Generation Interconnection Feasibility Study Report – Web Version

For

PJM Generation Interconnection Request Queue Position AA1-092

Halfway-Milnor 34.5 kV Project

February, 2015

Feasibility Study Report

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Introduction

This Feasibility Study report provides the documentation of an assessment that has been performed by PJM Interconnection and FirstEnergy (FE) in response to a request made by Interconnection Customer for the connection of a 12.0 MW (8.0 MW Capacity) generation project to the Halfway-Milnor 34.5 kV line, PJM queue number AA1-092, on the Potomac Edison transmission system.

Connection Facilities

In compliance with the RTEP protocol, Interconnection Customer has submitted a "Form of Generation Interconnection Feasibility Study Agreement" to PJM that identifies its plan to construct the Halfway – Milnor 34.5 kV (AA1-092) Generation Project ("AA1-092") with Solar PV cells. The installed facilities will have a total generating capability of 12.0 MW, of which, 8.0 MW will be recognized by PJM as a Capacity resource.

The proposed point of interconnection ("POI") for the AA1-092 generation project will be located on the Halfway – Milnor 34.5 kV line. Attachment 1 provides the proposed location for the POI. The direct connection of AA1-092 will be accomplished by tapping the Halfway – Milnor 34.5 kV line 3.2 miles northeast of Huyetts Substation, and installing one (1) span of overhead 34.5 kV line, two (2) 34.5 kV gang-operated load-break air switches and 34.5 kV interconnection metering. Attachment 2 shows a conceptual one-line diagram of the proposed connection of AA1-092 to the Potomac Edison transmission system. 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 FE right-of-way unless permission to do so is expressly granted by FE. The FE facilities required to be upgraded for the Direct Connection of the generation project and the associated cost estimate are shown in Attachment 3.

PJM Network Impacts

The Queue Project AA1-092 was studied as a 12.0 MW (Capacity 8.0 MW) injection as a tap of the Halfway – Route 16 34.5 kV line in the APS area. Project AA1-092 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AA1-092 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Analysis - 2018

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)

None

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 - 2018

Light Load Studies to be conducted during later study phases (if required by PJM Manual 14B).

System 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)

None

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

None

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

None

Transmission Owner (FirstEnergy) Analysis

Power Flow Analysis

A power flow study was conducted to determine the reliability impact of the proposed AA1-092 generation project on the FE transmission system. This study was completed using a 2018 and 2020 summer peak power flow model that contain a detailed representation of the Potomac Edison transmission network in the area of the proposed AA1-092 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 AA1-092 generation project under study and earlier active queue projects are considered to be in-service. All active queue projects after the AA1-092 project are considered not in-service.

As shown in Attachment 2, the AA1-092 generation project was studied with a connection to the Halfway – Milnor 34.5 kV line 3.2 miles northeast of Huyetts Substation. The results of the FE analysis show that there are no transmission network upgrades required for the deliverability of the AA1-092 Generation Project generation to the FE transmission systems.

Note that a further conclusion of this study is that it will be mandatory for the AA1-092 Generation Project to have a range of dynamic reactive capability that supports its operation from a 0.95 leading to 0.95 lagging power factor. The FE studies show that the addition of solar projects can cause voltage swings as their output oscillates with moving clouds without continuous regulation, and system voltages can exceed the established limits. Should Interconnection Customer fail to provide dynamic reactive capability from the AA1-092 Generation Project for any reason once interconnected, the FE and/or PJM Dispatchers may need to take action to curtail both the energy and capacity portion of its output to prevent non-compliance with voltage criteria.

Short Circuit and Dynamics Analysis

In accordance with the RTEP process, a short circuit analysis was not conducted by PJM since the AA1-092 Project connection is to the Potomac Edison less than 100 kV transmission system. 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 FE transmission systems. 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 FE circuit breaker will exceed its interrupting capability with the implementation of the AA1-092 Project. Therefore no circuit breaker reinforcements will be required.

[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

In accordance with the RTEP Study process, if a dynamics study is needed, the study will be performed for the AA1-092 generation project 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 34.5kV Line protection for the Halfway – Milnor 34.5 kV Line and Interconnection Customer 34.5kV 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 AA1-092 generation project does not attribute to any planning criteria violations.

The direct connection requirements for the AA1-092 generation project to the Potomac Edison transmission system is detailed in Attachment 3. The associated one-line with the generation project 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 systems.

Interconnection Customer Requirements

In addition to the FE 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 AA1-092 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 AA1-092 generation project metering 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 direct connection will require the facility upgrades defined in Attachment 3. As shown in Attachment 3, the estimated cost of the new AA1-092 Direct Connection facilities is $ 310,800. This cost includes a Federal Income Tax Gross Up charge of $ 74,900. 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 FE primary Direct Connection and system upgrades required to support the AA1-092 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.

Note that the FE findings were made from a conceptual review of this project. A more detailed review of the connection facilities and their cost will be identified in the System Impact Study. Further note that the cost estimate data contained in this document should be considered high level estimates since it was produced without a detailed engineering review. The applicant will be responsible for the actual cost of construction.

Attachment 1
Halfway-Milnor 34.5 kV (AA1-092) Generation Project
Project Location

Attachment 2
Halfway-Milnor 34.5 kV (AA1-092) Generation Project
Proposed Interconnection Single Line Diagram

Attachment 3
Halfway-Milnor 34.5 kV (AA1-092) Generation Project
Primary Direct Connection Requirements

Estimate No.	Description	Total with Tax	Tax	Total Cost
PE-S-225	**Halfway Substation:** Revise relay settings on the Milnor 34.5kV line for AA1-092 Interconnection.	$ 7,100	$1,700	$ 5,400
WP-S-298	**Milnor Substation:** Revise relay settings on the Halfway 34.5kV line for AA1-092 Interconnection.	$ 7,100	$1,700	$ 5,400
	AA1-092 Customer Station: Procure and install FE 34.5kV metering equipment in the developer's collector SS. Developer to provide mounting structures and phone line.	$ 39,600	$ 9,600	$ 30,000
WR# 55487926.4	**Halfway-Milnor 34.5 kV Line:** Tap the Halfway – Milnor 34.5kV line and install 1 span of 34.5 kV line. Install 2-34.5kV gang operated load break airswitches at the tap point for PJM AA1-092.	$ 78,100	$ 18,800	$ 59,300
EOC FE-7 No OTB	Engineering Oversight and Commissioning - FE Construction (No-OTB) - FE-7	$ 178,900	$ 43,100	$ 135,800
	Totals	**$ 310,800**	**$ 74,900**	**$ 235,900**

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