Generation Interconnection

Feasibility Study Report

for

Queue Project AF1-284

PENN MAR-GARRETT 138 KV

12.5 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 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.

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 Garrett County, Pennsylvania. The installed facilities will have a total capability of 20 MW with 12.5 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is 12/31/2021. This study does not imply a TO commitment to this in-service date.

Queue Number	AF1-284
Project Name	PENN MAR-GARRETT 138 KV
State	Maryland
County	Garrett
Transmission Owner	PENELEC
MFO	20
MWE	20
MWC	12.5
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 constructing a new 115 kV three (3) breaker ring bus substation and looping the Deep Creek – Garrett – Penn Mar 115 kV line into the new station. The new substation will be located approximately 4.2 miles from Penn Mar substation. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection switching station and the associated facilities. The IC will also be responsible for the rough grade of the property and an access road to the proposed three breaker ring bus site. The project will also require non-direct connection upgrades at Deep Creek, Garrett, Penn Mar, and Somerset substations.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AF1-284 generation project to connect to the FirstEnergy ("FE") transmission system. IC will be responsible for constructing the facilities on its side of the POI, including the attachment facilities which connect the generator to the FE transmission system's direct connection facilities.

3.1.2 Secondary POI

The interconnection of the project at the Secondary POI can be accomplished by expanding Penn Mar substation to a 115 kV ring bus configuration. A full scope of work or estimated cost is not provided for the proposed Secondary POI.

3.2 Cost Summary

The AF1-284 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$305,900
Direct Connection Network Upgrade	$6,917,800
Non Direct Connection Network Upgrades	$2,348,600
Total Costs	**$9,572,300**

In addition, the AF1-284 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	**$23,236,500**

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 AF1-284 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

Primary POI

The interconnection of the project at the Primary POI will be accomplished by constructing a new 115 kV three (3) breaker ring bus substation and looping the Deep Creek – Garrett – Penn Mar 115 kV line into the new station. The new substation will be located approximately 4.2 miles from Penn Mar substation. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection switching station and the associated facilities. The IC will also be responsible for the rough grade of the property and an access road to the proposed three breaker ring bus site. The project will also require non-direct connection upgrades at Deep Creek, Garrett, Penn Mar, and Somerset substations.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AF1-284 generation project to connect to the FirstEnergy ("FE") transmission system. IC will be responsible for constructing the facilities on its side of the POI, including the attachment facilities which connect the generator to the FE transmission system's direct connection facilities.

Secondary POI

The interconnection of the project at the Secondary POI can be accomplished by expanding Penn Mar substation to a 115 kV ring bus configuration. A full scope of work or estimated cost is not provided for the proposed Secondary POI.

5 Attachment Facilities

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

Description	Total Cost
Install 115 kV terminal for AF1-284 generator lead line.	$242,700
Review drawings and provide nameplates for customer substation.	$63,200
Total Attachment Facility Costs	**$305,900**

6 Direct Connection Cost Estimate

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

Description	Total Cost
Construct new 115 kV three breaker ring bus interconnection substation.	$6,917,800
Total Direct Connection Facility Costs	**$6,917,800**

7 Non-Direct Connection Cost Estimate

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

Description	Total Cost
Loop the Deep Creek – Garrett – Penn Mar 115 kV line into the new interconnection substation.	$619,100
Install anti-islanding relaying at Deep Creek substation.	$576,500
Install anti-islanding relaying at Garrett substation.	$576,500
Install anti-islanding relaying at Penn Mar substation.	$576,500
Total Non-Direct Connection Facility Costs	**$2,348,600**

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 **19 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 Attachment Facility work. Full initial deposit will be required for the Non-Direct Connection work. This assumes that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the defined interconnection work, and that all 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

FE performed an analysis of its underlying transmission <100 kV system. The AF1-284 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.

