Generation Interconnection

Feasibility Study Report

for

Queue Project AE2-191

SAXONBURG 138 KV

21.84 MW Capacity / 52 MW Energy

July, 2019

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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 Allegheny Power System (APS).

2 Preface

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

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

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

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

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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.

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3 General

The Interconnection Customer (IC) has proposed a Solar generating facility located in Butler County, Pennsylvania. The installed facilities will have a total capability of 52 MW with 21.84 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is December 31, 2022. This study does not imply a Transmission Owner (TO) commitment to this in-service date.

Queue Number	**AE2-191**
Project Name	SAXONBURG 138 KV
Interconnection Customer	
State	PA
County	Butler
Transmission Owner	APS
MFO	52
MWE	52
MWC	21.84
Fuel	Solar
Basecase Study Year	2022

4 Point of Interconnection

4.1 Primary POI

The interconnection of the project at the Primary POI will be accomplished by constructing a new 138 kV terminal at Saxonburg. The project will also require non-direct connection upgrades at Cabot substation.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AE2-191 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 all of 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.

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5 Cost Summary

The AE2-191 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$550,305
Direct Connection Network Upgrade	$672,595
Non Direct Connection Network Upgrades	$324,400
Total Costs	$1,547,300

In addition, the AE2-191 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	$0

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 AE2-191 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.

6 Transmission Owner Scope of Work

The interconnection of the project at the Primary POI will be accomplished by constructing a new 138 kV terminal at Saxonburg. The project will also require non-direct connection upgrades at Cabot substation.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AE2-191 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 all of 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.

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7 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 Dead-End Structure, Foundations and Disconnect Switch for AE2-191 Terminal	$550,305
Total Attachment Facility Costs	$550,305

8 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
Install 138 kV Terminal with Wavetrap and Anti-islanding Relays at Saxonburg	$672,595
Total Direct Connection Facility Costs	$672,595

9 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
Upgrade Carrier Equipment and Relays at Cabot Substation	$324,400
Total Non-Direct Connection Facility Costs	$324,400

10 Schedule

Based on the scope of work for the Attachment Facilities and the Direct and Non-Direct Connection facilities, it is expected to take a minimum of 10 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 Attachment Facilities and Direct Connection work. Full initial deposit is 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 direct connection and network upgrades, and that all transmission system outages will be allowed when requested.

It should be noted that to resolve overload violations identified in the "Network Impacts" section of this report, Baseline RTEP project b3081 needs to be placed in-service prior to the AE2-191 going to Commercial Operation. The current projected in-service date for b3081 is 6/1/2022.

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11 Transmission Owner Analysis

11.1 Power Flow Analysis

FE performed an analysis of its underlying transmission <100 kV system. The AE2-191 project did not contribute to any overloads on the FE transmission <100 kV system.

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12 Interconnection Customer Requirements

12.1 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.

12.2 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 138 kV circuit breaker to protect the AE2-191 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 AE2-191 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.

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12.3 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.

13 Revenue Metering and SCADA Requirements

13.1 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.

13.2 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

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14 Network Impacts

The Queue Project AE2-191 was evaluated as a 52.0 MW (Capacity 21.8 MW) injection at the Saxonburg 138kV substation in the APS area. Project AE2-191 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-191 was studied with a commercial probability of 53%. Potential network impacts were as follows:

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Summer Peak Load Flow

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15 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
2623798	235205	01KRENDL	AP	239099	02SENECA	ATSI	1	235104 01CABOT 500 239280 02CRNBRY 500 1	single	352.0	99.47	100.06	DC	2.05

16 Multiple Facility Contingency

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

None

17 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
1607133	235205	01KRENDL	AP	239099	02SENECA	ATSI	1	ATSI-P2-3-OEE-138-139T	breaker	352.0	100.04	100.65	DC	4.78
1607134	235205	01KRENDL	AP	239099	02SENECA	ATSI	1	ATSI-P2-3-OEE-138-138T	breaker	352.0	100.04	100.65	DC	4.78

18 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.

