Generation Interconnection Feasibility Study Report-Web Version

For

PJM Generation Interconnection Request Queue Position AA2-084

Lappans-South 12.5 kV Project

August 2015

Feasibility Study Report

Lappans – South 12.5 kV Generation 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 4 MW (1.5 MW capacity resource) Lappans – South 12.5kV (AA2-084) Solar PV Generation Project to the Potomac Edison distribution system.

Connection Facilities

In compliance with the Regional Transmission Expansion Planning (RTEP) protocol, Interconnection Customer has submitted a "Form of Generation Interconnection Feasibility Study Agreement " to PJM (see Attachment 4) that identifies its plan to construct the Lappans – South 12.5kV (AA2-084) Project comprised of photo-voltaic solar panels and inverters on a property that is located at Route 65 & 68, Boonsboro, MD. The installed facilities will have a total capability of 4 MW with 1.5 MW of this output being recognized by PJM as capacity. This means that the remaining 2.5 MW will be subject to curtailment should a system reliability constraint occur.

As defined by Interconnection Customer, the proposed Lappans – South 12.5kV (AA2-084) Project site will be located at a point located at Route 65 & 68, Boonsboro, MD. The primary direct connection of this project will be accomplished by tapping the Lappans – South 12.5KV line located at Route 65 & 68, Boonsboro, MD. Interconnection Customer will be responsible for constructing a radial 12.5kV attachment line from the AA2-084 generation 12.5kV export bus to the 12.5kV point of interconnection. Interconnection Customer may not install above or below ground equipment within any FirstEnergy right-of-way unless permission to do so is expressly granted by FirstEnergy.

Attachment 1 shows a conceptual one-line diagram of the primary 12.5kV interconnection to accommodate the attachment of the Lappans – South 12.5kV (AA2-084) Project. Attachment 2 details the cost estimates for the direct connection facilities and attachment 3 details the cost of the network upgrades. Interconnection Customer will be responsible for constructing all of the facilities on its side of the point of interconnection including the attachment line.

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 AA2-084 was evaluated as a 4.0 MW (Capacity 1.5 MW) injection at the Marlowe 34.5kV substation in the APS area. Project AA2-084 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AA2-084 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)

Transmission Owner's Analysis Results

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 Lappans – South 12.5kV (AA2-084) Project on the FE transmission, subtransmission, and distribution systems. This study was completed using a 2019 summer peak load power flow that contains a detailed representation of the Potomac Edison transmission, subtransmission, and distribution systems in the area of the proposed Lappans – South 12.5kV (AA2-084) 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 Lappans – South 12.5kV (AA2-084) Project under study and all active queue projects are considered to be in service.

For the primary point of interconnection, the 4 MW Lappans – South 12.5kV (AA2-084) Project to be connected to the Lappans – South 12.5kV line at a point located at Route 65 & 68, Boonsboro, MD and with the remaining AA2 queue generation at their primary points of interconnections, the results of the FE analysis show that there are no transmission network upgrades required for the deliverability of the Lappans – South 12.5kV (AA2-084) Project generation to the FE transmission system for the primary point of interconnection. The results of the FE analysis show that there are no subtransmission network upgrades required for the deliverability of the Lappans – South 12.5kV (AA2-084) Project generation to the FE transmission system for the primary point of interconnection. The results of the FE analysis also shows that there are distribution network upgrades required as detailed in attachment 3 for the direct connection of the Lappans – South 12.5kV (AA2-084) Project to the Lappans – South 12.5KV distribution circuit.

Note that a further conclusion of this study is that it will be mandatory for the Lappans – South 12.5kV (AA2-084) Project to have a range of dynamic reactive capability that supports its operation from a 0.95 lead to 0.95 lag power factor and to maintain the power factor as close as possible to unity. Without a continuous regulation, the FE studies show that the addition of solar projects can cause voltage swings as their output oscillates with moving clouds and system voltages can exceed the established limits. Should Interconnection Customer fail to provide a dynamic reactive capability from the Lappans – South 12.5kV (AA2-084) 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 a 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 Lappans – South 12.5kV (AA2-084) Project connection is to the Potomac Edison distribution system.

Therefore, the Potomac Edison Planning and 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, subtransmission, or distribution 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 FE circuit breaker will exceed its interrupting capability with the implementation of the Lappans – South 12.5kV (AA2-084) Project. Therefore no circuit breaker reinforcements will be required.

Note that stability studies will be conducted by FE staff should this project proceed to the Impact Study stage of the RTEP process.

