Generation Interconnection

Feasibility Study Report

for

Queue Project AE2-215

BLAINE 115 KV

36 MW Capacity / 60 MW Energy

July, 2019

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1 Preface

The intent of the feasibility study is to determine a plan, with ballpark cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the Interconnection Customer. The Interconnection Customer may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: (1) Direct Connections, which are new facilities and/or facilities upgrades needed to connect the generator to the PJM network, and (2) Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system.

In some instances a generator interconnection may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection, may also contribute to the need for the same network reinforcement. Cost allocation rules for network upgrades can be found in PJM Manual 14A, Attachment B. The possibility of sharing the reinforcement costs with other projects may be identified in the feasibility study, but the actual allocation will be deferred until the impact study is performed.

The Interconnection Customer seeking to interconnect a wind or solar generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per Schedule H to the Interconnection Service Agreement and Section 8 of Manual 14D.

PJM utilizes manufacturer models to ensure the performance of turbines is properly captured during the simulations performed for stability verification and, where applicable, for compliance with low voltage ride through requirements. Turbine manufacturers provide such models to their customers. The list of manufacturer models PJM has already validated is contained in Attachment B of Manual 14G. Manufacturer models may be updated from time to time, for various reasons such as to reflect changes to the control systems or to more accurately represent the capabilities turbines and controls which are currently available in the field. Additionally, as new turbine models are developed, turbine manufacturers provide such new models which must be used in the conduct of these studies. PJM needs adequate time to evaluate the new models in order to reduce delays to the System Impact Study process timeline for the Interconnection Customer as well as other Interconnection Customers in the study group. Therefore, PJM will require that any Interconnection Customer with a new manufacturer model must supply that model to PJM, along with a $10,000 fully refundable deposit, no later than three (3) months prior to the starting date of the System Impact Study (See Section 4.3 for starting dates) for the Interconnection Request which shall specify the use of the new model. The Interconnection Customer will be required to submit a completed dynamic model study request form (Attachment B-1 of Manual 14G) in order to document the request for the study.

The Feasibility Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. The project developer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

2 General

The Interconnection Customer (IC) has proposed a Solar generating facility located in Perry County, Pennsylvania. The installed facilities will have a total capability of 60 MW with 36 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 Transmission Owner (TO) commitment to this in-service date.

Queue Number	**AE2-215**
Project Name	BLAINE 115 KV
Interconnection Customer	
State	None
County	Perry
Transmission Owner	PENELEC
MFO	60
MWE	60
MWC	36
Fuel	Solar
Basecase Study Year	2022

3 Point of Interconnection

3.1 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 at the existing Blain substation. The IC will be responsible for acquiring all easements, properties, and permits that may be required to expand Blain substation. The project will also require non-direct connection upgrades at Lewistown, Roxbury, and Shade Gap substations.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AE2-215 generation project to connect to the FirstEnergy ("FE") transmission system. Attachment 2 provides the proposed location for the point of interconnection. 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.

3.2 Cost Summary

The AE2-215 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 384,450
Direct Connection Network Upgrade	$3,460,050
Non Direct Connection Network Upgrades	$ 683,300
Total Costs	$4,527,800

In addition, the AE2-215 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	$13,000,000

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

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 AE2-215 generation project to the FE Transmission System is detailed in the following sections. The associated one-line with the generation project Attachment Facilities and the Primary Direct and Non-Direct Connection facilities are shown in Attachment 1.

4 Transmission Owner Scope of Work

The interconnection of the project at the Primary POI will be accomplished by constructing a new 115 kV three (3) breaker ring bus substation at the existing Blain substation. The IC will be responsible for acquiring all easements, properties, and permits that may be required to expand Blain substation. The project will also require non-direct connection upgrades at Lewistown, Roxbury, and Shade Gap substations.

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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 line exit take-off structure, foundations, disconnect switch and associated equipment at Blain substation.	$384,450
Total Attachment Facility Costs	$384,450

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
Expand Blain substation to a three breaker 115 kV ring bus.	$3,460,050
Total Direct Connection Facility Costs	$3,460,050

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
Install anti-islanding (transfer trip) equipment at Lewistown SS	$233,000
Install anti-islanding (transfer trip) equipment at Roxbury SS	$233,000
Install anti-islanding (transfer trip) equipment at Shade Gap SS	$217,300
Total Non-Direct Connection Facility Costs	$683,300

8 System Reinforcements Cost Estimate

Upgrade Description	Cost
PN-0002 (292) : Reconductor line with 336 ACSS high temperature conductor (6.4 miles). **Project Type : FAC** **Cost : $13,000,000** **Time Estimate : 20.0 Months**	$13,000,000
TOTAL COST	**$13,000,000**

9 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 14 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.

10 Transmission Owner Analysis

10.1 Power Flow Analysis

FE performed an analysis of its underlying transmission <100 kV system. The AE2-215 project did not contribute to any overloads on the FE transmission <100 kV system.

11 Interconnection Customer Requirements

11.1 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.

11.2 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 AE2-215 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 AE2-215 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.

11.3 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.

12 Revenue Metering and SCADA Requirements

12.1 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.

