Generation Interconnection Feasibility Study Report – Web Version

For

PJM Generation Interconnection Request Queue Position AA2-146

Catoctin 34.5 kV Project

August 2015

Feasibility Study Report

Catoctin 34.5 kV Project

Introduction

This Feasibility Study report provides the documentation of an assessment that has been performed by FirstEnergy (FE) in response to a request made by Interconnection Customer for the connection of a 20.0 MW (10.9 MW Capacity) PV generation project to the Catoctin-Yellow Springs 34.5 kV line, PJM queue number AA2-146, on the Potomac Edison ("PE") transmission system.

Connection Facilities

In compliance with the RTEP protocol, Interconnection Customer has submitted a "Form of Generation Interconnection Feasibility Study Agreement" to PJM (Attachment 4) that identifies its plan to construct the Catoctin 34.5 kV (AA2-146) Generation Project ("AA2-146") with PV cells. The installed facilities will have a total generating capability of 20.0 MW, of which, 10.9 MW will be recognized by PJM as a capacity resource.

As defined by Interconnection Customer and shown on Attachment 1, the proposed Interconnection Customer site will be located at a point approximately 3.5 miles south of Catoctin substation, on the east side of Catoctin Furnace Road. The primary direct connection of this project will be accomplished by tapping the existing 34.5 kV line between Catoctin and Yellow Springs. There is no alternate point of interconnection ("POI") for AA2-146. Attachment 2 shows a conceptual one-line diagram of the proposed primary direct connection of AA2-146 to the Potomac Edison transmission system. The Interconnection Customer will be responsible for constructing all of the facilities on its side of the POI including the attachment line. Interconnection Customer may not install above ground equipment within any PE right-of-way unless permission to do so is expressly granted by PE. The PE facilities required to be upgraded for the primary Direct Connection of the generation project and the associated cost estimate are shown in Attachment 3.

PJM Interconnection Study Results

The following is the report describing the results of the analysis performed by PJM engineers with respect to the transmission system impacts.

Network Impacts

The Queue Project AA2-146 was evaluated as a 20.0 MW (Capacity 10.9 MW) injection at Catonctin 34.5kV substation in the APS area. Project AA2-146 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AA2-146 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis - 2019

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)

None

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

Steady-State Voltage Requirements

(Results of the steady-state voltage studies should be inserted here)

To be determined

Short Circuit

(Summary of impacted circuit breakers)

To be determined

Affected System Analysis & Mitigation

Delivery of Energy Portion of Interconnection Request

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.

Only the most severely overloaded conditions are listed. 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 will study all overload conditions associated with the overloaded element(s) identified.

None

Light Load Analysis - 2019
Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

System Reinforcements

Short Circuit
(Summary form of Cost allocation for breakers will be inserted here if any)

To be determined

Stability and Reactive Power Requirement
(Results of the dynamic studies should be inserted here)

To be determined

Summer Peak Load Flow Analysis Reinforcements

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

None

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)
(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

Light Load Load Flow Analysis Reinforcements

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

None

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)
(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

Additional Interconnection Customer Responsibilities:

1. An Interconnection Customer entering the New Services Queue on or after October 1, 2012 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.

2. 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.

3. The Interconnection Customer seeking to interconnect a wind generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per item 5.iv. of Schedule H to the Interconnection Service Agreement.

Transmission Owner's Analysis

The following is the report generated by the Transmission Owner (TO) based upon its analysis of the project's impacts on the lower voltage system and the costs and schedules for any transmission and distribution system upgrades.

Power Flow Analysis

A power flow study was conducted to determine the reliability impact of the proposed AA2-146 generation project on the PE transmission system. This study was completed using a 2019 summer peak power flow model that contain a detailed representation of the Potomac Edison transmission networks in the area of the proposed AA2-146 generation project. The findings and the recommendations from this analysis are based on a contingency review that was performed to identify the facility loadings and/or voltage conditions that violate the ReliabilityFirst, PJM, or FE Planning Criteria and are attributable to this project. Note that in accordance with PJM RTEP study procedures, the AA2-146 generation project under study and earlier active queue projects are considered to be in-service. All active queue projects after the AA2-146 project are considered not in-service.

For the primary point of interconnection (see Attachment 2), the AA2-146 generation project connected to the 34.5 kV line between Catoctin and Yellow Springs substations. The results of the FE analysis show that there are no transmission network upgrades required for the deliverability of the AA2-146 Generation Project generation to the PE transmission system.

Interconnection Customer will be responsible for meeting all FE criteria as defined in the FE "Requirements for Transmission Connected Facilities" document. The AA2-146 generation project shall be designed with the ability to maintain a composite power delivery at a power factor of at least 0.95 leading (absorbing VARs) to 0.95 lagging (supplying VARs) across the full range of continuous rated power output. Because the AA2-146 generation project entered PJM's New Service Queue prior to May 1, 2015, this power factor requirement shall be measured at the Point of Interconnections. If the results of the System Impact Study show the need for a different power factor requirement, this requirement will be stated in the System Impact Study report and the Interconnection Service Agreement. A voltage flicker analysis will be performed during the System Impact Study.

