Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position X4-011

Mercersburg - Milnor 34.5kV

June 2012

Preface

The intent of the feasibility study is to determine a plan, with ballpark cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the Interconnection Customer. The Interconnection Customer may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: (1) Direct Connections, which are new facilities and/or facilities upgrades needed to connect the generator to the PJM network, and (2) Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system.

In some instances a generator interconnection may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection, may also contribute to the need for the same network reinforcement. The possibility of sharing the reinforcement costs with other projects may be identified in the feasibility study, but the actual allocation will be deferred until the impact study is performed.

The Feasibility 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.

General

The Interconnection Customer (IC)has proposed a solar generating facility located in Peters Township in Franklin County, Pennsylvania. The installed facilities will have a total capability of 20.0 MW with 7.6 MW of this output being recognized by PJM as capacity. This means that the remaining 12.4 MW will be curtailable should a system reliability constraint occur. The proposed in-service date for this project is December 15, 2012. **This study does not imply a FirstEnergy commitment to this in-service date.**

Point of Interconnection

X4-011 will interconnect with the West Penn Power Company's distribution system at one of two options.

Option 1 is to connect via a tap of the Mercersburg - Milnor 34.5 kV line 0.5 miles east of Upton substation.

Option 2 is to connect via Upton substation by terminating onto the 34.5 kV bus.

Cost Summary

The X4-011 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 0
Direct Connection Network Upgrades	$ 143,382
Non Direct Connection Network Upgrades	$ 0
Allocation for New System Upgrades	$ 0
Contribution for Previously Identified Upgrades	$ 0

Total Costs	**$ 143,382**

Attachment Facilities

None.

Direct Connection Cost Estimate

The Mercersburg - Milnor 34.5kV (X4-011) Project primary direct connection will require the facility upgrades defined below. As shown, the estimated cost of the primary direct connection facilities is $143,382. This cost includes a CIAC (Contribution in Aid of Construction) Federal Income Tax Gross Up charge of $32,748. This tax may or may not be charged based on whether or not this project meets the eligibility requirements of IRS Notice 88-129.

The total preliminary cost estimate for Direct Connection work is given in the following tables below:

Description	Total Cost
Install (2) - 34.5kV load break Air Switches and one (1) span 34.5kV line to dead end.	$ 54,486
X4-011 Collector SS: Procure and install FE 34.5kV metering equipment in the developer's collector SS. Developer to provide mounting structures and phone line	$ 31,148
Engineering Oversight and Commissioning	$ 25,000
Sub-Total	**$ 110,634**
Tax	**$ 32,748**
Total	**$ 143,382**

Install (2) - 34.5kV load break Air Switches and one (1) span 34.5kV line to dead end.

- $54,486

As defined by the Interconnection Customer and shown on Attachment 2, the proposed Interconnection Customer site will be located at a point approximately 8.0 miles from Upton substation. The primary direct connection of this project will be accomplished by tapping the Mercersburg – Milnor 34.5KV line 0.5 miles east of Upton substation, and installing 2-34.5kV load-break air switches and 34.5kV metering. An alternate point of interconnection would be accomplished by terminating onto the 34.5kV bus at Upton substation. The Interconnection Customer will be responsible for constructing a radial 34.5kV attachment line from the X4-011 generation 34.5kV export bus to the 34.5kV point of interconnection. The Interconnection Customer may not install above 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 34.5kV interconnection to accommodate the attachment of the Mercersburg - Milnor 34.5kV (X4-011) Project.

The Interconnection Customer will be responsible for constructing all of the facilities on its side of the point of interconnection including the attachment line. A summary of the FE facilities required for the Mercersburg - Milnor 34.5kV (X4-011) Project primary connection and cost estimate are shown above.

System Protection Information

An analysis was conducted to assess the impact of the Mercersburg - Milnor 34.5kV (X4-011) Project on the system protection requirements in the area. The results of this review have identified the following:

- Anti-Islanding Scheme between Mercersburg, Milnor, Upton, and Interconnection Customer Substations to remove the customer generation from service should both breakers at Mercersburg and Milnor open, or if the breaker at Upton opens.

