Generation Interconnection

Feasibility Study Report

for

Queue Project AE2-285

MAYSVILLE 69 KV

30 MW Capacity / 50 MW Energy

July, 2019

Table of Contents

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 American Transmission Systems Inc. (ATSI).

2 Preface

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

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

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

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

The Interconnection Customer will be required to submit a completed dynamic model study request form (Attachment B-1 of Manual 14G) in order to document the request for the study.

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

3 General

The Interconnection Customer (IC) has proposed a Solar generating facility located in Mercer County, Pennsylvania. The installed facilities will have a total capability of 50 MW with 30 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is June 30, 2022. This study does not imply a Transmission Owner (TO) commitment to this in-service date.

Queue Number	**AE2-285**
Project Name	MAYSVILLE 69 KV
Interconnection Customer	
State	Pennsylvania
County	Mercer
Transmission Owner	ATSI
MFO	50
MWE	50
MWC	30
Fuel	Solar
Basecase Study Year	2022

3.1 Point of Interconnection

3.1.1 Primary POI

The interconnection of the project at the Primary POI will be accomplished by extending the Maysville 69 kV bus, installing one (1) 69 kV circuit breaker, and extending a new line exit to the Primary POI. The IC will be responsible for acquiring all easements, properties, and permits that may be required to expand the Maysville substation and associated attachment facilities.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AE2-285 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.

3.1.2 Secondary POI

The interconnection of the project at the Secondary POI can be accomplished by tapping the Maysville-Jamestown section of the Andover (Maysville) 69 kV line and constructing a one span tap. The transmission line tap would be located approximately 2.1 miles from the Maysville substation. A full scope of work or estimated cost is not provided for the proposed Secondary POI. Only network impacts are provided for the Secondary POI which can be found in the "Network Impacts- Secondary Point of Interconnection" section of this report.

3.2 Cost Summary

The AE2-285 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$629,150
Direct Connection Network Upgrade	$629,150
Non Direct Connection Network Upgrades	$0
Total Costs	$1,258,300

In addition, the AE2-285 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 AE2-285 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 extending the Maysville 69 kV bus, installing one (1) 69 kV circuit breaker, and extending a new line exit to the Primary POI. The IC will be responsible for acquiring all easements, properties, and permits that may be required to expand the Maysville substation and associated attachment facilities.

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 ring bus substation	$629,150
Total Attachment Facility Costs	$629,150

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
Extend Maysville 69 kV bus and install one 69 kV breaker	$629,150
Total Direct Connection Facility Costs	$629,150

7 Non-Direct Connection Cost Estimate

There is no Non-Direct Connection scope of work required.

8 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 13 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. 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.

9 Transmission Owner Analysis

9.1 Power Flow Analysis

FE performed an analysis of its underlying transmission <100 kV system. The AE2-285 project did not contribute to any overloads on the FE transmission 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's GSU transformer winding configuration must not be in violation of section 14.2.6 of FE's "Requirements for Transmission Connected Facilities" document. Inverter-based generation that is UL1741 certified for anti-islanding protection connected to the FE Transmission System at <100kV shall have a delta or ungrounded wye winding on the transmission side.

Inverter-based generation that is not UL1741 certified for anti-islanding protection connected to the FE Transmission System at <100kV shall have a transmission-side winding determined by FE on a case-by case basis.

10.2 Compliance Issues and Interconnection

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 69 kV circuit breaker to protect the AE2-285 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 AE2-285 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 solar/battery 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 ATSI 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 Point of Interconnection

The Queue Project AE2-285 was evaluated as a 50.0 MW (Capacity 30.0 MW) injection at the Maysville 69kV substation in the ATSI area. Project AE2-285 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-285 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)

None

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)

None

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
8941534	940140	AE2-013 TAP	ATSI	930600	AB1-105 TAP	ATSI	1	ATSI-P1-2-SYS-345-880A_FSA	operation	1672.0	99.59	100.24	DC	10.93

12.5 System Reinforcements

None

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.

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 Descriptions

Contingency Name	Contingency Definition
ATSI-P1-2-SYS-345-880A_FSA	CONTINGENCY 'ATSI-P1-2-SYS-345-880A_FSA' /* LINE 02SAMMIS TO Z2-028 345 CK 1 DISCONNECT BRANCH FROM BUS 239092 TO BUS 919010 CKT 1 /* 02SAMMIS 345 AA1-123 345 END

Short Circuit

12.9 Short Circuit

The following Breakers are overduty:

None

13 Network Impacts – Secondary Point of Interconnection

The Queue Project AE2-285 was evaluated as a 50.0 MW (Capacity 30.0 MW) injection tapping the Maysville to James TP 69kV line in the ATSI area. Project AE2-285 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-285 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)

None

13.2 Multiple Facility Contingency

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

None

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)

None

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	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
8941534	940140	AE2-013 TAP	ATSI	930600	AB1-105 TAP	ATSI	1	ATSI-P1-2-SYS-345-880A_FSA	operation	1672.0	99.9	100.55	DC	10.93

13.5 System Reinforcements

None

13.6 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.

Affected Systems

13.7 Affected Systems

13.7.1 LG&E

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

13.7.2 MISO

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

13.7.3 TVA

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

13.7.4 Duke Energy Progress

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

13.7.5 NYISO

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

13.8 Contingency Descriptions

Contingency Name	Contingency Definition
ATSI-P1-2-SYS-345-880A_FSA	CONTINGENCY 'ATSI-P1-2-SYS-345-880A_FSA' /* LINE 02SAMMIS TO Z2-028 345 CK 1 DISCONNECT BRANCH FROM BUS 239092 TO BUS 919010 CKT 1 /* 02SAMMIS 345 AA1-123 345 END

Short Circuit

13.9 Short Circuit

The following Breakers are overduty:

None

Attachment 1 – One Line

Attachment 2 – Project Location