	1	PN-P2-2-PN-230-012T	bus	190.0	106.24	107.04	DC	3.36
3292587	200713	26ROCKTON	PENELEC	200714	26SHAWVL1	PENELEC	1	PN-P2-3-PN-230-7AT	breaker	190.0	106.24	107.04	DC	3.36
3292109	200720	26HARVY.RU	PENELEC	200712	26DUBOIS	PENELEC	1	PN-P2-2-PN-230-012T	bus	179.0	136.82	137.66	DC	3.36
3292410	200720	26HARVY.RU	PENELEC	200712	26DUBOIS	PENELEC	1	AP-P2-3-WP-230-708C	breaker	179.0	122.97	124.15	DC	4.67
3292411	200720	26HARVY.RU	PENELEC	200712	26DUBOIS	PENELEC	1	AP-P2-3-WP-230-445	breaker	179.0	111.57	112.56	DC	3.93
3292412	200720	26HARVY.RU	PENELEC	200712	26DUBOIS	PENELEC	1	PN-P2-3-PN-230-7AT	breaker	179.0	136.82	137.66	DC	3.36
3292413	200720	26HARVY.RU	PENELEC	200712	26DUBOIS	PENELEC	1	AP-P2-3-WP-230-708DT	breaker	179.0	122.92	124.1	DC	4.67
3292540	941190	AE2-113 TAP	PENELEC	200582	26RIDGWAY	PENELEC	1	PN-P2-3-PN-230-8I	breaker	160.0	105.05	109.42	DC	6.99
3293640	941190	AE2-113 TAP	PENELEC	200582	26RIDGWAY	PENELEC	1	PN-P7-1-PN-230-002A	tower	160.0	105.05	109.42	DC	6.99
3292176	944300	AF1-098 TAP	PENELEC	200927	26FOURMILE	PENELEC	1	PN-P2-2-PN-230-009	bus	245.0	114.7	115.58	DC	4.77
3292495	999401	STAR592	PJM	200011	KEYSTONE	PJM	4	PJM500_PN_P4-500-001D	breaker	634.0	129.81	130.32	DC	7.11

3292496	999401	STAR592	PJM	200011	KEYSTONE	PJM	4	PJM500_PN_P4-500-001A	breaker	634.0	129.81	130.32	DC	7.11

12.3 Contribution to Previously Identified Overloads

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

ID	FROM BUS#	FROM BUS	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
3293014	200674	26TOWANDA	PENELEC	200677	26NO MESHO	PENELEC	1	PN-P1-2-PN-230-013A	single	202.0	141.23	142.63	DC	2.82
3292367	200927	26FOURMILE	PENELEC	200820	26ERIE SE	PENELEC	1	PN-P2-3-PN-230-6G	breaker	245.0	162.1	162.95	DC	4.57

12.4 Potential Congestion due to Local Energy Deliverability

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

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

ID	FROM BUS#	FROM BUS	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
3293023	200513	26LEWISTWN	PENELEC	208005	JUNI BU2	PPL	1	Base Case	operation	493.0	147.71	148.19	DC	5.45
2758289	200581	26FOREST	PENELEC	235971	01SQUABHLLW	AP	1	PN-P1-2-PN-345-107T	operation	621.0	99.26	101.28	DC	12.52
2758290	200581	26FOREST	PENELEC	235971	01SQUABHLLW	AP	1	ATSI-P1-2-CEI-345-700T	operation	621.0	99.26	101.28	DC	12.52
3293348	200581	26FOREST	PENELEC	235971	01SQUABHLLW	AP	1	PN-P1-2-PN-345-107T	operation	621.0	99.26	101.28	DC	12.52
3293349	200581	26FOREST	PENELEC	235971	01SQUABHLLW	AP	1	ATSI-P1-2-CEI-345-700T	operation	621.0	99.26	101.28	DC	12.52
3293013	200674	26TOWANDA	PENELEC	200677	26NO MESHO	PENELEC	1	PN-P1-2-PN-230-013A	operation	202.0	160.55	161.19	DC	2.82
3293314	200711	26WHETSTON	PENELEC	200720	26HARVY.RU	PENELEC	1	AP-P1-2-WP-230-321T	operation	172.0	109.04	110.25	DC	4.62

3293205	200720	26HARVY.RU	PENELEC	200712	26DUBOIS	PENELEC	1	AP-P1-2-WP-230-321T	operation	179.0	123.09	124.26	DC	4.68
2758138	235248	01SHINGL	AP	200513	26LEWISTWN	PENELEC	1	Base Case	operation	491.0	196.27	196.8	DC	5.95
2758139	235248	01SHINGL	AP	200513	26LEWISTWN	PENELEC	1	AP-P1-2-WP-230-324T_FSA_B	operation	570.0	193.26	193.75	DC	6.32
2758140	235248	01SHINGL	AP	200513	26LEWISTWN	PENELEC	1	200909 26LOBO+ 230 919490 AA2-000 TAP 230 1	operation	570.0	193.26	193.75	DC	6.32
3292885	235248	01SHINGL	AP	200513	26LEWISTWN	PENELEC	1	Base Case	operation	491.0	196.27	196.8	DC	5.95
3292886	235248	01SHINGL	AP	200513	26LEWISTWN	PENELEC	1	AP-P1-2-WP-230-324T_FSA_B	operation	570.0	193.26	193.75	DC	6.32
3292887	235248	01SHINGL	AP	200513	26LEWISTWN	PENELEC	1	200909 26LOBO+ 230 919490 AA2-000 TAP 230 1	operation	570.0	193.26	193.75	DC	6.32
3293271	941190	AE2-113 TAP	PENELEC	200582	26RIDGWAY	PENELEC	1	PN-P1-2-PN-230-028-A	operation	160.0	105.62	110.16	DC	7.27
3293336	944300	AF1-098 TAP	PENELEC	200927	26FOURMILE	PENELEC	1	PN-P1-2-PN-230-003	operation	245.0	114.16	115.04	DC	4.78

