Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AE1-239

McDowell 138 kV

February 2019

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. 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 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.

General

The Interconnection Customer (IC), has proposed a solar generating facility located in Mercer County, PA. The installed facilities will have a total capability of 38.2 MW with 22.92 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is December 31, 2021. **This study does not imply a ATSI commitment to this in-service date.**

Point of Interconnection

AE1-239 will interconnect with the ATSI transmission system at the McDowell 138 kV Substation.

Cost Summary

The AE1-239 project will be responsible for the following costs:

Description	Total Cost	
Attachment Facilities	$	10,000
Direct Connection Network Upgrades	$	0
Non Direct Connection Network Upgrades	$	1,105,500
Total Costs	**$**	**1,115,500**

The transmission and substation costs given above exclude the Contribution in Aid of Construction ("CIAC") Federal Income Tax Gross up charge. If at a future date Federal CIAC taxes are deemed necessary by the IRS for this project, ATSI shall be reimbursed by the

Interconnection Customer for such taxes. ATSI estimates the tax, if applicable, would be approximately $143,200.

General Information

Queue Position: AE1-239

Interconnected Transmission Owner ("TO"): American Transmission Systems, Incorporated ("ATSI")

Impacted TO(s) (if applicable): American Transmission Systems, Incorporated ("ATSI")

PJM Zone: ATSI

FE Operating Company or Planning Region: Penn Power

Customer Connection Request

Requested Backfeed Date: TBD

Requested Commercial Operation Date: 12/31/2021

This study does not imply a FirstEnergy commitment to these dates.

New Facilities		Existing Facilities	
Capacity:	22.92 MW	Capacity:	NA
Energy:	38.20 MW	Energy:	NA
MFO[1]:	38.20 MW	MFO:	NA
Fuel:	Solar	Prior Queue Position(s):	NA

Point of Interconnection

Primary Point of Interconnection: McDowell 138 kV Substation

[1] Maximum Facility Output

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	Activity Cost
Install attachment facility line and associated hardware to accept the Interconnection Customer generator lead line	$ 10,000
Total Attachment Facility Costs	**$ 10,000**

Direct Connection Cost Estimate

No Direct Connection Facilities are required to support this interconnection request.

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	Activity Cost
Install new 138 kV terminal for the AE1-239 interconnection at McDowell substation	$ 1,105,500
Total Non-Direct Connection Facility Costs	**$ 1,105,500**

Transmission Owner Scope of Work

The interconnection of the project at the Primary POI will be accomplished by extending the existing McDowell 138 kV bus and installing one 138 kV breaker. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct the associated attachment facilities.

A summary of the connection facilities that will be required for the Primary POI and their estimated costs are shown in the following table. Based on this scope of work, it is expected to take a minimum of 13 months after the signing of an Interconnection Construction Service Agreement. This include preliminary payment that compensates FE for the first three months of the engineering design work that is related to the construction of the AE1-239 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 PJM will allow all transmission system outages when requested.

Interconnection Customer Requirements

1. The Interconnection Customer may be required to install and/or pay for metering as necessary to properly track real time output of the facility as well as installing metering which shall be used for billing purposes. See Section 8 of Appendix 2 to the Interconnection Service Agreement as well as Section 4 of PJM Manual 14D for additional information.

2. The Interconnection Customer seeking to interconnect a solar generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per the Interconnection Service Agreement.

3. The purchase and installation of a fully rated 138 kV circuit breaker to protect the AE1-239 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.

4. 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.

5. 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.

6. Compliance with the FE and PJM generator power factor and voltage control requirements.

7. The execution of a back-up service agreement to serve the customer load supplied from the AE1-239 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.

8. 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.

9. 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.

Revenue Metering and SCADA Requirements

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 Sections 24.1 and 24.2.

Metering

The IC will be require 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.

FE Requirements

The Interconnection Customer will be required to comply with all FE Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "FirstEnergy Requirements for Transmission Connected Facilities" document located at the following links:

http://www.firstenergycorp.com/feconnect
http://www.pjm.com/planning/design-engineering/to-tech-standards.aspx

System Protection

The IC must design it's 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.

Network Impacts

The Queue Project AE1-239 was evaluated as a 38.2 MW (Capacity 22.92 MW) injection at the McDowell 138 kV substation in the ATSI area. Project AE1-239 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE1-239 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis – 2022

Contingency Descriptions

The following contingencies resulted in overloads:

