



**Generation Interconnection  
Feasibility Study Report  
for  
Queue Project AE2-193  
SHENANGO 138 KV  
50.4 MW Capacity / 120 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 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.

An Interconnection Customer with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

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 Mercer County, Pennsylvania. The installed facilities will have a total capability of 120 MW with 50.4 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is 12/31/2022. This study does not imply a Transmission Owner (TO) commitment to this in-service date.

<b>Queue Number</b>	<b>AE2-193</b>
<b>Project Name</b>	<b>SHENANGO 138 KV</b>
<b>Interconnection Customer</b>	
<b>State</b>	PA
<b>County</b>	Mercer
<b>Transmission Owner</b>	ATSI
<b>MFO</b>	120
<b>MWE</b>	120
<b>MWC</b>	50.4
<b>Fuel</b>	Solar
<b>Base case Study Year</b>	2022

### 3 Point of Interconnection

The interconnection of the project at the Primary POI will be accomplished by extending the Shenango 138 kV bus, installing two (2) 138 kV circuit breakers 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 Shenango substation and associated attachment facilities.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AE2-193 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.

## 4 Cost Summary

The AE2-193 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	\$512,100
Direct Connection Network Upgrade	\$1,194,900
Non Direct Connection Network Upgrades	\$0
Total Costs	\$1,707,000

In addition, the AE2-193 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	\$325,000

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 AE2-193 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.



## 5 Transmission Owner Scope of Work

The interconnection of the project at the Primary POI will be accomplished by extending the Shenango 138 kV bus, installing two (2) 138 kV circuit breakers, 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 Shenango substation and associated attachment facilities.

## 6 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 breaker string at Shenango	\$512,100
<b>Total Attachment Facility Costs</b>	<b>\$512,100</b>

## 7 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
Add breaker and a half with (2) 138kV breakers at Shenango Substation	\$1,194,900
<b>Total Direct Connection Facility Costs</b>	<b>\$1,194,900</b>

## 8 Non-Direct Connection Cost Estimate

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

## 9 System Reinforcements

Facility	Upgrade Description	Cost
McDowell-Sharon Y-300 69 kV Line	OEE-008A: Upgrade limiting RT at McDowell so the TL is the limiting element. Project Type : FAC Cost : \$325,000 Time Estimate : 12 Months	\$325,000
	TOTAL COST	\$325,000

## 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 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.

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.

## 11 Transmission Owner Analysis

Penelec identified the following violation on their lower voltage system:

<b>Id</b>	<b>Violation Description</b>	<b>kV</b>	<b>CONT DESCRIPTION</b>
L1	112% Overload on the McDowell-Sharon Y-300 69 kV Line	69.0	Loss of the McDowell-Shenango 138 kV Line

## 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 AE2-193 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 AE2-193 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 solar 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

The Queue Project AE2-193 was evaluated as a 120 MW (Capacity 50.4 MW) injection at the Shenango 138 kV substation in the ATSI area. Project AE2-193 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-193 was studied with a commercial probability of 53%. Potential network impacts were as follows:



## Summer Peak Load Flow

## 15 Generation Deliverability

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

None

## 16 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
2263353	238642	02CRSLND	ATSI	238944	02MASURY	ATSI	1	ATSI-P7-1-OEE-138-015A	tower	242.0	89.1	98.24	DC	22.12

## 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)

None

## 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.

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
2263007	930600	AB1-105 TAP	ATSI	238781	02HANNA	ATSI	1	DLC_P12_320	operation	1672.0	120.61	121.95	DC	22.63
2263009	930600	AB1-105 TAP	ATSI	238781	02HANNA	ATSI	1	Base Case	operation	1413.0	114.51	116.09	DC	22.41
8820974	940140	AE2-013 TAP	ATSI	930600	AB1-105 TAP	ATSI	1	ATSI-P1-2-SYS-345-880A_FSA	operation	1672.0	97.59	99.19	DC	27.13