12.5 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
3292231,3292582	5	26DUBOIS 115.0 kV - 26ROCKTON 115.0 kV Ckt 1	**PENELEC** **PN-AF1-F-0020a : Replace wave trap at Dubois** **Project Type : FAC** **Cost : $119,000** **Time Estimate : 9.0 Months**	$119,000
3293028	1	26LEWISTWN 230.0 kV - JUNI BU2 230.0 kV Ckt 1	**PENELEC** **PN-AF1-F-0003b: Reconductor Lewistown - Juniata (~24.5 miles).** **Project Type : FAC** **Cost : $102,042,500** **Time Estimate : 6.0 Months** **PN-AF1-F-0003c: Replace relays at Lewistown** **Project Type : FAC** **Cost : $297,500** **Time Estimate : 12.0 Months** **PPL** **R-PL-0006 : Re-conductor PPL's ~0.9mi LEWI-JUNI 230kV Line** **Project Type : FAC** **Cost : $900,000** **Time Estimate : 24.0 Months**	$103,240,000
3292234,3292587	6	26ROCKTON 115.0 kV - 26SHAWVL 1 115.0 kV Ckt 1	**PENELEC** **PN-AF1-F-0021a : Reconductor Dubois - Rockton 115 kV (~0.01 miles)** **Project Type : FAC** **Cost : $0** **Time Estimate : 6.0 Months** **PN-AF1-F-0021b : Replace wave trap at Shawville** **Project Type : FAC** **Cost : $119,000** **Time Estimate : 9.0 Months**	$119,000
3292367	11	26FOURMILE 115.0 kV - 26ERIE SE 115.0 kV Ckt 1	**PENELEC** **PN-AF1-F-0056 : Replace substation conductor at Erie South and Four Mile. Reconductor Erie South - Four Mile 115 kV (~5 miles)** **Project Type : FAC** **Cost : $8,258,600** **Time Estimate : 6.0 Months**	$8,258,600

ID	Index	Facility	Upgrade Description	Cost
3292470,3292470	4	26WHETSTON 115.0 kV - 26HARVY.RU 115.0 kV Ckt 1	**PENELEC** **s1769.1:** Supplemental upgrade s1769.1: Dubois – Harvey Run – Whetstone 115 kV Line, Rehab approximately 14.25 miles of wood pole construction. The supplemental project has a projected in-service date of 12/31/2021. **Project Type:** CON **Cost :** $0 **s1769.2:** Supplemental upgrade s1769.2: Dubois 115 kV substation - Replace Line relaying, line trap, substation conductor, line tuner, CCVT, circuit breaker and breaker disconnects (on Dubois – Harvey Run – Whetstone 115 kV Line). The supplemental project has a projected in-service date of 12/31/2021. **Project Type:** FAC **Cost :** $0	$0
3292109,3292410,3292411,3292412,3292413	7	26HARVY.RU 115.0 kV - 26DUBOIS 115.0 kV Ckt 1	**s1769.3:** Supplemental upgrade s1769.3: Harvey Run 115 kV substation - Replace Substation conductor, disconnect switches and CVTs (on Dubois – Harvey Run – Whetstone 115 kV Line). The supplemental project has a projected in-service date of 12/31/2021. **Project Type:** CON **Cost :** $0 **s1769.4:** Supplemental upgrade s1769.4: Whetstone 115 kV substation - Replace Line relaying, line trap, substation conductor, line tuner, CCVT, circuit breaker and breaker disconnects (on Dubois – Harvey Run – Whetstone 115 kV Line). The supplemental project has a projected in-service date of 12/31/2021. **Project Type:** CON **Cost :** $0	
3292540,3293640	8	AE2-113 TAP 115.0 kV - 26RIDGWAY 115.0 kV Ckt 1	**PN-AF1-F-0010 : Reconductor Ridgway - AE2-133 line (~22 miles).** **Project Type : FAC** **Cost : $39,270,000** **Time Estimate : 6.0 Months**	$39,270,000
3293014	10	26TOWANDA 115.0 kV - 26NO MESHO 115.0 kV Ckt 1	**PENELEC** **PN-AF1-F-0012 :** • Replace disconnect switch at East Towanda • Replace substation conductor at East Towanda and North Meshoppen • Replace Wave Trap at East Towanda • Reconductor East Towanda - North Meshoppen 115 kV (~21 miles) • Replace relays at East Towanda and North Meshoppen • Replace CTs at East Towanda and North Meshoppen • Replace meters at East Towanda and North Meshoppen **Project Type : FAC** **Cost : $39,151,000** **Time Estimate : 12.0 Months**	$39,151,000

ID	Index	Facility	Upgrade Description	Cost
2758143,2758144,3292890,3292891	2	01SHINGL 230.0 kV - 26LEWISTWN 230.0 kV Ckt 1	**APS** **WP-AF1-F-0005a : Replace substation conductor at Shingletown** **Project Type : FAC** **Cost : $126,000** **Time Estimate : 6.0 Months** **WP-AF1-F-0005b : Replace substation conductor** **Replace switches at Shingletown** **Project Type : FAC** **Cost : $378,000** **Time Estimate : 9.0 Months** **WP-AF1-F-0005c : Replace substation conductor and relays at Lewistown and Shingletown** **Project Type : FAC** **Cost : $441,000** **Time Estimate : 12.0 Months** **WP-AF1-F-0005d : Replace circuit breaker at Shingletown** **Project Type : FAC** **Cost : $630,000** **Time Estimate : 12.0 Months** **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** **PN-AF1-F-0061c : Replace disconnect switches at Shingletown** **Replace substation conductor at Shingletown** **Replace relays at Lewistown and Shingletown** **Project Type : FAC** **Cost : $714,000** **Time Estimate : 12.0 Months** **PN-AF1-F-0061d : Replace 1600 Amp Generic circuit breaker at Shingletown** **Project Type : FAC** **Cost : $595,000** **Time Estimate : 12.0 Months**	$49,948,500

ID	Index	Facility	Upgrade Description	Cost
3292495,3292496	9	STAR592 1.0 kV - KEYSTONE 500.0 kV Ckt 4	**PENELEC** **PN-AF1-F-0046a : Replace transformer** **Replace substation conductor at Keystone (3A)** **Project Type : FAC** **Cost : $26,180,000** **Time Estimate : 24.0 Months** **PN-AF1-F-0046b : Replace relay at Keystone (3A)** **Project Type : FAC** **Cost : $357,000** **Time Estimate : 12.0 Months**	$26,537,000
3292176,3293337	3	AF1-098 TAP 115.0 kV - 26FOURMILE 115.0 kV Ckt 1	**PENELEC** **PN-AF1-F-0072: Reconductor AF1-098 - Four Mile 115 kV (~8 miles)** **Project Type : FAC** **Cost : $13,815,900** **Time Estimate : 6.0 Months**	$13,815,900
			TOTAL COST	**$280,459,000**

12.6 Flow Gate Details

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

12.6.1 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
3293028	200513	26LEWISTWN	PENELEC	208005	JUNI BU2	PPL	1	Base Case	single	493.0	101.2	102.29	DC	5.45

