Generation Interconnection

System Impact Study Report

for

Queue Project AE1-237

ANDOVER (MAYSVILLE) 69KV I

13.5 MW Capacity / 19.9 MW Energy

August, 2019

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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 **Welcome Solar II LLC**, 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 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

Welcome Solar II LLC, the Interconnection Customer (IC), has proposed a solar/storage generating facility located in Crawford County, Pennsylvania. The installed facilities will have a total capability of 19.9 MW with 13.5 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is September 30, 2020. **This study does not imply a ATSI commitment to this in-service date**.

Queue Number	**AE1-237**
Project Name	ANDOVER (MAYSVILLE) 69KV I
Interconnection Customer	Welcome Solar II LLC
State	PA
County	Crawford
Transmission Owner	ATSI
MFO	19.9
MWE	19.9
MWC	13.5
Fuel	Solar; Storage
Basecase Study Year	2022

3.1 Point of Interconnection

The interconnection of the project at the Primary POI will be accomplished by tapping the Dilworth-Maysville 69 kV Line and constructing a one span tap. The transmission line tap will be located approximately 14 miles from Maysville substation. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection line tap and the associated attachment facilities. The project will also require non-direct connection upgrades at Maysville substation.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AE1-237 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 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.

3.2 Cost Summary

The AE1-237 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$453,750
Direct Connection Network Upgrade	$0
Non Direct Connection Network Upgrades	$567,650
New System Upgrades	$0
Contribution to Previously Identified Upgrades	$0
Total Costs	$1,021,400

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 AE1-237 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 tapping the Andover (Maysville) 69 kV line and constructing a one span tap. The line tap will be located approximately 14 miles from Maysville substation. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection line tap and the associated attachment facilities. The project will also require non-direct connection upgrades at Maysville substation.

4.1 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 69 kV Tap Switch and associated line extension. Provide 69 kV Revenue Meter Package.	$ 453,750
Total Attachment Facility Costs	$453,750

4.2 Direct Connection Cost Estimate

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

4.3 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 Dilworth-Maysville 69 kV Line at or near structure 145. Install two 69 kV line switches with SCADA.	$ 295,850
Terminal end relay upgrades (@ Maysville)	$ 271,800
Total Non-Direct Connection Facility Costs	$ 567,650

5 Schedule

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 **9 months** after the signing of an Interconnection Construction Service Agreement. This includes preliminary payment that compensates FE for the first three months of the engineering design work that is related to the construction of the Attachment Facilities. Full initial deposit is required for Non-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 PJM will allow all transmission system outages when requested.

6 Transmission Owner Analysis

FE performed an analysis of its underlying transmission <100 kV system. The AE1-237 project did not contribute to any overloads on the FE transmission <100 kV system.

7 Interconnection Customer Requirements

7.1 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. Inverter-based generation that is UL1741 certified for anti-islanding protection connected to the FE Transmission System at <100kV shall have delta or ungrounded wye winding on the transmission side.

7.2 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 69 kV circuit breaker to protect the AE1-237 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 AE1-237 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.

7.3 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.

8 Revenue Metering and SCADA Requirements

8.1 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.

8.2 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

8.3 FE 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

9 Network Impacts

The Queue Project AE1-237 was evaluated as a 19.9 MW (Capacity 13.5 MW) injection at Maysville 69 kV substation in the ATSI area. Project AE1-237 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE1-237 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Load Flow

10 Generation Deliverability

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

None

11 Multiple Facility Contingency

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

None

12 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 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
4522505	930600	AB1-105 TAP	ATSI	238781	02HANNA	ATSI	1	ATSI-P1-2-SYS-345-812	operation	1672.0	99.9	100.1	AC	3.63

14 System Reinforcements

None

Affected Systems

15 Affected Systems

15.1 LG&E

None

15.2 MISO

MISO Impacts to be determined during the Facilities Study.