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 115 kV circuit breaker to protect the AF1-284 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 AF1-284 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 – Primary POI

The Queue Project AF1-284 was evaluated as a 20.0 MW (Capacity 12.5 MW) injection tapping the Penn-Marr to Garrett 138 kV line in the PENELEC area. Project AF1-284 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-284 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Load Flow

12.1 Generation Deliverability

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

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONTNAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
4138091 8	94619 0	AF1-284 TAP	115. 0	PENELEC	20076 2	26GARRETT	115. 0	PENELEC	1	Base Case	single	137.0	94.91	100.22	DC	7.28

12.2 Multiple Facility Contingency

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

None

12.3 Contribution to Previously Identified Overloads

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

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONTNAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
4169012 4	20074 5	26ALLEGHEN	115. 0	PENELEC	20088 4	26NEWBALT	115. 0	PENELEC	1	PN-P2-3-PN-115-35E	breaker	160.0	158.07	161.46	DC	5.42
4138085 0	20076 2	26GARRETT	115. 0	PENELEC	23547 0	01GARRET	115. 0	AP	1	Base Case	single	133.0	111.44	116.91	DC	7.27
4138085 2	20076 2	26GARRETT	115. 0	PENELEC	23547 0	01GARRET	115. 0	AP	1	AP-P1-2-WP-500-008	single	160.0	104.54	109.08	DC	7.27

12.4 Potential Congestion due to Local Energy Deliverability

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

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

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
41381421	200742	26TOWER 51	115.0	PENELEC	200741	26SEWARD	115.0	PENELEC	1	AP-P1-3-PN-115-010	operation	185.0	110.89	114.55	DC	6.77
41381131	200743	26HOOVERSV	115.0	PENELEC	200742	26TOWER 51	115.0	PENELEC	1	AP-P1-3-PN-115-010	operation	172.0	132.56	136.54	DC	6.86
41381136	200743	26HOOVERSV	115.0	PENELEC	200742	26TOWER 51	115.0	PENELEC	1	Base Case	operation	137.0	106.78	108.86	DC	2.86
41381428	200744	26SOMERST	115.0	PENELEC	200743	26HOOVERSV	115.0	PENELEC	1	AP-P1-3-PN-115-010	operation	190.0	115.32	120.07	DC	9.02
41381585	200744	26SOMERST	115.0	PENELEC	200802	26RALPHTON	115.0	PENELEC	1	AP-P1-3-PN-115-010	operation	185.0	101.66	105.75	DC	7.56
41381053	200745	26ALLEGHEN	115.0	PENELEC	200884	26NEW BALT	115.0	PENELEC	1	Base Case	operation	133.0	104.79	105.27	DC	1.43
41380929	200746	26ROCKWOOD	115.0	PENELEC	200744	26SOMERST	115.0	PENELEC	1	AP-P1-3-PN-115-010	operation	179.0	171.09	182.26	DC	19.99
41380934	200746	26ROCKWOOD	115.0	PENELEC	200744	26SOMERST	115.0	PENELEC	1	Base Case	operation	148.0	116.1	121.74	DC	8.35
41380845	200762	26GARRETT	115.0	PENELEC	235470	01GARRET	115.0	AP	1	PN-P1-2-PN-115-068	operation	160.0	193.04	205.53	DC	19.99
41380847	200762	26GARRETT	115.0	PENELEC	235470	01GARRET	115.0	AP	1	Base Case	operation	133.0	177.65	186.4	DC	11.64
41380888	200884	26NEW BALT	115.0	PENELEC	200501	26BDFORDN	115.0	PENELEC	1	Base Case	operation	133.0	125.48	125.96	DC	1.43
41380913	946190	AF1-284 TAP	115.0	PENELEC	200762	26GARRETT	115.0	PENELEC	1	PN-P1-2-PN-115-068	operation	167.0	173.61	185.59	DC	20.0
41380915	946190	AF1-284 TAP	115.0	PENELEC	200762	26GARRETT	115.0	PENELEC	1	Base Case	operation	137.0	163.96	172.46	DC	11.64

12.5 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
41380918	1	AF1-284 TAP 115.0 kV - 26GARRETT 115.0 kV Ckt 1	PENELEC PN-AF1-F-0086: Reconductor line. Project Type : FAC Cost : $12,852,000 Time Estimate : 24.0 Months	$12,852,000
41690124	2	26ALLEGHEN 115.0 kV - 26NEW BALT 115.0 kV Ckt 1	PENELEC PN-AF1-F-0034a : Reconductor Allegheny - New Baltimore 115 kV (~4 miles) Project Type : FAC Cost : $6,366,500 Time Estimate : 6.0 Months PN-AF1-F-0034b : Replace substation conductor at Allegheny Project Type : FAC Cost : $119,000 Time Estimate : 6.0 Months	$6,485,500
41380852,41380850	3	26GARRETT 115.0 kV - 01GARRET 115.0 kV Ckt 1	APS WP-AF1-F-0003 : Reconductor Garrett Tap - Garrett (~2.0 miles) Project Type : FAC Cost : $3,780,000 Time Estimate : 6.0 Months PENELEC PN-AF1-F-0038 : Replace substation conductor at Garrett Project Type : FAC Cost : $119,000 Time Estimate : 6.0 Months	$3,899,000
			TOTAL COST	**$23,236,500**

12.6 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.

