



**Generation Interconnection
Feasibility Study Report
for
Queue Project AF1-305
MAYSVILLE-MASURY 138 KV
21 MW Capacity / 35 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 American Transmission Systems, Inc. (ATSI – Penn Power zone).

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; Storage generating facility located in Mercer County, Pennsylvania. The installed facilities will have a total capability of 35 MW with 21 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is December 31, 2023. This study does not imply a TO commitment to this in-service date.

Queue Number	AF1-305
Project Name	MAYSVILLE-MASURY 138 KV
State	Pennsylvania
County	Mercer
Transmission Owner	ATSI/Penn Power zone
MFO	35
MWE	35
MWC	21
Fuel	Solar; Storage
Basecase Study Year	2023

4 Point of Interconnection (POI)

AF1-305 will interconnect with the ATSI transmission system and has chosen two POIs to be analyzed:

4.1 Primary POI

The interconnection of the project at the Primary POI will be accomplished by constructing a new 138 kV three (3) breaker ring bus substation and looping the Masury-Maysville 138 kV line into the new station. The new substation will be located approximately 14.5 miles from Masury 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 Masury and Maysville substations.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AF1-305 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.

4.2 Secondary POI

The interconnection of the project at a Secondary POI can be accomplished by extending the 138 kV bus at Maysville and installing a new 138 kV breaker. The new substation would be located approximately 4 miles from Maysville substation. A full scope of work or estimated cost is not provided for the proposed Secondary POI.

5 Cost Summary

The AF1-305 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	\$319,500
Direct Connection Network Upgrade	\$6,807,200
Non Direct Connection Network Upgrades	\$910,100
Total Costs	\$8,036,800

In addition, the AF1-305 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 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 AF1-305 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 three (3) breaker ring bus substation and looping the Masury-Maysville 138 kV line into the new station. The new substation will be located approximately 14.5 miles from Masury 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 Masury and Maysville substations.

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 one span of 795 ACSR towards the customer substation	\$ 246,000
Engineering review of customer drawings	\$73,500
Total Attachment Facility Costs	\$319,500

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
New 3-breaker ring bus interconnection substation to accommodate AF1-305	\$ 6,807,200
Total Direct Connection Facility Costs	\$6,807,200

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
Tap the Masury-Maysville 138 kV line roughly 4 miles from Maysville. Loop the Masury-Maysville 138 kV Line into the new 3-breaker ring bus using 795 ACSR	\$ 834,100
Relay setting changes at Masury	\$ 38,000

Description	Total Cost
Relay setting changes at Maysville	\$ 38,000
Total Non-Direct Connection Facility Costs	\$910,100

10 Schedule

Based on the scope of work for the Attachment Facilities and the Direct and/or Non-Direct Connection facilities, it is expected to take a minimum of **18 months** after the signing of an Interconnection Construction Service Agreement to complete the installation. This includes the requirement for the IC to make a preliminary payment that compensates FE for the first three months of the engineering design work that is related to the Attachment Facilities and Direct Connection work. The Non-Direct Connection work requires a full initial deposit. 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.

11 Transmission Owner Analysis

11.1 Power Flow Analysis

FE performed an analysis of its underlying transmission <100 kV system. The AF1-305 project did not contribute to any overloads on the FE transmission system.

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

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.

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 AF1-305 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 AF1-305 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.

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 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>

14 Network Impacts – Primary POI

The Queue Project AF1-305 was evaluated as a 35.0 MW (Capacity 21.0 MW) injection tapping the Maysville to Masury 138 kV line in the ATSI area. Project AF1-305 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-305 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Load Flow

14.1 Generation Deliverability

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

None

14.2 Multiple Facility Contingency

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

None

14.3 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

14.4 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
50178158	238833	02JACKSN	138.0	ATSI	238942	02MAPLE	138.0	ATSI	1	AP-P1-3-WP-138-050	operation	316.0	100.04	101.08	DC	3.26
41405458	239092	02SAMMIS	345.0	ATSI	253902	15BVRVAL	345.0	DLCO	1	Base Case	operation	1413.0	99.81	100.0	DC	2.85

14.5 System Reinforcements

None

Affected Systems

14.6 Affected Systems

14.6.1 LG&E

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

14.6.2 MISO

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

14.6.3 TVA

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

14.6.4 Duke Energy Progress

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

14.6.5 NYISO

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

14.7 Contingency Descriptions

Contingency Name	Contingency Definition
Base Case	
AP-P1-3-WP-138-050	CONTINGENCY 'AP-P1-3-WP-138-050' /* BUTLER #62 138/12KV XFMR DISCONNECT BRANCH FROM BUS 235152 TO BUS 235246 CKT 1 /* 01BUTLER 138 01SHANOR 138 DISCONNECT BRANCH FROM BUS 235152 TO BUS 235197 CKT 1 /* 01BUTLER 138 01KARNSC 138 DISCONNECT BRANCH FROM BUS 235152 TO BUS 235153 CKT E /* 01BUTLER 138 01CABOT 138 END

Short Circuit

14.8 Short Circuit

The following Breakers are overduty:

None

15 Network Impacts – Secondary POI

The Queue Project AF1-305 was evaluated as a 35.0 MW (Capacity 21.0 MW) injection at the Maysville 138 kV substation in the ATSI area. Project AF1-305 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-305 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Load Flow

15.1 Generation Deliverability

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

None

15.2 Multiple Facility Contingency

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

None

15.3 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

15.4 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
50178159	238833	02JACKSN	138.0	ATSI	238942	02MAPLE	138.0	ATSI	1	AP-P1-2-MP-500-510T	operation	316.0	99.53	100.27	DC	2.31
41405458	239092	02SAMMIS	345.0	ATSI	253902	15BVRVAL	345.0	DLCO	1	Base Case	operation	1413.0	99.81	100.0	DC	2.85

Affected Systems

15.5 Affected Systems

15.5.1 LG&E

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

15.5.2 MISO

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

15.5.3 TVA

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

15.5.4 Duke Energy Progress

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

15.5.5 NYISO

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

15.6 Contingency Descriptions

Contingency Name	Contingency Definition
Base Case	
AP-P1-2-MP-500-510T	CONTINGENCY 'AP-P1-2-MP-500-510T' /* WYLIE RIDGE - CRANBERRY 500KV APS-ATSI TIE DISCONNECT BRANCH FROM BUS 235703 TO BUS 239280 CKT 1 /* 01WYLIE R 500 02CRNBRY 500 END

Short Circuit

15.7 Short Circuit

The following Breakers are overduty:

None

16 Attachment One: One Line Diagram