Short Circuit and Dynamics Analysis

In accordance with the RTEP process, a short circuit analysis was not conducted by PJM since the AA2-146 generation project connection is to the Potomac Edison transmission system less than 100 kV. Therefore, the FE Protection staff conducted a short circuit review of the project connection. An assumption of this study was that solar generation projects will contribute no appreciable fault current to the breakers on the PE transmission system. As stated by EPRI: "Inverters are generally designed to limit fault currents to 130% or less of rated current. Thus they can usually be disregarded when conducting fault studies."[1] Based on this statement, the results of the FE analysis showed that no PE circuit breaker will

[1] EPRI Document TR-111490 "Integration of Distributed Resources in Electric Utility Distribution Systems: Distribution System Behavior Analysis for Suburban Feeder", published November 1998, page 62

exceed its interrupting capability with the implementation of the AA2-146 generation project. Therefore no circuit breaker reinforcements will be required.

In accordance with the RTEP study process, if a dynamics study is needed the results for the AA2-146 generation project will be included in the System Impact Study stage of the RTEP process.

System Protection Analysis

An analysis was conducted to assess the impact of the generation project on the system protection requirements in the area. The results of this review have identified the following:

- Standard 34.5 kV protection for the Catoctin-Yellow Springs 34.5 kV line and Interconnection Customer 34.5 kV line.

Specific power and protection equipment requirements will be included in the System Impact Study stage of the RTEP process.

Metering

Interconnection Customer will be required to comply with all FE revenue metering requirements for generation interconnection customers. The FE revenue metering requirements may be found in the FE "Requirements for Transmission Connected Facilities" document located at the following links:

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

Compliance Issues

The proposed interconnection facilities must be designed in accordance with the FE "Requirements for Transmission Connected Facilities" document located at:

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

Interconnection Customer will also be responsible for following the requirements of the FE "Approved Vendors and Contractors" document which is also located at the above link.

Interconnection Customer will also be required to meet all PJM, ReliabilityFirst and NERC reliability criteria and operating procedures for standards compliance. For example, Interconnection Customer 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.

FE Facility Upgrades and Costs

The results of the FE power flow analysis show that the AA2-146 generation project does not attribute to any planning criteria violations.

The primary direct connection requirements for the AA2-146 generation project to the Potomac Edison transmission system is detailed in Attachment 3. The associated one-line with the generation project primary direct connection is shown in Attachment 2. Note that all cost estimates contained in this document were produced without a detailed engineering review and are therefore subject to change. More accurate estimates will be determined as a part of the System Impact Study. Interconnection Customer will be responsible for the actual cost of the direct connection that is implemented. In addition, Interconnection Customer is responsible to provide metering, disconnect switches and high-side breakers for each unit, as Interconnection Customer will own this equipment. FE herein reserves the right to return to any issues in this document and, upon appropriate justification, request additional monies to complete any reinforcements to the transmission system.

Interconnection Customer Requirements

In addition to the PE facilities, Interconnection Customer will also be responsible for meeting all criteria as specified in the applicable sections of the FE "Requirements for Transmission Connected Facilities" document including:

1. The purchase and installation of fully rated 34.5 kV circuit breaker on the high side of the AA2-146 step-up transformer.
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. The establishment of dedicated communication circuits for SCADA to the FE Transmission System Control Center.

5. A compliance with the FE and PJM generator power factor and voltage control requirements.

6. The execution of a back-up service agreement to serve the customer load supplied from the AA2-146 generation project interconnection point when the units are out-of-service. This assumes the intent of Interconnection Customer is to net the generation with the load.

The above requirements are in addition to any metering or other requirements imposed by PJM.

Summary

The Interconnection Customer generation project primary direct connection will require the facility upgrades defined in Attachment 3. As shown in Attachment 3, the estimated cost of the new AA2-146 primary direct connection facilities is $334,000. This cost includes a Federal Income Tax Gross Up charge of $79,900. This tax may or may not be charged based on whether or not this project meets the eligibility requirements of IRS Notice 88-129.

Based on the extent of the PE primary direct connection and system upgrades required to support the AA2-146 generation project, it is expected to take a minimum of 12 months from the date of a fully executed Interconnection Construction Service Agreement to complete the installation. This includes the requirement for Interconnection Customer to make a preliminary payment to FE which funds the first three months of engineering design that is related to the construction of the Direct Connection facilities. It further assumes that Interconnection Customer will provide all rights-of-way, permits, easements, etc. that will be needed. A further assumption is 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 system outages will be allowed when requested.

Attachment 1
Project Location

Attachment 2

Proposed Interconnection Single Line Diagram

Attachment 3
Primary Direct Connection Requirements

Estimate No.	Description	Total with Tax	Tax	Total Cost
Region Line Tap	**Line Tap on Catoctin-Monocacy 34.5 kV Line:** Tap 34.5 kV line between Catoctin and Monocacy substations and install line switches. Costs associated with 34.5 kV metering package.	$ 282,800	$ 71,700	$ 211,100
PE-S-261	**Catoctin SS:** Modify relay settings	$ 25,600	$ 4,100	$ 21,500
PE-S-262	**Monocacy SS:** Modify relay settings	$ 25,600	$ 4,100	$ 21,500
	Totals	**$ 334,000**	**$ 79,900**	**$ 254,100**