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
41380918	946190	AF1-284 TAP	PENELEC	200762	26GARRETT	PENELEC	1	Base Case	single	137.0	94.91	100.22	DC	7.28

Bus #	Bus	MW Impact
200503	**26C.SLOPE (Deativation : 06/07/19)**	**4.9218**
200813	26YOUGH	0.4384
200834	26SW_E13_K22	0.0463
200835	26DSGENWIN	0.4429
200846	26FORWARD	0.0804
200888	26HIGHLAND	0.1239
200889	26STNY CRK	0.2158
200890	26BF_G21_K23	0.2172
200891	26CSLMN_L13	0.3407
200892	26LOOKOUT	0.3236
200915	26CHSTN_FL	0.0580
200925	26R32	0.1429
202225	26SCI_S29B	0.0721
202652	26RGH_Y1-033	0.3164
938351	AE1-053	3.0509
938881	AE1-116	0.8301
938991	AE1-128 C	7.2274
942361	AE2-249 C	0.8131
943711	AF1-039 C O1	4.0959
944751	AF1-140 C	0.6918
944781	AF1-143 C	18.3054
945671	AF1-232 C O1	16.2417
945901	AF1-255 C	0.5046
946081	AF1-273 C O1	9.3702
946191	AF1-284 C O1	7.2761
946241	AF1-289 C O1	1.7734
946571	AF1-321 C O1	1.1885
DUCKCREEK	DUCKCREEK	0.3397
NEWTON	NEWTON	0.3266
FARMERCITY	FARMERCITY	0.0171
G-007A	G-007A	0.9902
VFT	VFT	2.7154
PRAIRIE	PRAIRIE	0.7981
COFFEEN	COFFEEN	0.1596
EDWARDS	EDWARDS	0.1029
CHEOAH	CHEOAH	0.1727
TILTON	TILTON	0.1871
GIBSON	GIBSON	0.1660
CALDERWOOD	CALDERWOOD	0.1715
BLUEG	BLUEG	0.5347
TRIMBLE	TRIMBLE	0.1708

Bus #	Bus	MW Impact
CATAWBA	CATAWBA	0.1281

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
41690124	200745	26ALLEGHEN	PENELEC	200884	26NEW BALT	PENELEC	1	PN-P2-3-PN-115-35E	breaker	160.0	158.07	161.46	DC	5.42

Bus #	Bus	MW Impact
200813	26YOUGH	0.2589
200834	26SW_E13_K22	0.1329
200835	26DSGENWIN	0.6544
200840	26DEEPCRK1	0.2393
200841	26DEEPCRK2	0.2393
200890	26BF_G21_K23	0.3209
200891	26CSLMN_L13	0.5033
200892	26LOOKOUT	0.4782
202225	26SCI_S29B	0.2068
202652	26RGH_Y1-033	0.2457
235013	01AB1-065 C	0.0587
292350	K-023	14.8300
292542	L-013 1	14.4243
293432	R-040 E	0.8114
293902	O-048 E	12.9819
913142	Y1-033 E OP1	12.0240
917672	Z2-108 E	8.1137
930262	AB1-065 E	0.6975
938351	AE1-053	4.5076
938881	AE1-116	2.3805
943301	AF1-001 C	0.6667
943302	AF1-001 E	0.7436
943711	AF1-039 C O1	3.1810
943712	AF1-039 E O1	2.1206
944781	AF1-143 C	27.0456
944782	AF1-143 E	18.0304
945671	AF1-232 C O1	66.2355
945672	AF1-232 E O1	35.6653
946081	AF1-273 C O1	38.2128
946082	AF1-273 E O1	25.4752
946191	AF1-284 C O1	3.3882
946192	AF1-284 E O1	2.0330
LGEE	LGEE	0.1095
CPLE	CPLE	0.1555
WEC	WEC	0.0570
CBM-W2	CBM-W2	1.6134
NY	NY	0.3185
CBM-W1	CBM-W1	2.0892
TVA	TVA	0.2898
O-066	O-066	2.0227
CBM-S2	CBM-S2	1.3236

