Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position V4-077

Montgomery Avenue 4 kV

Web Version

PJM DOCS No. 590596 v1
April, 2010

Introduction

This Feasibility Study report provides the documentation of an assessment that has been performed by FirstEnergy (FE) and PJM Interconnection (PJM) in response to a request made by the customer for the connection of a 13 MW (4.9 MW Capacity) Montgomery Ave (V4-077) Solar Generation Project to the Penelec Transmission System. As per the PJM RTEP study process, the Montgomery Ave (V4-077) Project assessment was accomplished by: 1. Evaluating the reliability impact of the proposed facilities and connection on the interconnected transmission system by the performance of a power flow study; 2. Ensuring compliance with the NERC, ReliabilityFirst, PJM and FE Reliability Standards by identifying the system reinforcements that will need to be installed for an interconnection of the proposed project; 3. Coordinating and cooperating with the PJM staff and the Interconnection Customer by participating in project meetings and issuing this report as a part of the RTEP study process; 4. Performing a Steady State, Short-Circuit and Dynamics Study as necessary; 5. Conducting all studies in accordance with the PJM Manuals, the "FE Requirements for Transmission Connected Facilities", and internal procedures.

Transmission Level Analysis Results

Network Impacts

The queue V4-077 project was studied as a 13MW (4.9MW capacity) injection into the 46kV PENELEC system at LEWISTWN substations. Project V4-077 was evaluated for compliance with reliability criteria for summer peak conditions in 2014. Potential network impacts were as follows:

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

No problems identified.

Multiple Facility Contingency
(Double Circuit Tower Line contingencies only for the full energy output. Stuck breaker and bus fault contingencies will be performed for the Impact Study)

No problems identified.

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)

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

No problems identified.

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)

Short Circuit

Under study.

Potential Congestion due to Local Energy Deliverability

(PJM also studied the delivery of the energy portion of the surrounding generation. Any potential 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 Transmission Interconnection Request. Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full deliverability for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which analyzes all overload conditions associated with the identified overloaded element(s). As a result of the aggregate energy resources in the area, the following violations were identified:

1. The LEWISTWN-JUNI BU2 230 kV line (from bus 200513 to bus 208005 ckt 1) loads from 100.23% to 101.59% (DC power flow) of its normal rating (488 MVA) for non-contingency condition. This project contributes approximately 6.61 MW to cause the thermal violation.

FirstEnergy Analysis Results

Connection Facilities

In compliance with the Regional Transmission Expansion Planning (RTEP) protocol, the Interconnection Customer has submitted a "Generation Interconnection Feasibility Study Agreement" to PJM that identifies its plan to construct several arrays of solar panels connected to 13 1MW inverters with a total capability of 13 MW (4.9 MW Capacity) on a property that is approximately 0.5 mile northeast of the existing Montgomery Ave 46 kV substation (see Attachments 1A, 1B, 1C). For the primary choice of direct connection, Interconnection Customer has opted for a 46kV interconnection. As a second choice, a 12.5kV interconnection was selected. For purposes of this report, it has therefore been designated as the Montgomery Ave 46kV Project to reflect its primary choice interconnection voltage and its proximity to the Montgomery Ave substation. The primary choice direct connection of this project will be accomplished by the construction of a new 46 kV tap into the Lewistown - Logan (2LK) 46 kV line between the Maitland tap and Maitland Substation. Procurement and construction of the 46 kV transmission line extending from the tap pole to the solar collector 46kV export bus is the responsibility of Interconnection Customer as this facility is on the customer's side of the point of interconnection (POI). Interconnection Customer will be responsible for acquiring all easements, properties and permits that may be required to construct both the project connection

tap bus and the attachment facilities. A summary of the Montgomery Ave (V4-077) Project direct connection facilities that will be required and their estimated cost are shown on Attachment 3.

