Generation Interconnection System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AA1-092

Halfway – Milnor 34.5 kV

December 2015

System Impact Study Report

Halfway-Milnor 34.5 kV Project

Introduction

This System Impact Study report provides the documentation of an assessment that has been performed in response to a request made by Community Energy Renewables, LLC (the Interconnection Customer or IC) for the connection of a 12 MW (8 MW Capacity) PV generation project to the Halfway – Milnor 34.5 kV line, PJM queue number AA1-092, on the Potomac Edison transmission system.

The 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.

PJM Interconnection Study Results

The following are the results of the analysis performed by PJM engineers with respect to the transmission system impacts. This section also includes the reinforcements, their costs and schedules for upgrades on the Interconnected Transmission Owner and the affected Transmission Owner(s).

Network Impacts

Potential network impacts were as follows:

Generator Deliverability

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

None

Light Load Analysis

None

Multiple Facility Contingency

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

None

Short Circuit

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

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

Stability and Reactive Power Requirement

None

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

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

Interconnected Transmission Owner's Analysis Results

Power Flow Analysis

A power flow study was conducted to determine the reliability impact of the proposed Halfway – Milnor 34.5 kV (AA1-092) generation project on the Potomac Edison transmission system. This study was completed using a 2018 summer peak power flow model that contains 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 by tapping the Halfway – Milnor 34.5 kV line. The results of the FE analysis show that there are no transmission network upgrades required for the deliverability of the (AA1-092) generation to the Potomac Edison 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 measured at the point of interconnection. 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 Community Energy Renewables, LLC 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 Potomac Edison 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 Potomac Edison circuit breaker will exceed its interrupting capability with the implementation of the (AA1-092) project. Therefore no circuit breaker reinforcements will be required.

A dynamics study wasn't performed for the (AA1-092) generation project since it is an inverter based PV project less than 70 MW.

[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

System Protection Analysis

An analysis was conducted to assess the impact of the (AA1-092) generation project on the system protection requirements in the area. The review identified the following direct connection tie line protection requirements:

The inverters associated with the Halfway – Milnor 34.5 kV (AA1-092) generation project shall comply with IEEE 1547 and UL 1741. In addition, the GSU connecting to the Potomac Edison system shall be delta-wye, with the delta on the Potomac Edison side. This is to provide isolation for ground faults and to prevent the solar installation from becoming a ground source. The GSU transformers and all 34.5 kV facilities at the customer substation shall have redundant high speed protection.

Metering

Community Energy Renewables, LLC 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 link:

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

Community Energy Renewables, LLC will also be responsible for following the requirements of the FE "Approved Vendors and Contractors" document which is also located at the above link.

Community Energy Renewables, LLC will also be required to meet all PJM, ReliabilityFirst and NERC reliability criteria and operating procedures for standards compliance. For example, Community Energy Renewables, LLC 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 Potomac Edison system.

FE Facility Upgrades and Costs

The results of the FE power flow analysis for the Halfway - Milnor 34.5 kV (AA1-092) generation project show that there are no FE criteria violations directly attributable to the capacity of the (AA1-092) generation project.

The direct connection requirements for the Halfway - Milnor 34.5 kV (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 Facilities Study. Community Energy Renewables, LLC will be responsible for the actual cost of the direct connection that is implemented. In addition, Community Energy Renewables, LLC is responsible to provide disconnect switches and high-side breakers for each unit, as Community Energy Renewables, LLC 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 or subtransmission systems.

Community Energy Renewables, LLC Requirements

In addition to the Potomac Edison facilities, Community Energy Renewables, LLC 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 Community Energy Renewables, LLC is to net the generation with the load.