Bus #	Bus	MW Impact
CBM-S1	CBM-S1	1.7381
G-007	G-007	0.3047
MEC	MEC	0.2971

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
41380850	200762	26GARRETT	PENELEC	235470	01GARRET	AP	1	Base Case	single	133.0	111.44	116.91	DC	7.27

Bus #	Bus	MW Impact
200503	**26C.SLOPE (Deativation : 06/07/19)**	**4.9114**
200813	26YOUGH	0.4383
200834	26SW_E13_K22	0.0463
200835	26DSGENWIN	0.4427
200840	26DEEPCRK1	1.0127
200841	26DEEPCRK2	1.0127
200846	26FORWARD	0.0803
200888	26HIGHLAND	0.1237
200889	26STNY CRK	0.2156
200890	26BF_G21_K23	0.2171
200891	26CSLMN_L13	0.3406
200892	26LOOKOUT	0.3235
200915	26CHSTN_FL	0.0578
200925	26R32	0.1427
202225	26SCI_S29B	0.0721
202652	26RGH_Y1-033	0.3163
938351	AE1-053	3.0498
938881	AE1-116	0.8296
938991	AE1-128 C	7.2202
942361	AE2-249 C	0.8123
943711	AF1-039 C O1	4.0949
944751	AF1-140 C	0.6909
944781	AF1-143 C	18.2988
945671	AF1-232 C O1	16.2302
945901	AF1-255 C	0.5040
946081	AF1-273 C O1	9.3636
946191	AF1-284 C O1	7.2747
946241	AF1-289 C O1	1.7707
946571	AF1-321 C O1	1.1873
DUCKCREEK	DUCKCREEK	0.3524
NEWTON	NEWTON	0.3385
FARMERCITY	FARMERCITY	0.0177
G-007A	G-007A	0.9638
VFT	VFT	2.6445
PRAIRIE	PRAIRIE	0.8266
COFFEEN	COFFEEN	0.1654
EDWARDS	EDWARDS	0.1067
CHEOAH	CHEOAH	0.1782
TILTON	TILTON	0.1940
GIBSON	GIBSON	0.1720
CALDERWOOD	CALDERWOOD	0.1769
BLUEG	BLUEG	0.5538

Bus #	Bus	MW Impact
TRIMBLE	TRIMBLE	0.1770
CATAWBA	CATAWBA	0.1320

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
Base Case	
PN-P2-3-PN-115-35E	CONTINGENCY 'PN-P2-3-PN-115-35E' /* #14 STUCK TIE BREAKER BETWEEN BUSES 1 AND 2 DISCONNECT BRANCH FROM BUS 200734 TO BUS 200743 CKT 1 /* 26SCALP L. 115 26HOOVERSV 115 DISCONNECT BRANCH FROM BUS 200743 TO BUS 200802 CKT 1 /* 26HOOVERSV 115 26RALPHTON 115 DISCONNECT BRANCH FROM BUS 200743 TO BUS 200776 CKT 1 /* 26HOOVERSV 115 26HOOVER#1 23 DISCONNECT BRANCH FROM BUS 200743 TO BUS 200744 CKT 1 /* 26HOOVERSV 115 26SOMERST 115 DISCONNECT BRANCH FROM BUS 200742 TO BUS 200743 CKT 1 /* 26TOWER 51 115 26HOOVERSV 115 DISCONNECT BRANCH FROM BUS 200743 TO BUS 200789 CKT 2 /* 26HOOVERSV 115 26HOOVER#2 23 END
PN-P1-2-PN-115-068	CONTINGENCY 'PN-P1-2-PN-115-068' /* ROCKWOOD - SOMERSET 115KV DISCONNECT BRANCH FROM BUS 200744 TO BUS 200746 CKT 1 /* 26SOMERST 115 26ROCKWOOD 115 DISCONNECT BRANCH FROM BUS 200746 TO BUS 200773 CKT 1 /* 26ROCKWOOD 115 26ROCKWOOD 23 END
AP-P1-3-PN-115-010	CONTINGENCY 'AP-P1-3-PN-115-010' /* GARRETT 138/115KV XFMR FAULT OPEN BRANCH FROM BUS 235469 TO BUS 235470 CKT 1 /* 01GARRET 138.00 01GARRET 115.00 END
AP-P1-2-WP-500-008	CONTINGENCY 'AP-P1-2-WP-500-008' /* SOUTH BEND

Short Circuit

12.9 Short Circuit

The following Breakers are overduty:

None.