Bus #	Bus	MW Impact
200503	26C.SLOPE	9.92
200642	26SENECA#1	3.79
200643	26SENECA#2	3.58
200644	26SENECA#3	0.36
200649	26PENNTECH	0.99
200665	26SHAWVL 3	5.67
200666	26SHAWVL 4	5.58
200715	26SHAWVL 1	3.71
200722	26SHAWVL 2	3.8
200812	26ALY HYDR	1.07
200852	26WARR RDG	0.31
200870	26C_T85_W218	0.07
200886	26ARWF_N39	0.41
200888	26HIGHLAND	0.18
200905	26Q36	0.24
200913	26SHAW-D	0.17
200915	26CHSTN_FL	0.14
200925	26R32	0.21
200945	26CT_V3-030	0.08
201201	26WRREN CT	0.81
201477	26Y2-055	2.96
203034	26NA_O38_P22	0.36
203352	26CANZ2-011	0.26
203905	26W1-045 C	0.64
919491	AA2-000	84.88
922932	AB1-082 OP	1.91
930511	AB1-092	3.12
936421	AD2-055	6.42
936471	AD2-062 C O1	5.49
936991	AD2-133 C	3.05
938381	AE1-071 C	12.34
938991	AE1-128 C	6.83
939171	AE1-147 C	3.94
940201	AE2-001 C	3.96
940681	AE2-055 C	4.16
940861	AE2-074 C	1.45
941191	AE2-113 C	8.33
941231	AE2-117 C	4.39
941241	AE2-118 C	4.39
941251	AE2-119 C	2.41
941261	AE2-120 C	3.96
941271	AE2-121 C	2.08

Bus #	Bus	MW Impact
941321	AE2-126 C	2.19
941331	AE2-129 C	2.21
941351	AE2-131 C	2.21
942031	AE2-215 C	14.06
942121	AE2-224 C	7.13
942351	AE2-248 C	3.26
942361	AE2-249 C	0.77
942491	AE2-262 C	13.63
942501	AE2-263 C	12.81
942511	AE2-264 C	14.38
942961	AE2-316 C	5.55
943751	AF1-043	19.25
944001	AF1-068 C O1	4.37
944181	AF1-086 C O1	2.49
944311	AF1-099 C	20.69
944321	AF1-100 C O1	35.07
944381	AF1-103 O1	2.04
944471	AF1-112 C	4.05
944671	AF1-132 C O1	4.11
944691	AF1-134 C O1	1.55
944701	AF1-135 C	1.87
944731	AF1-138 C O1	4.39
944751	AF1-140 C	1.08
944771	AF1-142 C	33.11
944841	AF1-149 C	3.96
944881	AF1-153 C O1	2.1
944901	AF1-155 C	2.09
945071	AF1-172 C	30.41
945121	AF1-177	0.51
945161	AF1-181	0.19
945171	AF1-182	0.94
945181	AF1-183	0.22
945481	AF1-213 C	16.17
945491	AF1-214 C	3.96
945551	AF1-220 C	15.5
945771	AF1-242 C	2.09
945901	AF1-255 C	0.57
946091	AF1-274 C	9.14
946111	AF1-276 C	6.84
946121	AF1-277 C	6.84
946131	AF1-278	5.45
946241	AF1-289 C O1	2.62
946311	AF1-295	4.69
946381	AF1-302 C	2.42
946421	AF1-306 C	10.74
CBM-S1	CBM-S1	9.18
CBM-S2	CBM-S2	4.62
CBM-W1	CBM-W1	16.13
CBM-W2	CBM-W2	9.22
CPLE	CPLE	0.46
LGEE	LGEE	0.68
MEC	MEC	1.9

Bus #	Bus	MW Impact
TVA	TVA	1.47
WEC	WEC	0.39

12.6.2 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
3292890	235248	01SHINGL	AP	200513	26LEWISTWN	PENELEC	1	Base Case	single	491.0	149.81	150.98	DC	5.95

Bus #	Bus	MW Impact
200642	26SENECA#1	4.49
200643	26SENECA#2	4.24
200644	26SENECA#3	0.42
200649	26PENNTECH	1.27
200665	26SHAWVL 3	7.84
200666	26SHAWVL 4	7.72
200715	26SHAWVL 1	4.94
200722	26SHAWVL 2	5.06
200898	26AA1-106	2.43
200905	26Q36	0.2
200913	26SHAW-D	0.21
201201	26WRREN CT	0.93
201477	26Y2-055	3.41
203261	26BLOSSBCT	0.26
203349	26Z1-069 C	0.17
203351	26GROZ1-110	0.34
203352	26CANZ2-011	0.34
919201	AA1-144 OP	14.76
919491	AA2-000	118.0
922932	AB1-082 OP	2.12
923442	AB1-160 C	0.05
930511	AB1-092	4.33
934801	AD1-108	0.03
934811	AD1-109	0.02
936421	AD2-055	8.92
936991	AD2-133 C	2.58
939171	AE1-147 C	5.8
940201	AE2-001 C	5.82
940681	AE2-055 C	6.15
940861	AE2-074 C	1.61
941191	AE2-113 C	10.06
941251	AE2-119 C	3.05
941261	AE2-120 C	5.83
941271	AE2-121 C	3.06
941321	AE2-126 C	2.79
941331	AE2-129 C	2.32
941351	AE2-131 C	2.32
941421	AE2-139 C	6.91
942351	AE2-248 C	4.81
942491	AE2-262 C	19.56
942501	AE2-263 C	18.39
942961	AE2-316 C	6.86

Bus #	Bus	MW Impact
943751	AF1-043	26.76
944001	AF1-068 C O1	6.46
944181	AF1-086 C O1	2.33
944311	AF1-099 C	29.7
944321	AF1-100 C O1	48.5
944381	AF1-103 O1	2.35
944471	AF1-112 C	5.98
944671	AF1-132 C O1	6.08
944691	AF1-134 C O1	1.74
944701	AF1-135 C	2.09
944771	AF1-142 C	47.51
944841	AF1-149 C	5.83
944881	AF1-153 C O1	2.78
944901	AF1-155 C	2.76
945071	AF1-172 C	42.35
945121	AF1-177	0.59
945161	AF1-181	0.26
945171	AF1-182	1.29
945181	AF1-183	0.29
945331	AF1-198	0.24
945481	AF1-213 C	19.37
945491	AF1-214 C	5.83
945551	AF1-220 C	19.86
945771	AF1-242 C	2.76
946091	AF1-274 C	11.66
946111	AF1-276 C	7.46
946121	AF1-277 C	7.46
946131	AF1-278	5.95
946381	AF1-302 C	3.0
946421	AF1-306 C	14.32
CBM-S1	CBM-S1	3.37
CBM-S2	CBM-S2	0.91
CBM-W1	CBM-W1	7.38
CBM-W2	CBM-W2	3.6
CPLE	CPLE	0.04
LGEE	LGEE	0.28
MEC	MEC	0.79
TVA	TVA	0.52
WEC	WEC	0.17