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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
2623797	235205	01KRENDL	AP	239099	02SENECA	ATSI	1	235104 01CABOT 500 239280 02CRNBRY 500 1	operation	352.0	99.48	100.1	DC	4.88

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19 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
1607134,2623798,1607133	1	01KRENDL 138.0 kV - 02SENECA 138.0 kV Ckt 1	b3081 (262) : Replace breaker and bus conductor at Krendale.[1] New rating will be 312/380 MVA (SN/STE) Project Type : Facility Cost : $0 Time Estimate : N/A Months	$0
			TOTAL COST	$0

[1] Baseline RTEP project b3081 needs to be placed in-service prior to the AE2-191 going to Commercial Operation. The current projected in-service date for b3081 is 6/1/2022.

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20 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.

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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
1607134	235205	01KRENDL	AP	239099	02SENECA	ATSI	1	ATSI-P2-3-OEE-138-138T	breaker	352.0	100.04	100.65	DC	4.78

Bus #	Bus	MW Impact
235776	01AL DAM5	0.31
941841	AE2-189 C O1	1.44
941842	AE2-189 E O1	1.99
941861	AE2-191 C	2.01
941862	AE2-191 E	2.77
BLUEG	BLUEG	7.79
CALDERWOOD	CALDERWOOD	0.67
CANNELTON	CANNELTON	0.46
CATAWBA	CATAWBA	0.34
CBM-N	CBM-N	1.5
CHEOAH	CHEOAH	0.61
CHILHOWEE	CHILHOWEE	0.22
COFFEEN	COFFEEN	0.82
COTTONWOOD	COTTONWOOD	2.83
DUCKCREEK	DUCKCREEK	1.82
EDWARDS	EDWARDS	0.83
ELMERSMITH	ELMERSMITH	0.79
FARMERCITY	FARMERCITY	0.53
G-007A	G-007A	4.53
GIBSON	GIBSON	0.32
HAMLET	HAMLET	0.5
NEWTON	NEWTON	2.13
NYISO	NYISO	6.5
PRAIRIE	PRAIRIE	3.86
SANTEETLA	SANTEETLA	0.18
SMITHLAND	SMITHLAND	0.3
TATANKA	TATANKA	0.97
TILTON	TILTON	1.0
TRIMBLE	TRIMBLE	0.87
TVA	TVA	2.32
UNIONPOWER	UNIONPOWER	1.01
VFT	VFT	12.29

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Affected Systems

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22 Affected Systems

22.1 LG&E

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

22.2 MISO

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

22.3 TVA

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

22.4 Duke Energy Progress

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

22.5 NYISO

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

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23 Contingency Descriptions

Contingency Name	Contingency Definition
ATSI-P2-3-OEE-138-139T	CONTINGENCY 'ATSI-P2-3-OEE-138-139T' /* CRANBERRY 500KV BRKR FAILURE-B6 DISCONNECT BRANCH FROM BUS 239280 TO BUS 239281 CKT 2 /* 02CRNBRY 500 02CRNBRY 138 DISCONNECT BRANCH FROM BUS 239280 TO BUS 235104 CKT 1 /* 02CRNBRY 500 01CABOT 500 END
ATSI-P2-3-OEE-138-138T	CONTINGENCY 'ATSI-P2-3-OEE-138-138T' /* CRANBERRY 500KV BRKR FAILURE-B5 DISCONNECT BRANCH FROM BUS 239280 TO BUS 239281 CKT 1 /* 02CRNBRY 500 02CRNBRY 138 DISCONNECT BRANCH FROM BUS 239280 TO BUS 235104 CKT 1 /* 02CRNBRY 500 01CABOT 500 END
235104 01CABOT 500 239280 02CRNBRY 500 1	CONTINGENCY '235104 01CABOT 500 239280 02CRNBRY 500 1' / 8388 OPEN BRANCH FROM BUS 235104 TO BUS 239280 CKT 1 / 235104 01CABOT 500 239280 02CRNBRY 500 1 END

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Short Circuit

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24 Short Circuit

The following Breakers are overduty:

None

25 Attachment 1 – One Line

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26 Attachment 2 – Project Location