Generation Interconnection

System Impact Study Report

for

Queue Project AF2-341

MAYSVILLE 138 KV

12 MW Capacity / 20 MW Energy

February 2021

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1 Introduction

This System Impact Study has been prepared in accordance with the PJM Open Access Transmission Tariff, 205, as well as the System Impact Study Agreement between the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is ATSI.

2 Preface

The intent of the System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

In some instances an Interconnection Customer may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection or merchant transmission upgrade, 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 System Impact Study is performed.

The System Impact 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.

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.

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 20 MW with 12 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	**AF2-341**
Project Name	MAYSVILLE138 KV
State	Pennsylvania
County	Mercer
Transmission Owner	ATSI
MFO	20
MWE	20
MWC	12
Fuel	Solar
Basecase Study Year	2023

Any new service customers who can feasibly be commercially operable prior to June 1st of the basecase study year are required to request interim deliverability analysis.

4 Point of Interconnection

4.1 Primary Point of Interconnection

AF2-341 will interconnect with the ATSI transmission system by extending the Maysville 138 kV Bus, installing one (1) 138 kV circuit breaker and extending a new line exit to the Primary POI. Additionally, new 138 kV breakers will be installed at the Masury-Maysville 138 kV Line exit and on the high side of the Maysville 138/69 kV Transformer #1 at the Maysville Substation. 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. The project will also require Non-Direct Connection upgrades at Masury, Lincoln Park, Salt Springs, Crossland, Sharon, McDowell, and Shenango substations.

Attachment 1 shows a one-line diagram of the proposed primary Direct Connection facilities for the AF2-341 generation project to connect to the FirstEnergy ("FE") transmission system. 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.

5 Cost Summary

The AF2-341 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	$4,239,500
Total System Network Upgrade Costs (Summer Peak)	$0
Total System Network Upgrade Costs(Light Load)	$0
Total System Network Upgrade Costs (TO Identified)	$18,577,298
Total Costs	$22,816,798

*As your project progresses through the study process and other projects modify their request or withdraw, then your cost allocation could change.

This cost excludes a Federal Income Tax Gross Up charges. This tax may or may not be charged based on whether this project meets the eligibility requirements of IRS Notice 88-129. If at a future date it is determined that the Federal Income Tax Gross charge is required, the Transmission Owner shall be reimbursed by the Interconnection Customer for such taxes.

Note 1: PJM Open Access Transmission Tariff (OATT) section 217.3A outline cost allocation rules. The rules are further clarified in PJM Manual 14A Attachment B. The allocation of costs for a network upgrade will start with the first Queue project to cause the need for the upgrade. Later queue projects will receive cost

allocation contingent on their contribution to the violation and are allocated to the queues that have not closed less than 5 years following the execution of the first Interconnection Service Agreement which identifies the need for this upgrade.

Note 2: For customers with System Reinforcements listed: If your present cost allocation to a System Reinforcement indicates $0, then please be aware that as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, reducing in size, etc, the cost responsibilities can change and a cost allocation may be assigned to your project. In addition, although your present cost allocation to a System Reinforcement is presently $0, your project may need this system reinforcement completed to be deliverable to the PJM system. If your project comes into service prior to completion of the system reinforcement, an interim deliverability study for your project will be required.

6 Transmission Owner Scope of Work

AF2-341 will interconnect with the ATSI transmission system by extending the Maysville 138 kV Bus, installing one (1) 138 kV circuit breaker and extending a new line exit to the Primary POI. Additionally, new 138 kV breakers will be installed at the Masury-Maysville 138 kV Line exit and on the high side of the Maysville 138/69 kV Transformer #1 at the Maysville Substation. 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. The project will also require Non-Direct Connection upgrades at Masury, Lincoln Park, Salt Springs, Crossland, Sharon, McDowell, and Shenango substations.

The total physical interconnection costs are given in the table below:

Description	**Total Cost**
Extend the Maysville 138 kV bus. Install one 138 kV breaker at Maysville for the AF2-341 customer connection. Install one 138 kV breaker at Maysville for the Masury – Maysville 138 kV line terminal. Install one 138 kV breaker at Maysville for the Maysville #1 138/69 kV transformer.	$3,450,500
Relay settings updates at Masury substation.	$107,700
Relay settings updates at Lincoln Park substation.	$107,700
Relay settings updates at Salt Springs substation.	$107,700
Relay settings updates at Crossland substation.	$107,700
Relay settings updates at Sharon substation.	$107,700
Relay settings updates at McDowell substation.	$107,700
Relay settings updates at Shenango substation.	$107,700
Review customer drawings, relay settings, and nameplates.	$35,100
Total Physical Interconnection Costs	$4,239,500

7 Schedule

Based on the scope of work for the interconnection facilities, it is expected to take a minimum of **22 months** after the signing of an Interconnection Construction Service Agreement and construction kickoff call to complete the installation of the physical 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 interconnection work, and that all system outages will be allowed when requested.