12.6.3 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
3292176	944300	AF1-098 TAP	PENELEC	200927	26FOURMILE	PENELEC	1	PN-P2-2-PN-230-009	bus	245.0	114.7	115.58	DC	4.77

Bus #	Bus	MW Impact
200642	26SENECA#1	4.58
200643	26SENECA#2	4.33
200644	26SENECA#3	0.43
201201	26WRREN CT	1.82
201477	26Y2-055	6.59
922932	AB1-082 OP	1.13
940861	AE2-074 C	0.86
940862	AE2-074 E	1.13
941191	AE2-113 C	4.34
941192	AE2-113 E	4.67
941321	AE2-126 C	0.68
941322	AE2-126 E	0.46
942813	AE2-299 BAT	10.84
944301	AF1-098 C	37.3
944302	AF1-098 E	24.87
944381	AF1-103 O1	4.57
944392	AF1-104 BAT	1.02
944881	AF1-153 C O1	0.62
944882	AF1-153 E O1	0.42
944901	AF1-155 C	0.62
944902	AF1-155 E	0.41
945121	AF1-177	1.14
945551	AF1-220 C	6.08
945552	AF1-220 E	4.05
945771	AF1-242 C	0.62
945772	AF1-242 E	0.41
946091	AF1-274 C	3.05
946092	AF1-274 E	2.03
946111	AF1-276 C	5.98
946112	AF1-276 E	2.95
946121	AF1-277 C	5.98
946122	AF1-277 E	2.95
946131	AF1-278	4.77
946421	AF1-306 C	3.68
946422	AF1-306 E	14.72
BLUEG	BLUEG	0.74
CALDERWOOD	CALDERWOOD	0.17
CATAWBA	CATAWBA	0.1
CHEOAH	CHEOAH	0.17
COFFEEN	COFFEEN	0.23
DUCKCREEK	DUCKCREEK	0.51

Bus #	Bus	MW Impact
EDWARDS	EDWARDS	0.16
FARMERCITY	FARMERCITY	0.02
G-007A	G-007A	1.14
GIBSON	GIBSON	0.24
MADISON	MADISON	0.02
NEWTON	NEWTON	0.46
PRAIRIE	PRAIRIE	1.08
TILTON	TILTON	0.28
TRIMBLE	TRIMBLE	0.24
VFT	VFT	3.13

12.6.4 Index 4

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
3292472	200711	26WHETSTON	PENELEC	200720	26HARVY.RU	PENELEC	1	AP-P2-3-WP-230-708DT	breaker	172.0	108.9	110.11	DC	4.62

Bus #	Bus	MW Impact
200642	26SENECA#1	3.64
200643	26SENECA#2	3.44
200644	26SENECA#3	0.34
200649	26PENNTECH	1.61
201477	26Y2-055	2.65
235007	AC1-025 BAT	0.08
916202	Z1-069 E	2.92
922932	AB1-082 OP	1.57
923443	AB1-160 E	0.83
940861	AE2-074 C	1.2
940862	AE2-074 E	1.57
941191	AE2-113 C	11.19
941192	AE2-113 E	12.05
944313	AF1-099 BAT	2.67
944323	AF1-100 BAT	6.84
944381	AF1-103 O1	1.83
944773	AF1-142 BAT	4.26
945121	AF1-177	0.46
945483	AF1-213 BAT	6.33
945551	AF1-220 C	31.19
945552	AF1-220 E	20.81
946111	AF1-276 C	5.79
946112	AF1-276 E	2.85
946121	AF1-277 C	5.79
946122	AF1-277 E	2.85
946131	AF1-278	4.62
946423	AF1-306 BAT	19.01
CBM-S1	CBM-S1	1.28
CBM-S2	CBM-S2	0.49
CBM-W1	CBM-W1	2.68
CBM-W2	CBM-W2	1.33
CPLE	CPLE	0.04
G-007	G-007	0.33
LGEE	LGEE	0.1
MEC	MEC	0.29
O-066	O-066	2.16
TVA	TVA	0.2
WEC	WEC	0.06

12.6.5 Index 5

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
3292582	200712	26DUBOIS	PENELEC	200713	26ROCKTON	PENELEC	1	PN-P2-3-PN-230-7AT	breaker	190.0	107.93	108.72	DC	3.36

Bus #	Bus	MW Impact
200649	26PENNTECH	2.95
916202	Z1-069 E	3.64
922932	AB1-082 OP	1.96
923443	AB1-160 E	1.04
940861	AE2-074 C	1.49
940862	AE2-074 E	1.96
941191	AE2-113 C	18.46
941192	AE2-113 E	19.87
941321	AE2-126 C	8.26
941322	AE2-126 E	5.5
944323	AF1-100 BAT	4.65
945483	AF1-213 BAT	4.39
945551	AF1-220 C	49.61
945552	AF1-220 E	33.09
946091	AF1-274 C	32.98
946092	AF1-274 E	21.98
946111	AF1-276 C	4.22
946112	AF1-276 E	2.08
946121	AF1-277 C	4.22
946122	AF1-277 E	2.08
946131	AF1-278	3.36
CBM-S1	CBM-S1	0.53
CBM-S2	CBM-S2	0.18
CBM-W1	CBM-W1	1.16
CBM-W2	CBM-W2	0.57
CPLE	CPLE	0.01
G-007	G-007	0.16
LGEE	LGEE	0.04
MEC	MEC	0.12
O-066	O-066	1.01
TVA	TVA	0.08
WEC	WEC	0.03

12.6.6 Index 6

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
3292587	200713	26ROCKTON	PENELEC	200714	26SHAWVL 1	PENELEC	1	PN-P2-3-PN-230-7AT	breaker	190.0	106.24	107.04	DC	3.36

Bus #	Bus	MW Impact
200649	26PENNTECH	2.95
916202	Z1-069 E	3.64
922932	AB1-082 OP	1.96
923443	AB1-160 E	1.04
940861	AE2-074 C	1.49
940862	AE2-074 E	1.96
941191	AE2-113 C	18.46
941192	AE2-113 E	19.87
941321	AE2-126 C	8.26
941322	AE2-126 E	5.5
944323	AF1-100 BAT	4.65
945483	AF1-213 BAT	4.39
945551	AF1-220 C	49.61
945552	AF1-220 E	33.09
946091	AF1-274 C	32.98
946092	AF1-274 E	21.98
946111	AF1-276 C	4.22
946112	AF1-276 E	2.08
946121	AF1-277 C	4.22
946122	AF1-277 E	2.08
946131	AF1-278	3.36
CBM-S1	CBM-S1	0.53
CBM-S2	CBM-S2	0.18
CBM-W1	CBM-W1	1.16
CBM-W2	CBM-W2	0.57
CPLE	CPLE	0.01
G-007	G-007	0.16
LGEE	LGEE	0.04
MEC	MEC	0.12
O-066	O-066	1.01
TVA	TVA	0.08
WEC	WEC	0.03