System Protection Analysis

An analysis was conducted to assess the impact of the Lappans – South 12.5kV (AA2-084) Project on the system protection requirements in the area. The results of this review show that there are no system protection upgrades required for the Lappans – South 12.5kV (AA2-084) Project.

Metering

Interconnection Customer will be required to comply with all FE Revenue Metering Requirements for Generation Interconnection Customers. The FirstEnergy Revenue Metering Requirements may be found in the FirstEnergy Requirements for Distribution Connected Facilities document located at the following links:

www.firstenergycorp.com/feconnect/potomacedison/wholesale.html

Compliance Issues

The proposed interconnection facilities must be designed in accordance with the FirstEnergy "Generator Interconnection Technical Requirements for Distribution Connected Facilities" located at:

www.firstenergycorp.com/feconnect/potomacedison/wholesale.html

Interconnection Customer will also be responsible for following the requirements of the "FirstEnergy Wholesale Generation Interconnection (WGI) Manual" and the "FE Approved Vendors and Contractors" documents which are 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

[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

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. Also, the developer will need to provide documentation that its inverters meet the requirements of UL1741 and IEEE Standard 929. 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 generation capacity of the Lappans – South 12KV circuit is exceeded; a hydraulic line recloser is overloaded and reverse power flow conditions can exist on the No. 1 XFMR at Lappans SS. Therefore substation line recloser for the Lappans – South 12KV circuit must be upgraded to a Viper recloser with electronic control, a hydraulic line recloser needs to be relocated, the settings for the No. 1 12KV Bus A phase regulator need to be changed, the No. 1 12 KV bus B and C phase regulator controllers need changed, and SCADA needs to be added to the Lappans SS. These network upgrades are illustrated in attachment 1 and detailed in attachment 3. The Lappans – South 12KV (AA2-084) project is the only active project in the AA2 queue contributing to these planning criteria violations and therefore the Interconnection Customer will be solely responsible for the actual cost for these network upgrades.

The primary direct connection requirements for the Lappans – South 12.5kV (AA2-084) Project to the Potomac Edison distribution system is detailed in Attachment 2. The associated one-line with the Lappans – South 12.5kV (AA2-084) Project primary direct connection is shown in Attachment 1. 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 the distribution line between the point of interconnection and the Lappans – South 12.5kV (AA2-084) Project collector station, as Interconnection Customer will own this distribution line. 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, subtransmission, or distribution 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 "Generator Interconnection Technical Requirements for Distribution Connected Facilities" document including:

1. The purchase and installation of a fully rated 12.5kV circuit breaker or fuse to permit tripping of the entire plant.

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 report to the FE Transmission System Control Center.

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

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

Summary

The Lappans – South 12.5kV (AA2-084) Project primary direct connection will require the facility upgrades defined in Attachment 2 and the facility upgrades detailed in Attachment 3. As shown, the estimated cost of the primary direct connection facilities is $71,830. This cost includes a CIAC (Contribution in Aid of Construction) Federal Income Tax Gross Up charge of $16,830. As shown, the estimated cost of the network facility upgrades is $218,550. This cost includes a CIAC (Contribution in Aid of Construction) Federal Income Tax Gross Up charge of $53,550. 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 this 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 required for the Lappans – South 12.5kV (AA2-084) Project. 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
AA2-084 12.5kV Interconnection Configuration

Attachment 2
Primary Direct Connection Requirements

Upgrade ID	Description	Cost	Tax (If applicable)	Total Cost
1	Install (1)-12.5kV 300A disconnect switch and one span 336 ACSR span to dead end.	$ 22,000	$ 6,732	$ 28,732
2	AA2-084 Collector SS: Procure and install FE 12.5kV metering equipment in the developer's collector SS. Developer to provide mounting structures and phone line	$ 33,000	$ 10,098	$ 43,098
TOTAL		**$ 55,000**	**$ 16,830**	**$ 71,830**

Attachment 3
Network Facility Reinforcement Conceptual Cost Estimates

Upgrade ID	Description	Cost	Tax (If applicable)	Total Cost
1	Upgrade substation recloser to Viper recloser with electronic control	$ 55,000	$16,830	$ 71,830
2	Change settings on the No. 1 12KV bus A phase regulator	$ 1,000	$ 306	$ 1,306
3	Change the No. 1 12KV bus B and C phase regulator controllers	$ 7,000	$ 2,142	$ 9,142
4	Relocate line recloser	$ 2,000	$ 3,672	$ 5,672
5	Add SCADA to Lappans Substation	$ 100,000	$ 30,600	$ 130,600
TOTAL		**$ 165,000**	**$ 53,550**	**$ 218,550**