The schedule for any required Network Impact Reinforcements will be more clearly identified in future study phases. The estimated time to complete each of the required reinforcements is identified in the "System Reinforcements" section of the report.

8 Transmission Owner Analysis[1]

8.1 Transmission Owner Identified Network Impacts to Distribution Facilities

Potential TO identified network impacts to Transmission Owner distribution facilities were as follows:

None

8.2 Transmission Owner Identified Network Impacts to Sub-Regional Facilities

Potential TO identified network impacts to Transmission Owner Sub-Regional facilities were as follows:

Idx	Overloaded Element	Contingency	Rating [MVA]	Loading Before %	Loading After %	Contribution [MW]
13	Maysville – Y299 Tap 69 kV Line	ATSI-P1-2-OEE-138-012-A	53	114.21%	129.24%	8.15
14	Maysville – AE1-079 Tap 69 kV Line	238948 02MAYSVL 138 946410 AF1-305 TAP 138 1	43	90.49%	109.47%	8.19
24	Maysville – AE1-079 Tap 69 kV Line	239941 02HNDERSN 69.0 939540 AE1-183 TAP 69.0 1	43	100.17%	106.56%	2.72
11	Maysville – AE1-079 Tap 69 kV Line	ATSI-P1-2-OEE-138-012-A	43	147.25%	166.17%	8.19
19	Maysville – AE1-079 Tap 69 kV Line	ATSI-P1-2-OEE-69-024	43	102.97%	111.16%	3.45
25	Maysville – AE1-079 Tap 69 kV Line	ATSI-P1-2-OEE-69-027-A	43	100.01%	106.40%	2.72
16	Maysville – AE1-079 Tap 69 kV Line	Base Case	27	124.90%	133.87%	2.39
12	AE1-079 Tap – Camp Reynolds 69 kV Line	238948 02MAYSVL 138 946410 AF1-305 TAP 138 1	43	107.80%	126.75%	8.19
20	AE1-079 Tap – Camp Reynolds 69 kV Line	239941 02HNDERSN 69.0 939540 AE1-183 TAP 69.0 1	43	109.62%	116.01%	2.72
10	AE1-079 Tap – Camp Reynolds 69 kV Line	ATSI-P1-2-OEE-138-012-A	43	164.34%	183.20%	8.19
17	AE1-079 Tap – Camp Reynolds 69 kV Line	ATSI-P1-2-OEE-69-024	43	116.07%	124.26%	3.45
21	AE1-079 Tap – Camp Reynolds 69 kV Line	ATSI-P1-2-OEE-69-027-A	43	109.45%	115.84%	2.72
15	AE1-079 Tap – Camp Reynolds 69 kV Line	Base Case	27	137.61%	146.62%	2.39
26	AE2-183 Tap – Henderson 69 kV Line	ATSI-P1-2-OEE-138-012-A	46	95.06%	102.01%	3.66

8.3 System Reinforcements on Distribution Facilities

None

[1] For TO Distribution Facilities that need upgrades, the TO has applied their cost allocation rules. For TO Sub-Regional Facilities in need of upgrades, PJM Cost Allocation Criteria has been applied.

8.4 System Reinforcements on Sub-Regional Facilities

<table>
<tr><th>Idx</th><th>Facility</th><th>Upgrade ID</th><th>Upgrade Description</th><th>Cost</th><th>Cost Allocated to AF2-341</th><th>Queue Dependencies</th></tr>
<tr><td>13</td><td>238949 02MAYSVL 69.0 239893 02Y299+ 69.0 Ckt 1
(Maysville – Y299 Tap 69 kV Line)</td><td>OEE-014B</td><td><u>ATSI</u>
OEE-014B: Reconductor the Maysville-Sharon Tap 69 kV Line segment (9.4 miles). Upgrade remote ends so that the TL is the most limiting element of the circuit.