13 Network Impacts – Secondary POI

The Queue Project AF1-284 was evaluated as a 20.0 MW (Capacity 12.5 MW) injection at the Penn-Marr 115 kV substation in the PENELEC area. Project AF1-284 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-284 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Load Flow

13.1 Generation Deliverability

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

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
55393617	200747	26PENN-MAR	115.0	PENELEC	200762	26GARRETT	115.0	PENELEC	1	Base Case	single	137.0	96.25	101.03	DC	6.54

13.2 Multiple Facility Contingency

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

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
55393442	946080	AF1-273 TAP	115.0	PENELEC	945670	AF1-232 TAP	115.0	PENELEC	1	PN-P2-3-PN-115-35E	breaker	160.0	99.45	103.32	DC	6.18

13.3 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
41380850	200762	26GARRETT	115.0	PENELEC	235470	01GARRET	115.0	AP	1	Base Case	single	133.0	112.59	117.51	DC	6.54
41380852	200762	26GARRETT	115.0	PENELEC	235470	01GARRET	115.0	AP	1	AP-P1-2-WP-500-008	single	160.0	105.55	109.64	DC	6.54

13.4 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
41381421	200742	26TOWER 51	115.0	PENELEC	200741	26SEWARD	115.0	PENELEC	1	AP-P1-3-PN-115-010	operation	185.0	111.94	115.6	DC	6.77
41381131	200743	26HOOVERSV	115.0	PENELEC	200742	26TOWER 51	115.0	PENELEC	1	AP-P1-3-PN-115-010	operation	172.0	133.71	137.7	DC	6.86
41381136	200743	26HOOVERSV	115.0	PENELEC	200742	26TOWER 51	115.0	PENELEC	1	Base Case	operation	137.0	107.56	109.94	DC	3.26
41381428	200744	26SOMERST	115.0	PENELEC	200743	26HOOVERSV	115.0	PENELEC	1	AP-P1-3-PN-115-010	operation	190.0	118.96	123.71	DC	9.02
41381584	200744	26SOMERST	115.0	PENELEC	200802	26RALPHTON	115.0	PENELEC	1	PN-P1-2-PN-115-066	operation	185.0	107.21	110.64	DC	6.34
41380929	200746	26ROCKWOOD	115.0	PENELEC	200744	26SOMERST	115.0	PENELEC	1	AP-P1-3-PN-115-010	operation	179.0	171.09	182.26	DC	19.99
41380934	200746	26ROCKWOOD	115.0	PENELEC	200744	26SOMERST	115.0	PENELEC	1	Base Case	operation	148.0	115.46	121.9	DC	9.53
55393612	200747	26PENN-MAR	115.0	PENELEC	200762	26GARRETT	115.0	PENELEC	1	PN-P1-2-PN-115-068	operation	167.0	173.73	185.71	DC	20.0
55393614	200747	26PENN-MAR	115.0	PENELEC	200762	26GARRETT	115.0	PENELEC	1	Base Case	operation	137.0	166.05	173.69	DC	10.47
41380845	200762	26GARRETT	115.0	PENELEC	235470	01GARRET	115.0	AP	1	PN-P1-2-PN-115-068	operation	160.0	193.04	205.53	DC	19.99
41380847	200762	26GARRETT	115.0	PENELEC	235470	01GARRET	115.0	AP	1	Base Case	operation	133.0	179.58	187.45	DC	10.47
41381693	200802	26RALPHTON	115.0	PENELEC	200743	26HOOVERSV	115.0	PENELEC	1	PN-P1-2-PN-115-066	operation	191.0	98.71	102.03	DC	6.34
41380888	200884	26NEW BALT	115.0	PENELEC	200501	26BDFORDN	115.0	PENELEC	1	Base Case	operation	133.0	115.66	116.21	DC	1.63

13.5 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.