12.6.7 Index 7

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
3292412	200720	26HARVY.RU	PENELEC	200712	26DUBOIS	PENELEC	1	PN-P2-3-PN-230-7AT	breaker	179.0	136.82	137.66	DC	3.36

Bus #	Bus	MW Impact
200649	26PENNTECH	2.95
916202	Z1-069 E	3.64
922932	AB1-082 OP	1.96
923443	AB1-160 E	1.04
940861	AE2-074 C	1.49
940862	AE2-074 E	1.96
941191	AE2-113 C	18.46
941192	AE2-113 E	19.87
944323	AF1-100 BAT	4.65
945483	AF1-213 BAT	4.39
945551	AF1-220 C	49.61
945552	AF1-220 E	33.09
946091	AF1-274 C	32.98
946092	AF1-274 E	21.98
946111	AF1-276 C	4.22
946112	AF1-276 E	2.08
946121	AF1-277 C	4.22
946122	AF1-277 E	2.08
946131	AF1-278	3.36
CBM-S1	CBM-S1	0.53
CBM-S2	CBM-S2	0.18
CBM-W1	CBM-W1	1.16
CBM-W2	CBM-W2	0.57
CPLE	CPLE	0.01
G-007	G-007	0.16
LGEE	LGEE	0.04
MEC	MEC	0.12
O-066	O-066	1.01
TVA	TVA	0.08
WEC	WEC	0.03

12.6.8 Index 8

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
3293640	941190	AE2-113 TAP	PENELEC	200582	26RIDGWAY	PENELEC	1	PN-P7-1-PN-230-002A	tower	160.0	105.05	109.42	DC	6.99

Bus #	Bus	MW Impact
203349	26Z1-069 C	0.21
235007	AC1-025 BAT	0.09
916202	Z1-069 E	6.39
922932	AB1-082 OP	3.41
923442	AB1-160 C	0.06
923443	AB1-160 E	1.82
940861	AE2-074 C	2.59
940862	AE2-074 E	3.41
941191	AE2-113 C	29.73
941192	AE2-113 E	32.01
944313	AF1-099 BAT	2.97
944323	AF1-100 BAT	6.78
944773	AF1-142 BAT	4.75
945483	AF1-213 BAT	3.58
946111	AF1-276 C	8.77
946112	AF1-276 E	4.32
946121	AF1-277 C	8.77
946122	AF1-277 E	4.32
946131	AF1-278	6.99
946423	AF1-306 BAT	32.29
CBM-S1	CBM-S1	0.54
CBM-S2	CBM-S2	0.22
CBM-W1	CBM-W1	1.08
CBM-W2	CBM-W2	0.56
CPLE	CPLE	0.02
G-007	G-007	0.12
LGEE	LGEE	0.04
MEC	MEC	0.12
O-066	O-066	0.7
TVA	TVA	0.09
WEC	WEC	0.02

12.6.9 Index 9

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
3292496	999401	STAR592	PJM	200011	KEYSTONE	PJM	4	PJM500_PN_P4-500-001A	breaker	634.0	129.81	130.32	DC	7.11

Bus #	Bus	MW Impact
200503	26C.SLOPE	16.73
200636	26IUP CO-G	0.41
200794	26CONEMAGH	0.28
200805	26COLVER13	19.54
200809	26SITHE	1.28
200833	26SEWRDB34	13.29
200834	26SW_E13_K22	0.04
200835	26DSGENWIN	0.2
200837	26HOMER C1	22.01
200838	26HOMER C2	18.45
200839	26HOMER C3	19.53
200846	26FORWARD	0.15
200864	K-013 E	4.29
200883	Q-053 E	7.89
200886	26ARWF_N39	0.37
200888	26HIGHLAND	0.33
200889	26STNY CRK	0.25
200890	26BF_G21_K23	0.1
200891	26CSLMN_L13	0.16
200892	26LOOKOUT	0.15
200894	26K02	5.03
200898	26AA1-106	1.9
200906	26KEYSTN#3	0.68
200915	26CHSTN_FL	0.17
200925	26R32	0.38
200945	26CT_V3-030	0.13
201144	W3-099 C OP1	1.04
201477	26Y2-055	2.97
202158	26CON.GEN1	0.07
202160	26CON.GEN2	0.05
202225	26SCI_S29B	0.07
203034	26NA_O38_P22	0.32
203910	26Z1-091	1.72
203999	P-047 E	9.02
235003	AC1-025 E	0.13
236828	01GRAYMONT	0.34
290086	Q-036 E	5.59
292350	K-023	4.63
292542	L-013 1	4.5
293301	N-039 E	10.47
293393	V3-030E	4.83
293432	R-040 E	0.25

Bus #	Bus	MW Impact
293603	O-018 E	9.33
293902	O-048 E	4.05
294515	O38_P22	9.16
294903	P-060 E	7.18
296332	R-032 E	10.77
903644	W3-099 E OP1	6.98
913142	Y1-033 E OP1	3.68
916202	Z1-069 E	7.19
917672	Z2-108 E	2.53
918682	AA1-082 E	4.9
919201	AA1-144 OP	13.93
919491	AA2-000	43.49
920341	AA2-132	1.9
922932	AB1-082 OP	2.62
923443	AB1-160 E	2.06
930511	AB1-092	1.6
935191	AD1-154	2.77
936421	AD2-055	3.29
936991	AD2-133 C	2.51
936992	AD2-133 E	11.5
938351	AE1-053	1.41
938881	AE1-116	0.75
938951	AE1-123	1.95
938991	AE1-128 C	12.7
938992	AE1-128 E	8.47
939171	AE1-147 C	1.02
939172	AE1-147 E	0.68
939291	AE1-160 C	1.21
939292	AE1-160 E	0.69
939381	AE1-169 C O1	4.93
939382	AE1-169 E O1	3.28
940201	AE2-001 C	1.02
940202	AE2-001 E	0.68
940681	AE2-055 C	1.0
940682	AE2-055 E	0.67
940861	AE2-074 C	1.99
940862	AE2-074 E	2.62
941191	AE2-113 C	7.79
941192	AE2-113 E	8.38
941231	AE2-117 C	1.28
941232	AE2-117 E	0.85
941241	AE2-118 C	1.28
941242	AE2-118 E	0.85
941251	AE2-119 C	1.38
941252	AE2-119 E	0.92
941261	AE2-120 C	1.02
941262	AE2-120 E	0.68
941271	AE2-121 C	0.55
941272	AE2-121 E	0.36
941321	AE2-126 C	1.36
941322	AE2-126 E	0.91
941331	AE2-129 C	1.54

