Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position X3-082

Lopatcong

February 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 Phillipsburg, New Jersey. The installed facilities will have a total capability of 10.0 MW with 3.8 MW of this output being recognized by PJM as capacity. This means that the remaining 6.2 MW will be curtailable should a system reliability constraint occur.

Point of Interconnection

X2-082 will interconnect with the Jersey Central Power & Light system at one of two options. Option 1 is to connect at the 34kV line F6 between the Marble Hill and Morris Park substations. Option 2 is to connect at the 34kV line T124 between the Ingersol and Morris Park substations.

FirstEnergy Analysis

As shown on Attachment 2, the proposed primary point of interconnection (POI) for the X3-082 Project will be located about 1 mile north of the Morris Park substation. Attachment 3 shows a conceptual one-line diagram of the Direct Connection facilities that will be required for the X3-082 Project. As indicated and shown on Attachment 3, it will be studied as a 10 MW injection at pole number NJ1LXF6NJ of the Morris Park – Marble Hill (F6) 34.5 kV line. From that pole, FE will extend a 1.7 mile 34.5 kV tap, building over an existing distribution circuit to pole NJ387LX. SCADA-controlled line and radial disconnect switches and a fuse will be needed at the point of attachment in addition to a circuit breaker and switch on the system side of the generator step-up transformer. 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 X3-082 Project Direct Connection and their cost estimate is shown on Attachment 4.

The Interconnection Customer also chose a secondary point of interconnection on the Morris Park – Ingersol (T124) 34.5 kV line. This connection will require a tap of the T124 line, with a SCADA-controlled switch on the tap and on one pole. The point of interconnection will be at the tap pole and the Interconnection Customer will be responsible for building, owning, operating, and maintaining the connection line from the tap pole to the X3-082 Project site. This connection line would cross under two 34.5 kv lines, a 115 kV line, and a 230 kV line on the FE right-of-way (ROW). To avoid having to raise those lines for clearance, the Interconnection Customer stated an intent to build their connecting line with underground construction. After crossing the FE ROW from the T124 tap pole, the Interconnection Customer must obtain new ROW for the remaining path of their connecting line. Note that the Interconnection Customer must obtain permission from the FE Real Estate group for any use or crossing of any FE ROW, and inclusion of the secondary point of interconnection in this report does not imply that permission will be granted. No cost estimate for the secondary point of interconnection is included in this report.

Power Flow Analysis

A Power Flow study was conducted to determine the reliability impact of the proposed X3-082 Project on the FE Transmission System. This study was completed using a 2013 summer peak load power flow that contains a detailed representation of the Jersey Central transmission networks in the area of the proposed X3-082 Project. Note that the year 2013 was chosen for study rather than 2015 since this is the first summer period when the X Queue solar projects are scheduled for service. 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 Reliability*First*, PJM or FE Planning Criteria and are attributable to this project.

The results of the FE analysis show that there are no network upgrades required for the deliverability of the X3-082 Project generation to the Jersey Central transmission system, for either the primary or secondary points of interconnection. There also are no reinforcements defined for previous projects for which this project will have an impact. However, voltage criteria violations such as high voltage under light load conditions and high and low voltages caused by swings in MW output of the attached generation may be constraining.

Note that a further conclusion of this study is that it will be mandatory for the X3-082 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 that can exceed the established limits. Should the Interconnection Customer fail to provide a dynamic reactive capability from the X3-082 Project for any reason once interconnected, the Jersey Central 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 will not be conducted by PJM since the X3-082 Project connection is to the 34.5 kV 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 system. As defined 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 fact, the results of the FE analysis showed that no FE circuit breaker will exceed its interrupting capability with the implementation of the X3-082 Project. Therefore no circuit breaker reinforcements will be required.

System Protection Analysis

An analysis was conducted to assess the impact of the X3-082 Project on the system protection requirements in the area. The results of this review have identified the following:

The X3-082 Project causes the need for the addition of an SEL-279 reclosing relay on the Morris Park – Marble Hill (F6) 34.5 kV line circuit breaker at Morris Park. Under the assumption that the X3-082 Project generation will not supply fault current to the Jersey Central transmission system, there will be no other protection upgrades needed. However, the X3-082 Project will be required to have two independent high-speed zones of protection to sense and clear faults on the interconnection transformer.