Power Flow Analysis (46kV network as lumped equivalent at 115kV)

A Power Flow study was conducted to determine the reliability impact of the proposed Montgomery Ave (V4-077) Project on the FE Transmission System. This included the performance of a contingency analysis to identify any facility overload or voltage condition that violates the FE Planning Criteria. Any such violation that is either directly attributable to this project or for which it will have a shared responsibility is included in this report with a least cost plan identified to mitigate them.

The Montgomery Ave (V4-077) Project Power Flow Analysis that was performed was completed using a 2014 summer peak load base case power flow provided by the PJM staff. This base case included an equivalent representation of the Penelec 46kV transmission system. However, 46kV load in the area of the proposed Montgomery Ave 46 kV substation was modeled as lumped equivalent load at the Lewistown 115 kV substation. The Montgomery Ave (V4-077) Project was modeled as an injection into the Lewistown 115 kV substation. A simulation of all possible contingencies within the NERC and FE Planning Standards that are impacted by the Montgomery Ave (V4-077) Project was conducted to test for criteria compliance.

The results from the study Power Flow Analysis showing a comparison of the FE and PJM contingency study results is detailed on Attachment 4. The results are valid for both the primary choice 46kV interconnection and the secondary choice 12.5kV interconnection. As shown, the FE conclusion from this analysis is that there are no new bulk electric system network upgrades required for the Montgomery Ave (V4-077) Project. Furthermore, there are no findings of previously identified criteria violations from other generation or transmission interconnection projects in which the Montgomery Ave (V4-077) Project contributes.

In addition, the findings show that there is a criteria violation which will have an impact on network congestion and local energy deliverability. The facility impacted is the Lewistown – Juniata 230kV line. The Interconnection Customer will therefore be subject to generation curtailment in order to mitigate this violation.

Power Flow Analysis (Detailed 46kV network)

In order to identify any overloads on the 46kV system near the Montgomery Ave (V4-077) Project, FirstEnergy studied its own detailed model for the 2014 Penelec Summer Peak case. The Montgomery Ave (V4-077) Project was modeled at both 4.9 MW and 13 MW output, and with the generator at unity power factor. For the primary choice 46kV interconnection, the generator was modeled as injecting into the 46kV 2LK Line along the Maitland tap (see Attachment 2). For the secondary choice 12.5kV interconnection, the generator was modeled at the Montgomery Ave Substation 46kV bus. All Penelec NERC Category B contingencies were evaluated. This includes the loss of all single generating units, lines, transformers, circuit breakers, or capacitors.

4.9 MW Capacity Output

No overload/voltage issues identified

13 MW Energy Output
No overload/voltage issues identified

Power Flow Analysis (12.5kV network – Second choice for interconnection)

For the secondary choice of interconnection only, in order to identify any overloads on the 12.5kV distribution system near the Montgomery Ave (V4-077) Project, FirstEnergy performed a load flow analysis and voltage analysis using a detailed model of the distribution system (see Attachment 1D).

The results are that connecting this project (13.0MW) to the existing Montgomery Ave 12.5kV circuit (00119-81) will overload the existing 4/0 ACSR primary conductor, overload the 46/12.5kV 5.0MVA transformer #2 at Montgomery Ave substation, and result in voltage fluctuations up to 4.5%.

Even if the 4/0 ACSR primary conductor and the 46/12.5kV 5.0MVA transformer #2 were both upgraded to avoid the possibility of thermal overload, the voltage fluctuations would still exceed the 3% maximum allowed. The 12.5kV direct connection choice is therefore not feasible.

This project cannot connect to the existing 12.5kV facilities.

Short Circuit and Dynamics Analysis

A short circuit analysis will be performed in the System Impact Study stage, if required.

System Protection Analysis

An analysis was conducted to assess the impact of the Montgomery Ave (V4-077) Project on the system protection requirements in the area. The results of this review show that the following relay additions and upgrades will be required:

Logan Substation – 46kV 2LK line exit

- Replace existing relaying with SEL311B primary and SEL311B backup relaying.
- Primary and backup relaying to be on separate CTs to be installed as necessary.
- Install/upgrade 46kV Bus PTs for SEL311B potential.