Bus #	Bus	MW Impact
941332	AE2-129 E	1.03
941351	AE2-131 C	1.54
941352	AE2-131 E	1.03
941421	AE2-139 C	5.24
941422	AE2-139 E	3.5
942121	AE2-224 C	11.1
942122	AE2-224 E	7.4
942351	AE2-248 C	0.81
942352	AE2-248 E	0.54
942361	AE2-249 C	1.43
942362	AE2-249 E	0.95
942491	AE2-262 C	4.6
942492	AE2-262 E	3.09
942501	AE2-263 C	4.32
942502	AE2-263 E	2.88
942511	AE2-264 C	6.09
942512	AE2-264 E	4.06
942811	AE2-299 C	2.59
942812	AE2-299 E	10.36
942961	AE2-316 C	4.22
942962	AE2-316 E	6.02
943151	AE2-344 C	5.53
943152	AE2-344 E	3.68
943351	AF1-006 C	0.95
943352	AF1-006 E	0.54
943711	AF1-039 C O1	0.97
943712	AF1-039 E O1	0.65
943751	AF1-043	9.86
943871	AF1-055 C O1	4.0
943872	AF1-055 E O1	2.67
944001	AF1-068 C O1	1.07
944002	AF1-068 E O1	0.6
944181	AF1-086 C O1	3.29
944182	AF1-086 E O1	14.32
944261	AF1-094 C	1.01
944262	AF1-094 E	0.67
944281	AF1-096 C	1.14
944282	AF1-096 E	0.76
944301	AF1-098 C	3.98
944302	AF1-098 E	2.66
944311	AF1-099 C	6.98
944312	AF1-099 E	4.65
944321	AF1-100 C O1	14.94
944322	AF1-100 E O1	9.96
944381	AF1-103 O1	2.05
944391	AF1-104 O1	1.38
944411	AF1-106 O1	2.07
944471	AF1-112 C	1.01
944472	AF1-112 E	0.67
944671	AF1-132 C O1	1.0
944672	AF1-132 E O1	0.67
944691	AF1-134 C O1	1.41

Bus #	Bus	MW Impact
944692	AF1-134 E O1	1.41
944701	AF1-135 C	1.69
944702	AF1-135 E	1.13
944731	AF1-138 C O1	1.28
944732	AF1-138 E O1	0.85
944741	AF1-139 C O1	1.15
944742	AF1-139 E O1	0.76
944751	AF1-140 C	1.69
944752	AF1-140 E	1.13
944771	AF1-142 C	11.16
944772	AF1-142 E	7.44
944781	AF1-143 C	8.44
944782	AF1-143 E	5.63
944841	AF1-149 C	1.02
944842	AF1-149 E	0.68
944881	AF1-153 C O1	1.22
944882	AF1-153 E O1	0.81
944901	AF1-155 C	1.22
944902	AF1-155 E	0.81
945021	AF1-167 C	0.89
945022	AF1-167 E	0.6
945051	AF1-170 C	3.44
945052	AF1-170 E	2.29
945071	AF1-172 C	14.28
945072	AF1-172 E	9.52
945121	AF1-177	0.51
945161	AF1-181	0.08
945171	AF1-182	0.4
945181	AF1-183	0.11
945331	AF1-198	0.28
945451	AF1-210 C	0.83
945452	AF1-210 E	0.55
945481	AF1-213 C	11.71
945482	AF1-213 E	7.81
945491	AF1-214 C	1.02
945492	AF1-214 E	0.68
945551	AF1-220 C	10.19
945552	AF1-220 E	6.8
945671	AF1-232 C O1	17.68
945672	AF1-232 E O1	9.52
945751	AF1-240 C O1	1.66
945752	AF1-240 E O1	1.11
945771	AF1-242 C	1.22
945772	AF1-242 E	0.81
945901	AF1-255 C	0.99
945902	AF1-255 E	1.37
946071	AF1-272 C O1	17.96
946072	AF1-272 E O1	11.97
946081	AF1-273 C O1	10.2
946082	AF1-273 E O1	6.8
946091	AF1-274 C	5.76
946092	AF1-274 E	3.84

Bus #	Bus	MW Impact
946111	AF1-276 C	8.93
946112	AF1-276 E	4.4
946121	AF1-277 C	8.93
946122	AF1-277 E	4.4
946131	AF1-278	7.11
946191	AF1-284 C O1	1.01
946192	AF1-284 E O1	0.61
946211	AF1-286 C O1	0.84
946212	AF1-286 E O1	0.57
946221	AF1-287 C	0.95
946222	AF1-287 E	0.64
946241	AF1-289 C O1	4.16
946242	AF1-289 E O1	2.78
946381	AF1-302 C	1.84
946382	AF1-302 E	2.46
946401	AF1-304 C	5.84
946402	AF1-304 E	3.9
946421	AF1-306 C	5.98
946422	AF1-306 E	23.93
946431	AF1-307 C	7.14
946432	AF1-307 E	4.76
946571	AF1-321 C O1	2.24
946572	AF1-321 E O1	1.5
946771	AF1-217 C O1	0.95
946772	AF1-217 E O1	0.64
BLUEG	BLUEG	0.91
CALDERWOOD	CALDERWOOD	0.29
CATAWBA	CATAWBA	0.22
CHEOAH	CHEOAH	0.29
COFFEEN	COFFEEN	0.27
DUCKCREEK	DUCKCREEK	0.56
EDWARDS	EDWARDS	0.17
FARMERCITY	FARMERCITY	0.03
G-007	G-007	0.04
GIBSON	GIBSON	0.28
MADISON	MADISON	0.03
NEWTON	NEWTON	0.55
PRAIRIE	PRAIRIE	1.34
TILTON	TILTON	0.31
TRIMBLE	TRIMBLE	0.29

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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
3293014	200674	26TOWANDA	PENELEC	200677	26NO MESHO	PENELEC	1	PN-P1-2-PN-230-013A	single	202.0	141.23	142.63	DC	2.82