## 19 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
2263353	1	02CRSLND 138.0 kV - 02MASURY 138.0 kV Ckt 1	No Reinforcement Needed. Not a valid violation <sup>1</sup>	\$0
L1	See TO Analysis	McDowell-Sharon Y-300 69 kV Line	OEE-008A: Upgrade limiting RT at McDowell so the TL is the limiting element. Project Type : FAC Cost : \$325,000 Time Estimate : 12 Months	\$325,000
			TOTAL COST	\$325,000

<sup>1</sup> If “No Reinforcement Needed. Not a valid violation” was provided as the Upgrade Description for a facility in the System Reinforcements table then that facility met one of the following conditions:

- The loading on the facility at your queue position was less than 100%; therefore, the facility is not yet overloaded, but may be overloaded by end of the AE2 queue.
- The TO reviewed their ratings on the facility and determined that the current rating was greater than the rating in PJM’s model. This new rating was greater than the loading at your queue position making the violation invalid.
- The TO reviewed the contingency and determined that contingency was not valid; therefore the violation is invalid. Any contingency corrections will be assessed and corrected in the AE2 impact study phase.

## 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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## 21 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
2263353	238642	02CRSLND	ATSI	238944	02MASURY	ATSI	1	ATSI-P7-1-OEE-138-015A	tower	242.0	89.1	98.24	DC	22.12

Bus #	Bus	MW Impact
934021	AD1-026	6.72
936951	AD2-120 C O1	9.17
936952	AD2-120 E O1	12.66
938202	AE1-029 E	2.58
938583	AE1-079 CBAT	0.24
938584	AE1-079 EBAT	0.59
939973	AE1-237 C2	0.27
939974	AE1-237 EBAT	0.4
940513	AE2-036 EBAT	1.57
941881	AE2-193 C	9.29
941882	AE2-193 E	12.83
942611	AE2-277 C	1.62
942612	AE2-277 E	2.25
943143	AE2-343 BAT	0.67
BLUEG	BLUEG	1.08
CALDERWOOD	CALDERWOOD	0.09
CANNELTON	CANNELTON	0.06
CATAWBA	CATAWBA	0.05
CBM-N	CBM-N	0.14
CHEOAH	CHEOAH	0.09
CHILHOWEE	CHILHOWEE	0.03
COFFEEN	COFFEEN	0.11
COTTONWOOD	COTTONWOOD	0.39
DUCKCREEK	DUCKCREEK	0.25
EDWARDS	EDWARDS	0.12
ELMERSMITH	ELMERSMITH	0.11
FARMERCITY	FARMERCITY	0.07
G-007A	G-007A	0.4
GIBSON	GIBSON	0.04
HAMLET	HAMLET	0.07
NEWTON	NEWTON	0.3
NYISO	NYISO	0.59
PRAIRIE	PRAIRIE	0.54
SANTEETLA	SANTEETLA	0.03
SMITHLAND	SMITHLAND	0.04
TATANKA	TATANKA	0.13
TILTON	TILTON	0.14
TRIMBLE	TRIMBLE	0.12
TVA	TVA	0.32
UNIONPOWER	UNIONPOWER	0.14
VFT	VFT	1.08

## Affected Systems

## **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).

## 23 Contingency Descriptions

Contingency Name	Contingency Definition
Base Case	
DLC_P12_320	CONTINGENCY 'DLC_P12_320' DISCONNECT BRANCH FROM BUS 253902 TO BUS 238781 CKT 1      /* 15BVRVAL 345.00 02HANNA 345.00 END
ATSI-P7-1-OEE-138-015A	CONTINGENCY 'ATSI-P7-1-OEE-138-015A'      /* SHENANGO-MASURY & SHENANGO-BOARDMAN 138KV DISCONNECT BRANCH FROM BUS 238944 TO BUS 239107 CKT 1      /* 02MASURY 138 02SHNAGO 138 DISCONNECT BRANCH FROM BUS 238578 TO BUS 239107 CKT 1      /* 02BORDMN 138 02SHNAGO 138 END
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

## 24 Short Circuit

The following Breakers are overduty:

None

## 25 Attachment 1 – One Line

## 26 Attachment 2 – Project Location