Fault current at the interconnection point is listed below.

	THREE-PHASE	SINGLE-LINE
X/R	4.9	7.3
Fault Current (Amps)	7705	2696

These values are for the current system configuration. Any system changes in the area could have a significant impact on these values. It will be the Interconnection Customer's responsibility to make any protection upgrades required should this occur.

For the 10 MW output, S&C SMD-1A 200E Standard size fuses should be used at the tap point.

1

The cost estimate for the required FE system protection facilities is included on Attachment 4.

Metering

The FirstEnergy Revenue Metering Requirements may be found in the FirstEnergy Requirements for Transmission Connected Facilities document located at the following links:

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

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

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 3.3 MVARs) and .95 lagging (producing 3.3 MVARs). If this capability cannot be provided, a dynamic device such as a STATCOM or SVC must be installed at the X3-082 Project substation at the Interconnection Customer's cost.

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.

The Interconnection Customer will also be required to meet all PJM, Reliability*First* and NERC reliability criteria and operating procedures 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 Reliability*First* 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 analysis shows that no planning criteria violations are attributable to the addition of the X3-082 Project for the conditions studied. Therefore the conclusion is that no transmission or distribution reinforcements will be required to provide the requested service.

Interconnection Customer 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. Since the X3-082 Project will be connected to the 34.5 kV network, the Interconnection Customer will also be responsible for compliance with the FirstEnergy "Technical Requirements for the Interconnection of Parallel-Operated Generation to the FirstEnergy Distribution System". This includes but is not limited to the following:

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. This includes the installation of intertie relays at the point of interconnection that either trip the breaker at the point of interconnection or the individual generators beyond the point of interconnection. The function of the intertie relays must include over/under voltage and over/under frequency protection. Note that these intertie relays are in addition to and must be separate from of the two relays that provide independent high speed zone of protection to sense and clear faults. They include the installation of an SEL-351-7 (Version 7) relay or its equivalent for power elements, a potential transformer or CCVT's on the high side of the transformer, and current transformers on the high side of the transformer.

2. A compliance with the FE and PJM generator power factor and voltage control requirements. Note that the X3-082 Project may need to absorb reactive power at the point of interconnection to minimize the voltage change should the units rapidly reduce their output or trip off line.

3. The execution of a back-up service agreement to serve the customer load supplied from the Interconnection Customer 34.5 kV substation when the units are out-of-service. This assumes the intent of the Interconnection Customer is to net the generation with the station load.

4. Any complaints from other customers (e.g. flicker complaints) will have to be corrected by the Interconnection Customer. Correction may include changing operation, reducing generation, disconnecting the generators from the Jersey Central system, or other measures.

5. 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. The RTU, the communications channel and all related equipment will be furnished and maintained by the Interconnection Customer. The RTU must communicate with the FirstEnergy EMS via DNP 3.0 protocol.

6. The following status, control, and metering points will be required:

    a. Interconnection breaker position status and trip control.

    b. Generator real and reactive power output measured at the high-side of the generator step-up transformer.

    c. Generator voltage at the point of interconnection.

7. An installation of two independent high-speed zones of protection to sense and clear faults on the interconnection transformer.

8. A compliance with the inverter standard UL1741 and IEEE 1547, “Standard for Interconnecting Distributed resources with Electrical Power Systems”, in addition to the power quality standards defined by Reliability*First* and PJM.

9. A provision of the necessary generator protection, synchronization controls, and fault detection to initiate a trip to protect the X3-082 Project equipment from faults on the Jersey Central System.

10. A compliance with the PJM Manuals and Operating instructions to have a plant operator on call 24/7 to respond within a minute to reduce the output of X3-082 Project when network constraints occur.

11. The Interconnection Customer will not excavate, construct facilities or locate solar panels under the existing FE transmission facilities or on FE right-of-ways without the express permission of FE.

12. The purchase and installation of the standard voice grade (analog) telephone line and associated conduit between the telephone company source and the meter socket or enclosure.

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

Note that an assumption of this study is that the X3-082 Project generation will automatically be disconnected whenever the local area network is islanded. If this assumption is not correct, a direct transfer trip scheme will need to be implemented for such situations at the Interconnection Customer's cost.