Bus #	Bus	MW Impact
200649	26PENNTECH	0.3
200665	26SHAWVL 3	1.24
200666	26SHAWVL 4	1.21
200887	26ARMNA MT	0.48
200898	26AA1-106	3.31
200949	26X1-109	21.29
203261	26BLOSSBCT	0.39
203283	26MANOR_T86	0.04
203349	26Z1-069 C	0.2
203350	26MILZ1-092	0.49
203351	26GROZ1-110	0.46
203352	26CANZ2-011	0.46
919201	AA1-144 OP	32.01
919491	AA2-000	44.77
920351	AA2-133	0.19
922932	AB1-082 OP	1.63
923442	AB1-160 C	0.06
930511	AB1-092	1.64
934801	AD1-108	0.03
934811	AD1-109	0.03
935061	AD1-142	0.03
936421	AD2-055	3.38
940861	AE2-074 C	1.24
941191	AE2-113 C	3.49
941421	AE2-139 C	10.94
942491	AE2-262 C	2.53
942501	AE2-263 C	2.37
943751	AF1-043	10.15
944311	AF1-099 C	3.83
944321	AF1-100 C O1	7.62
944411	AF1-106 O1	3.51
944771	AF1-142 C	6.13
945071	AF1-172 C	12.03
945161	AF1-181	0.04
945171	AF1-182	0.2
945331	AF1-198	0.37
946111	AF1-276 C	3.54
946121	AF1-277 C	3.54
946131	AF1-278	2.82
946211	AF1-286 C O1	1.42
CBM-S1	CBM-S1	4.12

Bus #	Bus	MW Impact
CBM-S2	CBM-S2	2.12
CBM-W1	CBM-W1	7.21
CBM-W2	CBM-W2	4.14
CPLE	CPLE	0.21
LGEE	LGEE	0.3
MEC	MEC	0.85
TVA	TVA	0.66
WEC	WEC	0.17

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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
3292367	200927	26FOURMILE	PENELEC	200820	26ERIE SE	PENELEC	1	PN-P2-3-PN-230-6G	breaker	245.0	162.1	162.95	DC	4.57

Bus #	Bus	MW Impact
200642	26SENECA#1	3.44
200643	26SENECA#2	3.25
200644	26SENECA#3	0.33
201144	W3-099 C OP1	5.72
201201	26WRREN CT	1.22
201477	26Y2-055	4.42
203910	26Z1-091	1.0
203999	P-047 E	4.21
903644	W3-099 E OP1	38.25
915952	Y3-092 NFTWR	52.78
916202	Z1-069 E	3.53
920341	AA2-132	1.11
922932	AB1-082 OP	1.37
923443	AB1-160 E	1.01
923821	AB2-019 FTWR	1.48
940861	AE2-074 C	1.04
940862	AE2-074 E	1.37
941191	AE2-113 C	4.25
941192	AE2-113 E	4.58
942811	AE2-299 C	13.9
942812	AE2-299 E	55.59
944301	AF1-098 C	21.89
944302	AF1-098 E	14.59
944381	AF1-103 O1	3.06
944392	AF1-104 BAT	1.08
944411	AF1-106 O1	1.16
944741	AF1-139 C O1	0.67
944742	AF1-139 E O1	0.45
945121	AF1-177	0.77
945331	AF1-198	0.13
945551	AF1-220 C	5.21
945552	AF1-220 E	3.48
946091	AF1-274 C	2.63
946092	AF1-274 E	1.75
946111	AF1-276 C	5.74
946112	AF1-276 E	2.83
946121	AF1-277 C	5.74
946122	AF1-277 E	2.83
946131	AF1-278	4.57
946211	AF1-286 C O1	0.47
946212	AF1-286 E O1	0.32

Bus #	Bus	MW Impact
946403	AF1-304 BAT	6.44
946421	AF1-306 C	3.04
946422	AF1-306 E	12.15
AA3-300	AA3-300	5.23
BLUEG	BLUEG	0.99
CALDERWOOD	CALDERWOOD	0.23
CATAWBA	CATAWBA	0.13
CHEOAH	CHEOAH	0.23
COFFEEN	COFFEEN	0.3
DUCKCREEK	DUCKCREEK	0.68
EDWARDS	EDWARDS	0.21
FARMERCITY	FARMERCITY	0.03
G-007A	G-007A	1.78
GIBSON	GIBSON	0.31
MADISON	MADISON	0.02
NEWTON	NEWTON	0.62
PRAIRIE	PRAIRIE	1.44
TILTON	TILTON	0.37
TRIMBLE	TRIMBLE	0.32
VFT	VFT	4.9

Affected Systems

12.7 Affected Systems

12.7.1 LG&E

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

12.7.2 MISO

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

12.7.3 TVA

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

12.7.4 Duke Energy Progress

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

12.7.5 NYISO

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

12.8 Contingency Definitions

Contingency Name	Contingency Definition
PN-P1-2-PN-230-003	CONTINGENCY 'PN-P1-2-PN-230-003' /* ERIE SOUTH - WARREN 230KV DISCONNECT BRANCH FROM BUS 200918 TO BUS 200811 CKT 1 /* 26ERIE S TIE230 26WARREN 230 END
PJM500_PN_P4-500-001A	CONTINGENCY 'PJM500_PN_P4-500-001A' /* KEYSTONE 500KV BKR 1 DISCONNECT BRANCH FROM BUS 200011 TO BUS 200810 CKT 3 /* KEYSTONE 500 26KEYSTONE 230 REMOVE MACHINE H FROM BUS 200033 /* KEYS G2 20 REMOVE MACHINE L FROM BUS 200033 /* KEYS G2 20 DISCONNECT BUS 200033 /* KEYS G2 20 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
PN-P2-2-PN-230-012T	CONTINGENCY 'PN-P2-2-PN-230-012T' /* FOREST 230KV BUS DISCONNECT BRANCH FROM BUS 200581 TO BUS 200593 CKT 1 /* 26FOREST 230 26GLADE 230 DISCONNECT BRANCH FROM BUS 200581 TO BUS 235971 CKT 1 /* 26FOREST 230 01SQUABHLLW 230 DISCONNECT BRANCH FROM BUS 200581 TO BUS 200647 CKT 1 /* 26FOREST 230 26FOREST 115 DISCONNECT BUS 200581 /* 26FOREST 230 END
PN-P2-3-PN-230-7AT	CONTINGENCY 'PN-P2-3-PN-230-7AT' /* FOREST STUCK 230KV BREAKER DISCONNECT BRANCH FROM BUS 200581 TO BUS 200593 CKT 1 /* 26FOREST 230 26GLADE 230 DISCONNECT BRANCH FROM BUS 200581 TO BUS 235971 CKT 1 /* 26FOREST 230 01SQUABHLLW 230 DISCONNECT BRANCH FROM BUS 200647 TO BUS 200581 CKT 1 /* 26FOREST 115 26FOREST 230 END
PN-P1-2-PN-230-004	CONTINGENCY 'PN-P1-2-PN-230-004' /* GLADE - WARREN 230KV DISCONNECT BRANCH FROM BUS 200811 TO BUS 200593 CKT 1 /* 26WARREN 230 26GLADE 230 END
AP-P1-2-WP-230-321T	CONTINGENCY 'AP-P1-2-WP-230-321T' /* FOREST - SQUAB HOLLOW 230KV APS-PN TIE DISCONNECT BRANCH FROM BUS 235971 TO BUS 200581 CKT 1 /* 01SQUABHLLW 230 26FOREST 230 END
PN-P7-1-PN-230-002A	CONTINGENCY 'PN-P7-1-PN-230-002A' /* GLADE - FOREST 230KV & GLADE - LEWIS RUN 230KV DISCONNECT BRANCH FROM BUS 200593 TO BUS 200581 CKT 1 /* 26GLADE 230 26FOREST 230 DISCONNECT BRANCH FROM BUS 200593 TO BUS 200704 CKT 1 /* 26GLADE 230 26LEWIS RN 230 END
ATSI-P1-2-CEI-345-700T	CONTINGENCY 'ATSI-P1-2-CEI-345-700T' /* PN/ATSI ERIE WEST - ASHTABULA - PERRY 345KV DISCONNECT BRANCH FROM BUS 239036 TO BUS 238547 CKT 1 /* 02PERRY 345 02AT 345 DISCONNECT BRANCH FROM BUS 238547 TO BUS 239082 CKT 1 /* 02AT 345 02S8-ATT 345 DISCONNECT BRANCH FROM BUS 239082 TO BUS 238544 CKT 8 /* 02S8-ATT 345 02ASH_3 138 DISCONNECT BRANCH FROM BUS 238547 TO BUS 200599 CKT 1 /* 02AT 345 26ERIE W 345