12.2 FE 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.

13 Network Impacts

The Queue Project AE2-215 was evaluated as a 60.0 MW (Capacity 36.0 MW) injection at the Blain 115kV substation in the PENELEC area. Project AE2-215 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-215 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Load Flow

14 Generation Deliverability

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

None

15 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
7195191	938380	AE1-071 TAP	PENELEC	200520	26ROXBURY	PENELEC	1	PL:10:P22:100582	bus	160.0	89.54	104.02	DC	23.17
7195192	938380	AE1-071 TAP	PENELEC	200520	26ROXBURY	PENELEC	1	PN-P2-2-PN-230-006AT	bus	160.0	88.18	102.66	DC	23.17

16 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)

None

17 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.

None

18 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
7195192,7195191	1	AE1-071 TAP 115.0 kV - 26ROXBURY 115.0 kV Ckt 1	PN-0002 (292) : Reconductor line with 336 ACSS high temperature conductor (6.4 miles). Project Type : FAC Cost : $13,000,000 Time Estimate : 20.0 Months	$13,000,000
			TOTAL COST	$13,000,000

19 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.

19.1 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
7195191	938380	AE1-071 TAP	PENELEC	200520	26ROXBURY	PENELEC	1	PL:10:P22:100582	bus	160.0	89.54	104.02	DC	23.17

Bus #	Bus	MW Impact
200812	26ALY HYDR	0.31
200852	26WARR RDG	0.09
236828	01GRAYMONT	0.45
290086	Q-036 E	2.36
293301	N-039 E	3.84
293802	O-038 E	2.4
294515	P-022 E	0.96
919491	AA2-000	29.82
925512	AC1-025 E	0.17
930511	AB1-092	1.09
936421	AD2-055	2.25
936991	AD2-133 C	1.06
936992	AD2-133 E	4.85
938381	AE1-071 C	41.88
938382	AE1-071 E	25.63
939171	AE1-147 C	1.34
939172	AE1-147 E	0.89
940201	AE2-001 C	1.35
940202	AE2-001 E	0.9
940681	AE2-055 C	1.41
940682	AE2-055 E	0.94
941231	AE2-117 C	1.47
941232	AE2-117 E	0.98
941241	AE2-118 C	1.47
941242	AE2-118 E	0.98
941251	AE2-119 C	0.84
941252	AE2-119 E	0.56
941261	AE2-120 C	1.35
941262	AE2-120 E	0.9
941271	AE2-121 C	0.71
941272	AE2-121 E	0.47
941321	AE2-126 C	0.77
941322	AE2-126 E	0.51
941331	AE2-129 C	0.77
941332	AE2-129 E	0.51
941351	AE2-131 C	0.77
941352	AE2-131 E	0.51
942031	AE2-215 C	13.9
942032	AE2-215 E	9.27
942351	AE2-248 C	1.11
942352	AE2-248 E	0.74

Bus #	Bus	MW Impact
942491	AE2-262 C	4.67
942492	AE2-262 E	3.14
942501	AE2-263 C	4.39
942502	AE2-263 E	2.93
942511	AE2-264 C	4.79
942512	AE2-264 E	3.19
CATAWBA	CATAWBA	0.02
CBM-N	CBM-N	0.51
CBM-S1	CBM-S1	0.34
CBM-W1	CBM-W1	1.35
CBM-W2	CBM-W2	3.23
CIN	CIN	0.47
G-007	G-007	0.35
HAMLET	HAMLET	0.07
IPL	IPL	0.31
LGEE	LGEE	0.13
MEC	MEC	0.83
MECS	MECS	1.12
NYISO	NYISO	2.21
O-066	O-066	2.01
WEC	WEC	0.14

Affected Systems

20 Affected Systems

20.1 LG&E

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

20.2 MISO

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

20.3 TVA

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

20.4 Duke Energy Progress

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

20.5 NYISO

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

21 Contingency Descriptions

Contingency Name	Contingency Definition
PN-P2-2-PN-230-006AT	CONTINGENCY 'PN-P2-2-PN-230-006AT' /* LEWISTOWN #1 230KV BUS / PJM FIXED DISCONNECT BRANCH FROM BUS 200513 TO BUS 208005 CKT 1 /* 26LEWISTWN 230 JUNI BU2 230 /UPDATED JUNI BUS # DISCONNECT BRANCH FROM BUS 200513 TO BUS 200531 CKT 1 /* 26LEWISTWN 230 26YEAGRTWN 230 DISCONNECT BRANCH FROM BUS 200513 TO BUS 200512 TO BUS 200548 CKT 1/* 26LEWISTWN 230 26LEWISTWN 115 26LEWISTWN 46.00 REDUCE BUS 200513 SHUNT BY 100 PERCENT /* 26LEWISTWN 230 END
PL:10:P22:100582	CONTINGENCY 'PL:10:P22:100582' /* JUNIATA 230KV BUS 2 DISCONNECT BUS 208005 /* END

Short Circuit

22 Short Circuit

The following Breakers are overduty:

None

23 Attachment 1 – One Line

24 Attachment 2 – Project Location