13.5.1 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
55393617	200747	26PENN-MAR	PENELEC	200762	26GARRETT	PENELEC	1	Base Case	single	137.0	96.25	101.03	DC	6.54

Bus #	Bus	MW Impact
200503	**26C.SLOPE (Deativation : 06/07/19)**	**4.9218**
200813	26YOUGH	0.4384
200834	26SW_E13_K22	0.0463
200835	26DSGENWIN	0.4429
200846	26FORWARD	0.0804
200888	26HIGHLAND	0.1239
200889	26STNY CRK	0.2158
200890	26BF_G21_K23	0.2172
200891	26CSLMN_L13	0.3407
200892	26LOOKOUT	0.3236
200915	26CHSTN_FL	0.0580
200925	26R32	0.1429
202225	26SCI_S29B	0.0721
202652	26RGH_Y1-033	0.3164
938351	AE1-053	3.0509
938881	AE1-116	0.8301
938991	AE1-128 C	7.2274
942361	AE2-249 C	0.8131
943711	AF1-039 C O2	4.7108
944751	AF1-140 C	0.6918
944781	AF1-143 C	18.3054
945671	AF1-232 C O2	16.6764
945901	AF1-255 C	0.5046
946081	AF1-273 C O2	9.9522
946191	AF1-284 C O2	6.5427
946241	AF1-289 C O2	1.7482
946571	AF1-321 C O2	0.7877
DUCKCREEK	DUCKCREEK	0.3397
NEWTON	NEWTON	0.3266
FARMERCITY	FARMERCITY	0.0171
G-007A	G-007A	0.9902
VFT	VFT	2.7154
PRAIRIE	PRAIRIE	0.7981
COFFEEN	COFFEEN	0.1596
EDWARDS	EDWARDS	0.1029
CHEOAH	CHEOAH	0.1727
TILTON	TILTON	0.1871
GIBSON	GIBSON	0.1660
CALDERWOOD	CALDERWOOD	0.1715
BLUEG	BLUEG	0.5347
TRIMBLE	TRIMBLE	0.1708
CATAWBA	CATAWBA	0.1281

13.5.2 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
55393442	946080	AF1-273 TAP	PENELEC	945670	AF1-232 TAP	PENELEC	1	PN-P2-3-PN-115-35E	breaker	160.0	99.45	103.32	DC	6.18

Bus #	Bus	MW Impact
200813	26YOUGH	0.2589
200834	26SW_E13_K22	0.1329
200835	26DSGENWIN	0.6544
200840	26DEEPCRK1	0.2393
200841	26DEEPCRK2	0.2393
200890	26BF_G21_K23	0.3209
200891	26CSLMN_L13	0.5033
200892	26LOOKOUT	0.4782
202225	26SCI_S29B	0.2068
202652	26RGH_Y1-033	0.2457
235013	01AB1-065 C	0.0587
292350	K-023	14.8300
292542	L-013 1	14.4243
293432	R-040 E	0.8114
293902	O-048 E	12.9819
913142	Y1-033 E OP1	12.0240
917672	Z2-108 E	8.1137
930262	AB1-065 E	0.6975
938351	AE1-053	4.5076
938881	AE1-116	2.3805
943301	AF1-001 C	0.6667
943302	AF1-001 E	0.7436
943711	AF1-039 C O2	2.7821
943712	AF1-039 E O2	1.8547
944781	AF1-143 C	27.0456
944782	AF1-143 E	18.0304
945673	AF1-232 BAT	7.5814
946081	AF1-273 C O2	35.9934
946082	AF1-273 E O2	23.9956
946191	AF1-284 C O2	3.8640
946192	AF1-284 E O2	2.3184
LGEE	LGEE	0.1095
CPLE	CPLE	0.1555
WEC	WEC	0.0570
CBM-W2	CBM-W2	1.6134
NY	NY	0.3185
CBM-W1	CBM-W1	2.0892
TVA	TVA	0.2898
O-066	O-066	2.0227
CBM-S2	CBM-S2	1.3236
CBM-S1	CBM-S1	1.7381

Bus #	Bus	MW Impact
G-007	G-007	0.3047
MEC	MEC	0.2971

13.5.3 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
41380850	200762	26GARRETT	PENELEC	235470	01GARRET	AP	1	Base Case	single	133.0	112.59	117.51	DC	6.54