	END
AP-P2-3-WP-230-708DT	CONTINGENCY 'AP-P2-3-WP-230-708DT' /* SQUAB HOLLOW 230 STK BKR - NEW4 DISCONNECT BRANCH FROM BUS 235971 TO BUS 235972 CKT 1 /* 01SQUABHLLW 230-138 TR DISCONNECT BRANCH FROM BUS 235971 TO BUS 200581 CKT 1 /* 01SQUABHLLW 230 26FOREST 230 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-P2-3-WP-230-708C	CONTINGENCY 'AP-P2-3-WP-230-708C' /* SQUAB HOLLOW 230 STK BKR - NEW3 DISCONNECT BRANCH FROM BUS 235175 TO BUS 235971 CKT 1 /* 01ELKO 230 01SQUABHLLW 230 DISCONNECT BRANCH FROM BUS 235971 TO BUS 235972 CKT 1 /* 01SQUABHLLW 230-138 TR END
PN-P2-3-PN-230-8I	CONTINGENCY 'PN-P2-3-PN-230-8I' /* GLADE STUCK BREAKER B5 (FOREST/LEWIS RUN) DISCONNECT BRANCH FROM BUS 200593 TO BUS 200704 CKT 1 /* 26GLADE 230 26LEWIS RN 230 DISCONNECT BRANCH FROM BUS 200581 TO BUS 200593 CKT 1 /* 26FOREST 230 26GLADE 230 END
PN-P2-3-PN-230-6G	CONTINGENCY 'PN-P2-3-PN-230-6G' /* ERIE SOUTH 230KV SB 35 OPEN BUS 200819 /*ERIE SOUTH 1 230KV BUS OPEN BUS 200918 /*ERIE SOUTH 230 KV BUS TIE END
PN-P1-2-PN-230-028-A	CONTINGENCY 'PN-P1-2-PN-230-028-A' /* LEWIS RUN - PIERCE BROOK 230KV DISCONNECT BRANCH FROM BUS 200704 TO BUS 946130 CKT 1 /* 26LEWIS RN 230 AF1-278 TAP 230 END
Base Case	
PN-P1-2-PN-230-013A	CONTINGENCY 'PN-P1-2-PN-230-013A' /* EAST TOWANDA - NORTH MESHOPPEN 230KV DISCONNECT BRANCH FROM BUS 200675 TO BUS 200924 CKT 1 /* 26E.TWANDA 230 26CANYON 230 DISCONNECT BRANCH FROM BUS 200924 TO BUS 200706 CKT 1 /* 26CANYON 230 26N.MESHPN 230 END
PN-P2-2-PN-230-009	CONTINGENCY 'PN-P2-2-PN-230-009' /* ERIE SOUTH 230KV TIE BUS DISCONNECT BRANCH FROM BUS 200918 TO BUS 200819 CKT ZB /* 26ERIE S TIE230 26ERIE SE 230 DISCONNECT BRANCH FROM BUS 200918 TO BUS 200568 CKT ZB /* 26ERIE S TIE230 26ERIE SO. 230 DISCONNECT BRANCH FROM BUS 200918 TO BUS 200811 CKT 1 /* 26ERIE S TIE230 26WARREN 230 DISCONNECT BUS 200918 /* 26ERIE S TIE230 END

PN-P1-2-PN-345-107T	CONTINGENCY 'PN-P1-2-PN-345-107T' /* ERIE WEST - ASHTABULA - PERRY 345KV DISCONNECT BRANCH FROM BUS 200599 TO BUS 238547 CKT 1 /* 26ERIE W 345 02AT 345 DISCONNECT BRANCH FROM BUS 238547 TO BUS 239082 CKT 1 /* 02AT 345 02S8-ATT 345 DISCONNECT BRANCH FROM BUS 238547 TO BUS 239036 CKT 1 /* 02AT 345 02PERRY 345 DISCONNECT BUS 238547 /* 02AT 345 END
AP-P2-3-WP-230-445	CONTINGENCY 'AP-P2-3-WP-230-445' /* 454 DISCONNECT BRANCH FROM BUS 235174 TO BUS 235175 CKT 1 /* 01ELKO 138 01ELKO 230 DISCONNECT BRANCH FROM BUS 235971 TO BUS 235175 CKT 1 /* 01SQUABHLLW 230 01ELKO 230 DISCONNECT BRANCH FROM BUS 235174 TO BUS 235237 CKT 1 /* 01ELKO 138 01RIDGWY 138 DISCONNECT BRANCH FROM BUS 235159 TO BUS 235174 CKT 1 /* 01CARB J 138 01ELKO 138 END
PJM500_PN_P4-500-001D	CONTINGENCY 'PJM500_PN_P4-500-001D' /* KEYSTONE 500KV BKR 4 DISCONNECT BRANCH FROM BUS 200011 TO BUS 200810 CKT 3 /* KEYSTONE 500 26KEYSTONE 230 REMOVE MACHINE H FROM BUS 200032 /* KEYS G1 20 REMOVE MACHINE L FROM BUS 200032 /* KEYS G1 20 DISCONNECT BUS 200032 /* KEYS G1 20 END

Short Circuit

12.9 Short Circuit

The following Breakers are overduty:

None.

13 Attachment 1 – One Line