Time Estimate: 48
Cost: $23,707,472
Ratings: 177.0/203.0/203.0 MVA

<table><tr><th>Queue</th><th>MW</th><th>Cost %</th><th>Cost $</th></tr><tr><td>AF2-176</td><td>7.7</td><td>48.58%</td><td>$11,517,195</td></tr><tr><td>AF2-341</td><td>8.15</td><td>51.42%</td><td>$12,190,277</td></tr></table></td><td>$23,707,472</td><td>$12,190,277</td><td>AF2-176, AF2-341</td></tr>
<tr><td>14,24,11, 19,25,16</td><td>238949 02MAYSVL 69.0 938580 AE1-079 TAP 69.0 Ckt 1
(Maysville – AE1-079 Tap 69 kV Line)</td><td>OEE-012C</td><td><u>ATSI</u>
OEE-012C: Reconductor the Maysville-AE1-079 Tap 69 kV Line segment (1.25 miles). The AE1-079 generator is roughly 1.25 miles from Maysville and 2.35 from Camp Raynolds (near structure 62 of the Maysville-Sharon Y-301 69 kV Line)

Time Estimate: 30
Cost: $3,140,063
Ratings: 177.0/203.0/203.0 MVA

Queue Project AF2-341 presently does not receive cost allocation for this upgrade.

Note 1: as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, reducing in size, etc, Queue Project AF2-341 could receive cost allocation.

Note 2: Although Queue Project AF2-341 may not have cost responsibility for this upgrade, Queue Project AF2-341 may need this upgrade in-service to be deliverable to the PJM system. If Queue Project AF2-341 comes into service prior to completion of the upgrade, Queue Project AF2-341 will need an interim study</td><td>$3,140,063</td><td>$0</td><td>AF1-250, AF2-176, AF2-341</td></tr>
<tr><td>12,20,10, 17,21,15</td><td>938580 AE1-079 TAP 69.0 239861 02CP.REYN+ 69.0 Ckt 1
(AE1-079 Tap – Camp Reynolds 69 kV Line)</td><td>OEE-011C</td><td><u>ATSI</u>
OEE-011C: Reconductor the AE1-079 Tap-Camp Reynolds 69 kV Line segment (2.35 miles). The AE1-079 generator is roughly 1.25 miles from Maysville and 2.35 from Camp Reynolds (near structure 62 of the Maysville-Sharon Y-301 69 kV Line)

Time Estimate: 30
Cost: $5,997,519
Ratings: 177.0/203.0/203.0 MVA

<table><tr><th>Queue</th><th>MW</th><th>Cost %</th><th>Cost $</th></tr><tr><td>AF1-250</td><td>3.27</td><td>9.07%</td><td>$544,170</td></tr><tr><td>AF2-176</td><td>24.58</td><td>68.20%</td><td>$4,090,428</td></tr><tr><td>AF2-341</td><td>8.19</td><td>22.72%</td><td>$1,362,921</td></tr></table></td><td>$5,997,519</td><td>$1,362,921</td><td>AF1-250, AF2-176, AF2-341</td></tr>
</table>

<table>
<tr><td>26</td><td>939540 AE1-183 TAP 69.0 239941 02HNDERSN 69.0 Ckt 1 (AE1-183 Tap – Henderson 69 kV Line)</td><td>OEE-016B</td><td><u>ATSI</u>
OEE-016B: Reconductor the AE1-183 Tap-Henderson Tap 69 kV Line segment. The AE1-183 generator is roughly 8.1 miles from McDowell (near structure 108 of the Maysville-McDowell 69 kV Line).

Time Estimate: 30
Cost: $5,024,100
Ratings: 111.0/134.0/134.0 MVA

<table><tr><th>Queue</th><th>MW</th><th>Cost %</th><th>Cost $</th></tr><tr><td>AF2-341</td><td>1.06</td><td>100.00%</td><td>$5,024,100</td></tr></table></td><td>$5,024,100</td><td>$5,024,100</td><td>AF2-341</td></tr>
<tr><td></td><td></td><td></td><td>TOTAL COST</td><td>$37,869,154</td><td>$18,577,298</td><td></td></tr>
</table>

9 Interconnection Customer Requirements

9.1 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.

9.2 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 AF2-341 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 AF2-341 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 Transmission System.

9.3 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.

10 Revenue Metering and SCADA Requirements

10.1 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.