Bus #	Bus	MW Impact
200503	**26C.SLOPE (Deativation : 06/07/19)**	**4.9114**
200813	26YOUGH	0.4383
200834	26SW_E13_K22	0.0463
200835	26DSGENWIN	0.4427
200840	26DEEPCRK1	1.0127
200841	26DEEPCRK2	1.0127
200846	26FORWARD	0.0803
200888	26HIGHLAND	0.1237
200889	26STNY CRK	0.2156
200890	26BF_G21_K23	0.2171
200891	26CSLMN_L13	0.3406
200892	26LOOKOUT	0.3235
200915	26CHSTN_FL	0.0578
200925	26R32	0.1427
202225	26SCI_S29B	0.0721
202652	26RGH_Y1-033	0.3163
938351	AE1-053	3.0498
938881	AE1-116	0.8296
938991	AE1-128 C	7.2202
942361	AE2-249 C	0.8123
943711	AF1-039 C O2	4.7098
944751	AF1-140 C	0.6909
944781	AF1-143 C	18.2988
945671	AF1-232 C O2	16.6660
945901	AF1-255 C	0.5040
946081	AF1-273 C O2	9.9462
946191	AF1-284 C O2	6.5414
946241	AF1-289 C O2	1.7455
946571	AF1-321 C O2	0.7864
DUCKCREEK	DUCKCREEK	0.3524
NEWTON	NEWTON	0.3385
FARMERCITY	FARMERCITY	0.0177
G-007A	G-007A	0.9638
VFT	VFT	2.6445
PRAIRIE	PRAIRIE	0.8266
COFFEEN	COFFEEN	0.1654
EDWARDS	EDWARDS	0.1067
CHEOAH	CHEOAH	0.1782
TILTON	TILTON	0.1940
GIBSON	GIBSON	0.1720
CALDERWOOD	CALDERWOOD	0.1769
BLUEG	BLUEG	0.5538

Bus #	Bus	MW Impact
TRIMBLE	TRIMBLE	0.1770
CATAWBA	CATAWBA	0.1320

Affected Systems

13.6 Affected Systems

13.6.1 LG&E

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

13.6.2 MISO

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

13.6.3 TVA

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

13.6.4 Duke Energy Progress

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

13.6.5 NYISO

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

13.7 Contingency Definitions

Contingency Name	Contingency Definition
PN-P1-2-PN-115-066	CONTINGENCY 'PN-P1-2-PN-115-066' /* HOOVERSVILLE - SOMERSET 115KV DISCONNECT BRANCH FROM BUS 200743 TO BUS 200744 CKT 1 /* 26HOOVERSV 115 26SOMERST 115 END
AP-P1-3-PN-115-010	CONTINGENCY 'AP-P1-3-PN-115-010' /* GARRETT 138/115KV XFMR FAULT OPEN BRANCH FROM BUS 235469 TO BUS 235470 CKT 1 /* 01GARRET 138.00 01GARRET 115.00 END
AP-P1-2-WP-500-008	CONTINGENCY 'AP-P1-2-WP-500-008' /* SOUTH BEND
PN-P2-3-PN-115-35E	CONTINGENCY 'PN-P2-3-PN-115-35E' /* #14 STUCK TIE BREAKER BETWEEN BUSES 1 AND 2 DISCONNECT BRANCH FROM BUS 200734 TO BUS 200743 CKT 1 /* 26SCALP L. 115 26HOOVERSV 115 DISCONNECT BRANCH FROM BUS 200743 TO BUS 200802 CKT 1 /* 26HOOVERSV 115 26RALPHTON 115 DISCONNECT BRANCH FROM BUS 200743 TO BUS 200776 CKT 1 /* 26HOOVERSV 115 26HOOVER#1 23 DISCONNECT BRANCH FROM BUS 200743 TO BUS 200744 CKT 1 /* 26HOOVERSV 115 26SOMERST 115 DISCONNECT BRANCH FROM BUS 200742 TO BUS 200743 CKT 1 /* 26TOWER 51 115 26HOOVERSV 115 DISCONNECT BRANCH FROM BUS 200743 TO BUS 200789 CKT 2 /* 26HOOVERSV 115 26HOOVER#2 23 END
PN-P1-2-PN-115-068	CONTINGENCY 'PN-P1-2-PN-115-068' /* ROCKWOOD - SOMERSET 115KV DISCONNECT BRANCH FROM BUS 200744 TO BUS 200746 CKT 1 /* 26SOMERST 115 26ROCKWOOD 115 DISCONNECT BRANCH FROM BUS 200746 TO BUS 200773 CKT 1 /* 26ROCKWOOD 115 26ROCKWOOD 23 END
Base Case	

Short Circuit

13.8 Short Circuit

The following Breakers are overduty:

None.

14 Attachment 1 – One Line