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

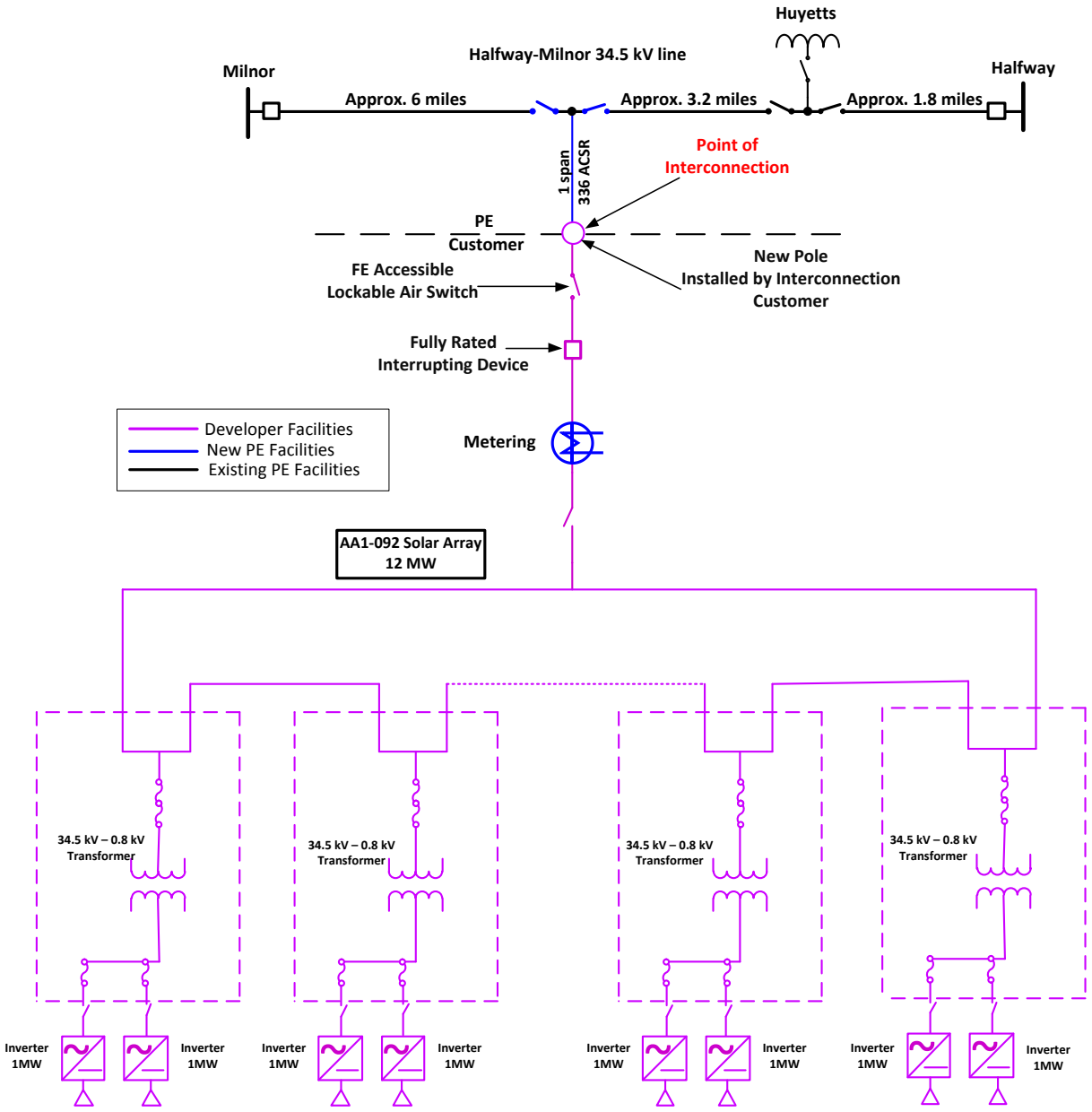
Summary

The Community Energy Renewables, LLC Halfway - Milnor 34.5 kV (AA1-092) 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 connect facilities (substation, breaker, disconnects, CTs, VTs, etc.) is $302,800. This cost includes a Federal Income Tax Gross Up charge of $72,400. This tax may or may not be charged based on whether or not this project meets the eligibility requirements of IRS Notice 88-129. Power flow results for the (AA1-092) generation project show that no facility upgrades in the Potomac Edison service territory are required.

Based on the extent of the Potomac Edison primary direct connection and system upgrades required to support the (AA1-092) generation project, it is expected to take a minimum of twelve (12) months from the date of a fully executed Interconnection Construction Service Agreement to complete the installation. This includes the requirement for Community Energy Renewables, LLC 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 Community Energy Renewables, LLC 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.

Project Location

Attachment 2
Proposed Interconnection Single Line Diagram



Attachment Facilities

- Tap the Halfway – Milnor 34.5kV line and install 1 span of 336 ACSR or equivalent overhead 34.5kV line. Install 2-34.5kV gang operated load break airswitches at the tap point. Install 34.5kV metering in the Interconnection Customers Substation.
- Revise relay settings at the Halfway and Milnor substations as needed.

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

Number of Months to Complete --- 12 Months.

SS/LN	Estimate No.	Description	Total with Tax	Tax	Total Cost
LN	Region Line Tap	Halfway – Milnor 23.5 kV Line. Tap the Halfway – Milnor 34.5 kV line including 34.5 kV metering package.	$243,700	$64,000	$179,700
		DC Sub-Total.	**$243,700**	**$64,000**	**$179,700**
SS	PE-S-226.1A	Halfway SS. Revise relay settings, on the Milnor 34.5kV line, for AA1-092 Interconnection.	$28,800	$4,100	$24,700
SS	PE-S-226.2A	Milnor SS. - Revise relay settings, on the Milnor 34.5kV line, for AA1-092 Interconnection	$30,300	$4,300	$26,000
		NDC Sub-Total.	**$59,100**	**$8,400**	**$50,700**
		Totals	**$302,800**	**$72,400**	**$230,400**