10.2 Meteorological Data Reporting Requirements

The solar generation facility shall provide the Transmission Provider with site-specific meteorological data including:

- Back Panel temperature (Fahrenheit) - (Required for plants with Maximum Facility Output of 3 MW or higher)
- Irradiance (Watts/meter2) - (Required for plants with Maximum Facility Output of 3 MW or higher)
- Ambient air temperature (Fahrenheit) - (Accepted, not required)
- Wind speed (meters/second) - (Accepted, not required)
- Wind direction (decimal degrees from true north) - (Accepted, not required)

10.3 Interconnected Transmission Owner Requirements

The IC will be required to comply with all Interconnected Transmission Owner's revenue metering requirements for generation interconnection customers located at the following link:

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

11 Summer Peak Analysis

The Queue Project AF2-341 was evaluated as a 20.0 MW (Capacity 12.0 MW) injection at the Maysville 138 kV substation in the ATSI area. Project AF2-341 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF2-341 was studied with a commercial probability of 100.0 %. Potential network impacts were as follows:

11.1 Generation Deliverability

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

None

11.2 Multiple Facility Contingency

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

None

11.3 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

11.4 Steady-State Voltage Requirements

To be determined in the Facilities Study phase.

11.5 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	CONTNAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
10076785 6	238948	02MAYSVL	138.0	ATSI	946410	AF1-305 TAP	138.0	ATSI	1	ATSI-P1-2-OEE-69-022-B	operation	110.0	45.73	59.43	AC	15.1

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONTNAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
10076774	946410	AF1-305 TAP	138.0	ATSI	238944	02MASURY	138.0	ATSI	1	ATSI-P1-2-OEE-69-022-B	operation	110.0	87.9	101.53	AC	15.1
10076774	946410	AF1-305 TAP	138.0	ATSI	238944	02MASURY	138.0	ATSI	1	Base Case	operation	110.0	72.64	85.31	AC	14.06

11.6 System Reinforcements

None

Note : For customers with System Reinforcements listed: If your present cost allocation to a System Reinforcement indicates $0, then please be aware that as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, reducing in size, etc, the cost responsibilities can change and a cost allocation may be assigned to your project. In addition, although your present cost allocation to a System Reinforcement is presently $0, your project may need this system reinforcement completed to be deliverable to the PJM system. If your project comes into service prior to completion of the system reinforcement, an interim deliverability study for your project will be required.

11.7 Flow Gate Details

The following indices contain additional information about each facility presented in the body of the report. For each index, a description of the flowgate and its contingency was included for convenience. The intent of the indices is to provide more details on which projects/generators have contributions to the flowgate in question. All New Service Queue Requests, through the end of the Queue under study, that are contributors to a flowgate will be listed in the indices. Please note that there may be contributors that are subsequently queued after the queue under study that are not listed in the indices. Although this information is not used "as is" for cost allocation purposes, it can be used to gage the impact of other projects/generators. It should be noted the project/generator MW contributions presented in the body of the report are Full MW Impact contributions which are also noted in the indices column named "Full MW Impact", whereas the loading percentages reported in the body of the report, take into consideration the PJM Generator Deliverability Test rules such as commercial probability of each project as well as the ramping impact of "Adder" contributions. The MW Impact found and used in the analysis is shown in the indices column named "Gendeliv MW Impact".

11.8 Queue Dependencies

The Queue Projects below are listed in one or more indices for the overloads identified in your report. These projects contribute to the loading of the overloaded facilities identified in your report. The percent overload of a facility and cost allocation you may have towards a particular reinforcement could vary depending on the action of these earlier projects. The status of each project at the time of the analysis is presented in the table. This list may change as earlier projects withdraw or modify their requests.

None.

11.9 Contingency Descriptions

Contingency Name	Contingency Definition
Base Case	
ATSI-P1-2-OEE-69-022-B	CONTINGENCY 'ATSI-P1-2-OEE-69-022-B' /* MAYSVILLE - SHARON 69 [Y-301] DISCONNECT BRANCH FROM BUS 938580 TO BUS 239861 CKT 1 /* AE1-079 TAP 69 02CP.REYN+ 69 DISCONNECT BRANCH FROM BUS 239104 TO BUS 239861 CKT 1 /* 02SHARON 69 02CP.REYN+ 69 DISCONNECT BUS 239894 /* 02CP.REYNL 69 DISCONNECT BUS 239890 /* 02GRNV MTL 69 END

12 Light Load Analysis

Light load analysis not required for solar projects.

13 Short Circuit Analysis

The following Breakers are overdutied:

None

13.1 System Reinforcements - Short Circuit

None

14 Stability and Reactive Power

To be determined in the Facilities Study Phase.

15 Affected Systems

15.1 NYISO

None

15.2 MISO

None

16 Attachment 1: One Line Diagram