Network Impacts

Queue project X3-082 was studied as a(n) 10.0 MW (3.8 MW of which was Capacity) injection into JCPL's system. Project X3-082 was evaluated for compliance with reliability criteria for summer peak conditions in 2015.

Option 1: 50.0% tap between Marble Hill and Morris Park34.5 kV line

Potential transmission network impacts are as follows:

Generator Deliverability

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

No violations identified.

Multiple Facility Contingency

(Double Circuit Tower Line contingencies only with full energy output. Stuck Breaker and Bus Fault contingencies will be applied during the Impact Study)

No violations 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.)

No violations identified.

New System Reinforcements

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

None required.

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 required.

Short Circuit

(Report over-dutied breakers.)

None required.

Energy Portion of Interconnection Request

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. 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 analyzes all overload conditions associated with the overloaded element(s) identified. As a result of the aggregate energy resources in the area, the following violations were identified.

No violations identified.

Option 2: 50.0% tap between Ingersoll Rand and Morris Park34.5 kV line

Potential transmission network impacts are as follows:

Generator Deliverability

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

No violations identified.

Multiple Facility Contingency

(Double Circuit Tower Line contingencies only with full energy output. Stuck Breaker and Bus Fault contingencies will be applied during the Impact Study)

No violations 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.)

No violations identified.

New System Reinforcements

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

None required.

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 required.

Short Circuit

(Report over-dutied breakers.)

None required.

Energy Portion of Interconnection Request

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. 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 analyzes all overload conditions associated with the overloaded element(s) identified. As a result of the aggregate energy resources in the area, the following violations were identified.

No violations identified.

Summary

The connection of the X3-082 Project to the FE transmission system will require no network upgrades. Therefore the Interconnection Customer will only have a cost responsibility for the Direct Connection of the X3-082 Project to the Jersey Central transmission system. As shown on Attachment 4, the estimated cost of these facilities is $2,666,600. This cost includes a CIAC (Contribution in Aid of Construction) Federal Income Tax Gross Up charge of $653,200. 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 direct connection and system upgrades required to support this project, it is estimated that it will take eighteen (18) months from the date of a fully executed Interconnection Construction Service Agreement to complete the upgrades required for the X3-082 Project. Full payment of the estimated cost of the project will be required upon execution of the Interconnection Service Agreement/Interconnection Construction Service Agreement (ISA/CSA). True up of the actual cost versus estimated cost of the project will be performed by FE at the end of the project. It further assumes that the Interconnection Customer will provide the property and right of way for the attachment facilities that will be needed. A further assumption is that there will be no delays in acquiring the necessary permits for implementing the defined direct connection and network upgrades, and that all 34.5 kV transmission system outages can be scheduled when needed.

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 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 connections to the transmission system.

Attachment 1
Site View

Attachment 2
Aerial View

Attachment 3
Single Line Diagram

Attachment 4
Estimated Costs

Item	Description
1	Construct approximately 1.7 miles of new overhead 34.5kV line from a point on the F6-1 34.5kV line (Morris Park-Marble Hill).
2	Construct a new tap pole, replace 49 existing distribution poles with taller subtransmission poles and overbuild new 34.5kV subtransmission line, install a switch on the tap, (Motor Operated/SCADA controlled load break switch included in estimate), install a Motor Operated/SCADA controlled load break switch on pole, all necessary guying, etc., and a span of wire to a customer owned pole
3	Transfer the existing distribution facilities to the new transmission structures.
4	Install 120/240V power to the motor-operated switches.
5	Environmental permitting review shows no need for environmental permitting at the preliminary service point indicated on the applicant's submitted sketch. If any of the proposed work is close enough to the adjacent creek to require protective matting or special vehicles for access to poles in wetlands, additional un-estimated costs will then be added.
6	No estimate for Right-of-Way investigation and engineering is included. Developer is responsible for providing valid rights to JCP&L to overbuild the existing distribution lines.
7	Estimate includes $23,000 for metering to be mounted in customer substation.
8	Add SEL-279 reclosing relay to the Morris Park – Marble Hill (F6) 34.5 kV line circuit breaker at Morris Park.
9	Miscellaneous Protection, Fuses, Metering, RTU, SCADA
	Direct Connection Costs: $ 2,013,400 **Taxes (if Applicable): $ 653,200** **Total: $ 2,666,600**