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
ATSI-P7-1-OEE-345-002A	CONTINGENCY 'ATSI-P7-1-OEE-345-002A' /* HIGHLAND-Z2-028 345KV 1 AND 2 DISCONNECT BRANCH FROM BUS 238796 TO BUS 917130 CKT 1 /* 02HGHLND 345 Z2-028 345 DISCONNECT BRANCH FROM BUS 238796 TO BUS 917140 CKT 1 /* 02HGHLND 345 Z2-028 345 END
AP-P2-3-WP-500-463T	CONTINGENCY 'AP-P2-3-WP-500-463T' /* 470 DISCONNECT BRANCH FROM BUS 235104 TO BUS 239280 CKT 1 /* 01CABOT 500 02CRNBRY 500 DISCONNECT BRANCH FROM BUS 235104 TO BUS 235153 CKT 2 /* 01CABOT 500 01CABOT 138 DISCONNECT BRANCH FROM BUS 235104 TO BUS 235153 CKT 4 /* 01CABOT 500 01CABOT 138 END
ATSI-P7-1-OEE-345-004_NO_FSA	CONTINGENCY 'ATSI-P7-1-OEE-345-004_NO_FSA' /* HOYTDALE-SHENANGO & HOYTDALE-MN 345KV DISCONNECT BRANCH FROM BUS 238812 TO BUS 918320 CKT 1 /* 02HOYTDL 345 Y1-015 TAP 345 DISCONNECT BRANCH FROM BUS 239106 TO BUS 918320 CKT 1 /* 02SHNAGO 345 Y1-015 TAP 345 DISCONNECT BRANCH FROM BUS 238812 TO BUS 238941 CKT 1 /* 02HOYTDL 345 02MANSFD 345 END

Generator Deliverability

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

None.

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
285664	936950	AD2-120 TAP	ATSI	239107	02SHNAGO	ATSI	1	AP-P2-3-WP-500-463T	breaker	186.0	102.71	113.61	DC	20.27
286958	936950	AD2-120 TAP	ATSI	239107	02SHNAGO	ATSI	1	ATSI-P7-1-OEE-345-004_NO_FSA	tower	186.0	93.44	104.22	DC	20.05
286959	936950	AD2-120 TAP	ATSI	239107	02SHNAGO	ATSI	1	ATSI-P7-1-OEE-345-002A	tower	186.0	90.37	101.2	DC	20.16

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)

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
285662	936950	AD2-120 TAP	ATSI	239107	02SHNAGO	ATSI	1	ATSI-P2-3-OEE-138-138T	breaker	186.0	110.5	121.35	DC	20.18
285663	936950	AD2-120 TAP	ATSI	239107	02SHNAGO	ATSI	1	ATSI-P2-3-OEE-138-139T	breaker	186.0	110.5	121.35	DC	20.18

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.

None.

Short Circuit

(Summary of impacted circuit breakers)

None.

Steady-State Voltage Requirements

(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

Steady State Voltage Studies to be conducted during later study phases

Stability and Reactive Power Requirement for Low Voltage Ride Through

(Summary of the VAR requirements based upon the results of the dynamic studies)

Stability Studies to be conducted during later study phases

Affected System Analysis & Mitigation

MISO Impacts:

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

Light Load Analysis - 2021

Light Load Studies to be conducted during later study phases

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.

None.

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)

ID	Index	Facility	Upgrade Description	Cost
285664,286959,286958,285662,285663	1	AD2-120 TAP 138.0 kV - 02SHNAGO 138.0 kV Ckt 1	Description : No Violation. The AD1-120 Tap - Shenango 138 kV has an STE rating of 249 MVA.	$0
		TOTAL COST	$0	

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)

None.

Attachment 1. Flowgate Details

Appendices

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.

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
285663	936950	AD2-120 TAP	ATSI	239107	02SHNAGO	ATSI	1	ATSI-P2-3-OEE-138-139T	breaker	186.0	110.5	121.35	DC	20.18

Bus #	Bus	MW Impact
936951	AD2-120 C O1	46.04
936952	AD2-120 E O1	63.58
939541	AE1-183 C	3.71
939542	AE1-183 E	2.48
939991	AE1-239 C	12.11
939992	AE1-239 E	8.07
BAYOU	BAYOU	0.64
BIG_CAJUN1	BIG_CAJUN1	0.97
BIG_CAJUN2	BIG_CAJUN2	1.95
BLUEG	BLUEG	3.56
CALDERWOOD	CALDERWOOD	0.3
CANNELTON	CANNELTON	0.21
CATAWBA	CATAWBA	0.15
CBM-N	CBM-N	0.68
CHEOAH	CHEOAH	0.27
CHILHOWEE	CHILHOWEE	0.1
CHOCTAW	CHOCTAW	0.63
COFFEEN	COFFEEN	0.37
COTTONWOOD	COTTONWOOD	2.54
DEARBORN	DEARBORN	0.82
DUCKCREEK	DUCKCREEK	0.84
EDWARDS	EDWARDS	0.39

Bus #	Bus	MW Impact
ELMERSMITH	ELMERSMITH	0.36
FARMERCITY	FARMERCITY	0.24
G-007A	G-007A	2.09
GIBSON	GIBSON	0.15
HAMLET	HAMLET	0.43
NEWTON	NEWTON	0.98
NYISO	NYISO	2.94
O-066A	O-066A	0.99
PRAIRIE	PRAIRIE	1.76
SANTEETLA	SANTEETLA	0.08
SMITHLAND	SMITHLAND	0.13
TATANKA	TATANKA	0.45
TILTON	TILTON	0.46
TRIMBLE	TRIMBLE	0.4
TVA	TVA	1.04
UNIONPOWER	UNIONPOWER	0.45
VFT	VFT	5.66