- Standard 34.5kV Line protection for the Mercersburg-Milnor 34.5kV Line and Interconnection Customer 34.5kV line.

No additional protection upgrades will be needed provided the X3-062 Project upgrades to Mercersburg, Milnor, and Upton substations are in-service.

X4-011 will have cost responsibility for the above listed upgrades should X3-062 drop out of the queue.

Transmission Owner Assumptions in Developing the Cost Estimates

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 Mercersburg - Milnor 34.5kV (X4-011) Project. This includes the requirement for the 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 as only ballpark since it was produced without a detailed engineering review. The applicant will be responsible for the actual cost of construction. 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.

Non-Direct Connection Estimate

None.

Revenue Metering and SCADA Requirements

PJM Requirements

The Interconnection Customer will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Sections 24.1 and 24.2.

FirstEnergy Requirements

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

http://www.firstenergycorp.com/feconnect
http://www.pjm.com/planning/design-engineering/to-tech-standards.aspx

Interconnection Customer Facility Requirements

In addition to the FE facilities, the 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 a fully rated 34.5kV circuit breaker 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. 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 Mercersburg - Milnor 34.5kV (X4-011) Project metering point when the units are out-of-service. This assumes the intent of the 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.

Compliance Issues

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

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

The 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.

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.

Network Impacts

The Queue Project #X4-011 was studied as a(n) 20.0MW(Capacity 7.6MW) injection as a tap into Upton-Route 16 34.5kV station in the APS area. Project #X4-011 was evaluated for compliance with reliability criteria for summer peak conditions in 2015. Potential network impacts were as follows:

Option 1 – Tap of the Mercersburg – Milnor 34.5 kV Line 0.5 miles east of Upton substation

Generator Deliverability

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

None.

Multiple Facility Contingency

(Double Circuit Tower Line contingencies were studied for the full energy output. The contingencies of Line with Failed Breaker and Bus Fault will be performed for the Impact Study.)

None.

Short Circuit

(Summary of impacted circuit breakers)

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

(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

To be determined during the System Impact Study phase.

Stability and Reactive Power Requirement for Low Voltage Ride Through

(Summary of the VAR requirements based upon the results of the dynamic studies)

To be determined during the System Impact Study phase.

Note that a further conclusion of this study is that it will be mandatory for the Mercersburg - Milnor 34.5kV (X4-011) Project to have a range of dynamic reactive capability that supports its operation from a .95 lead to .95 lag power factor. 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 the Interconnection Customer fail to provide a dynamic reactive capability from the Mercersburg - Milnor 34.5kV (X4-011) 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.

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)

None.

Potential Congestion due to Local Energy Deliverability

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.

Note: Only the most severely overloaded conditions are listed below. 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 shall study all overload conditions associated with the overloaded element(s) identified.

None.

Option 2 –Termination onto Upton substation's 34.5 kV Bus

Generator Deliverability

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

None.

Multiple Facility Contingency

(Double Circuit Tower Line contingencies were studied for the full energy output. The contingencies of Line with Failed Breaker and Bus Fault will be performed for the Impact Study.)

None.

Short Circuit

(Summary of impacted circuit breakers)

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

(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

To be determined during the System Impact Study phase.

Stability and Reactive Power Requirement for Low Voltage Ride Through

(Summary of the VAR requirements based upon the results of the dynamic studies)

To be determined during the System Impact Study phase.

Note that a further conclusion of this study is that it will be mandatory for the Mercersburg - Milnor 34.5kV (X4-011) Project to have a range of dynamic reactive capability that supports its operation from a .95 lead to .95 lag power factor. 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 the Interconnection Customer fail to provide a dynamic reactive capability from the Mercersburg - Milnor 34.5kV (X4-011) 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.

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)

None.

Potential Congestion due to Local Energy Deliverability

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.

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None.

Attachment 1

System Configuration

Attachment 2

X4-011 Project Location