15.3 TVA

None

15.4 Duke Energy Progress

None

15.5 NYISO

None

16 Contingency Descriptions

Contingency Name	Contingency Definition
ATSI-P1-2-SYS-345-812	CONTINGENCY 'ATSI-P1-2-SYS-345-812' /* LINE 02MANSFD TO 02HANNA 345 CK 1 DISCONNECT BRANCH FROM BUS 238941 TO BUS 238781 CKT 1 /* 02MANSFD 345 02HANNA 345 END

Short Circuit

17 Short Circuit

The following Breakers are overduty:

None

Stability

18 Stability Analysis

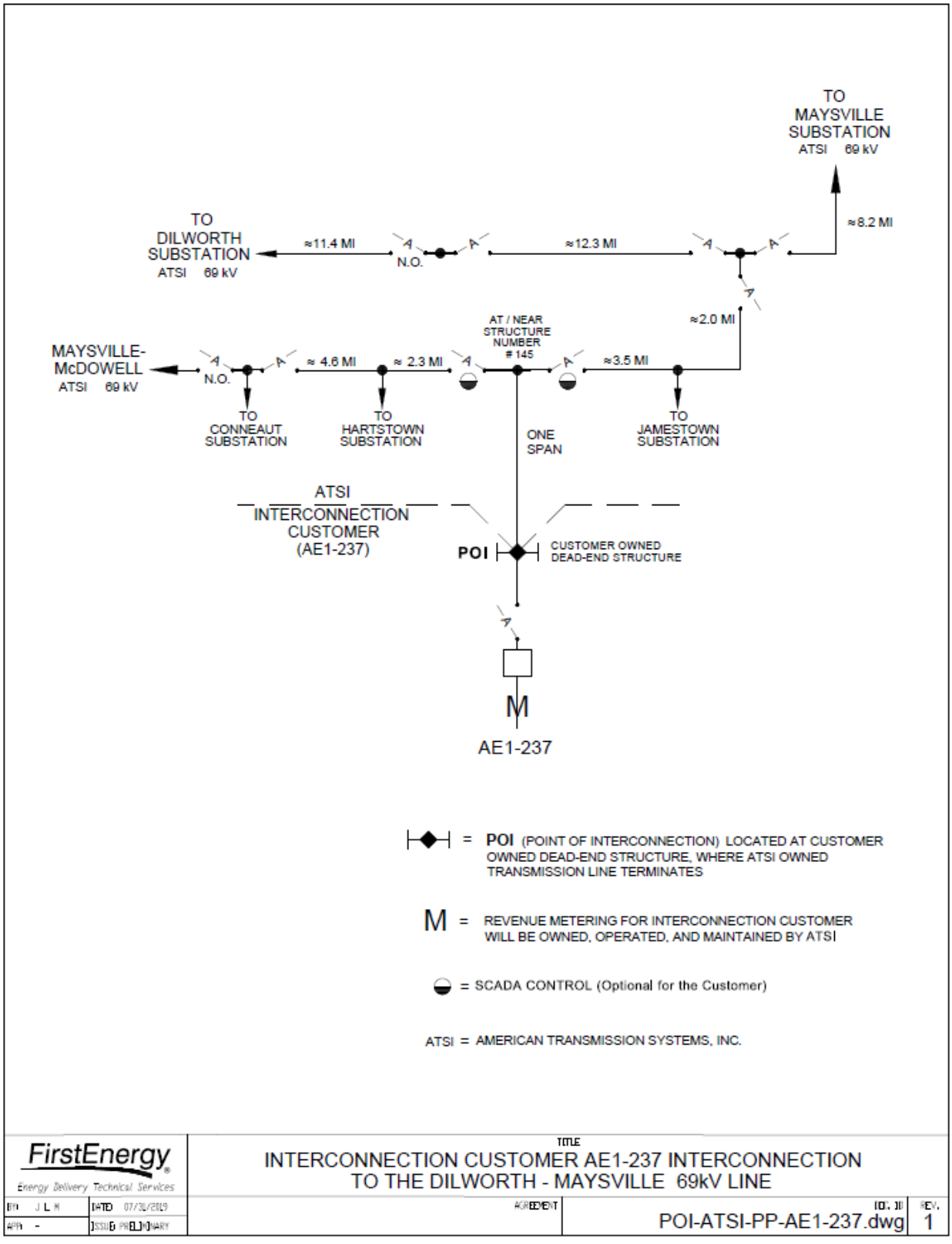
Not required for this project.

Light Load

19 Light Load Analysis

No impacts.

20 Attachment 1: One Line



21 Attachment 2: Site Plan