Lewistown Substation - 46kV 2LK line exit

- Replace existing relaying with SEL311B primary and SEL311B backup relaying.
- Primary and backup relaying to be on separate CTs to be installed as necessary.
- Install/upgrade 46kV Bus PTs for SEL311B potential.

V4-077 Generation Substation – V4-077 Interconnection line exit

- Transformer protection / Generation intertie and associated relaying will be supplied by the V4-077 customer.

Metering

Interconnection Customer will be required to comply with all FE Revenue Metering Requirements for Generation Interconnection Customers. These FE requirements are detailed on Attachment 7 of this report.

Compliance Issues

Interconnection Customer will be responsible for meeting all FE criteria as defined in the FE Requirements for Transmission Connected Facilities document. This includes the provision of a reactive power capability sufficient to maintain a composite power delivery for the facility at the interconnection point at a power factor between .95 leading (absorbing MVARs) and .90 lagging (producing MVARs).

Generators with no inherent VAR (reactive power) control capability, or those that have a restricted VAR capability less than the defined requirements, must provide dynamic supplementary reactive support located at the generation facility with electrical characteristics equivalent to that provided by a similar-sized synchronous generator.

Interconnection Customer must also meet all PJM, ReliabilityFirst and NERC reliability criteria and operating procedures required for standards compliance. For example, the Developer 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 from the FE power flow analysis (Attachment 4) show that there are no FE criteria violations that are directly attributable to the capacity of the Montgomery Ave (V4-077) Project. Furthermore, there are no violations affecting thermal overload on network branches in which the capacity of the Montgomery Ave (V4-077) Project is a contributor. However, there is one violation affecting network congestion and local energy delivery that the Montgomery Ave (V4-077) Project will impact. Note that the FE and PJM study results differ somewhat due to the differences in the study process and power flow programs utilized. However, the overall conclusions reached by the FE and PJM staff are the same. In accordance with the RTEP procedures defined in the PJM Open Access Transmission Tariff and PJM Manuals, Interconnection Customer is not responsible for network upgrades, and hence Attachment 5 has been omitted. The direct connection costs however are detailed in Attachment 3.

Note that all cost estimates contained in this document were produced without a detailed engineering review and are therefore subject to error. More accurate estimates will be determined as a part of the System Impact Study. The 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 transmission line between V4-077 interconnecting tap pole and the V4-077 generating substation, as Interconnection Customer will own this transmission 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 system.

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 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.

2. The purchase and installation of a 46 kV interconnection metering instrument transformer. FE will provide the ratio and accuracy specifications based on the customer load and generation levels.

3. The purchase and installation of a revenue class meter for each unit to measure the power delivered in compliance with the FE standards.

4. 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.

5. The establishment of dedicated communication circuits for SCADA report to the FE Transmission System Control Center.

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

7. The execution of a back-up service agreement to serve the customer load supplied from the either the Montgomery Ave or L & R substation when the units are out-of-service. This assumes the intent of Interconnection Customer is to net the generation with the load.

8. The rough grade of the property for the V4-077 Interconnection 46 kV tap pole and an access road for the delivery of equipment to this site.

The above requirements are in addition to any metering required by PJM.

Summary

The Montgomery Ave (V4-077) Project direct connection will require the facility upgrades defined in Attachment 3. As shown, the total estimated cost of the 46kV interconnection including new three disconnect switch tap pole and attachment lines is $563,900. The Montgomery Ave (V4-077) Project does not have any network upgrades.

Based on the scope of the FE direct connection, it is expected to take approximately one (1) year from the signing of a Connection Service Agreement to complete the installation required for the Montgomery Ave (V4-077) Project. This includes a preliminary payment that compensates FE for the first three months of the engineering design work that is related to the construction of a new V4-077 Interconnecting tap pole and the loop of the Penelec 46 kV lines to this site. It also assumes that Interconnection Customer will provide the property for the attachment tap pole and all right-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 PJM will allow all transmission system outages when requested.