

***Generation Interconnection
Feasibility Study Report***

For

***PJM Generation Interconnection Request
Queue Position W1-128***

Red School Lane 69kV

July 2010

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 20.0 MW (7.6 MW capacity) solar generating facility. The facility will be located in Phillipsburg, New Jersey (see Attachments 1 and 2). The proposed in-service date for the project is November 30, 2011.

The total cost estimate for this connection is \$7,358,300

Point of Interconnection

W1-128 will interconnect with the Jersey Central Power & Light transmission system at a 115kV line between the Morris Park and Merrill Creek substations.

Scope of Work

The proposed connection of the W1-128 Project will be located along the Morris Park-Merrill Creek Tap (S919) 115 kV line. To accommodate the project connection, a new looped 115 kV line will be constructed over an existing Distribution line that will extend to the W1-128 Project site. In compliance with the FE Connection Requirements, a new Brainards Road 115 kV three breaker ring bus will be constructed for the project attachment. A conceptual one-line diagram for the new Brainards Road 115 kV substation is shown on Attachment 3. While FE will construct, own and operate the new Brainards Road 115 kV substation and the facilities required for its attachment to the FE system, the Interconnection Customer will be responsible for acquiring all easements, properties and permits that will be needed. The Interconnection Customer will also be responsible for providing a level graded site for the new Brainards Road 115 kV substation and an access road as a prerequisite before work can begin. A summary of the W1-128 Project Attachment facilities that will be required and their estimated cost are shown on Attachment 4.

System Protection Analysis

An analysis was conducted to assess the impact of the W1-128 Project on the system protection requirements in the area. The results of this review have identified the following:

Under the assumption that the W1-128 project will not supply fault current to the JCP&L system and consists of a Delta connected bank on the 115kV side, the following protection upgrades will be needed:

Brainards Road 115 kV Substation

1. Construct a new control building to accommodate the SCADA equipment required for the Direct Connection facilities. A final determination will be made as a part of the Facilities Study.
2. Protective Zone: EACH OF THE THREE 40kA RATED BREAKERS:
 - (1) Breaker Failure Protective Relaying with fault detectors (current, breaker status)
 - (2) 2000/5 MR CTs on 1 3 5 side of breaker: C800 accuracy class, Thermal Factor = 2.0
 - (2) 2000/5 MR CTs on 2 4 6 side of breaker: C800 accuracy class, Thermal Factor = 2.0
3. Protective Zone: Interconnection Transformer:
 - (2) Independent high-speed zones of protection to sense and clear faults on the interconnection transformer.

NOTE: Breaker Failure is required for customers downstream breaker: It should trip the corresponding two ring bus breakers and be on an independent DC.

4. Protective Zone: S919 line from Brainards Road Three Breaker Ring Bus to Pequest River/Flanders Substations:
 - (2) Independent high-speed zones of protection to sense and clear faults.
 - (1) Breaker reclosing relay to be used to reclose shared line breaker for some line faults.
 - (1) Transfer Trip (from Flanders) Receiver [Could be relocated from Gilbert Substation]
 - (1) Transfer Trip (from Merrill Creek) Receiver [Could be relocated from Gilbert Substation]
 - (1) CCVT, Wavetrap, and line tuners to assure high speed tripping..
 - (1) Directional Comparison Blocking Carrier Transmitter/Receiver [Could be relocated from Gilbert Substation]
5. Protective Zone: S919 line from Brainards Road Three Breaker Ring Bus to Gilbert Substation:
 - (1) CCVT, Wavetrap, and line tuners to assure high speed tripping.
 - (2) Independent high-speed zones of protection to sense and clear line faults.
 - (1) Directional Comparison Blocking Carrier Transmitter/Receiver with auto-checkback
6. Three SATEC Meters (two line exits and one attachment point)

Gilbert 115 kV Substation

1. Line Tuner (may not need, existing may be able to be retuned to new frequency)
2. Directional comparison blocking carrier equipment with auto-checkback

Fault current on the S919 line, 1.25 miles west of pole JC132AHY (Morris Park to Merrill Creek line section) are listed below. These values are for the current system configuration. Any system changes in the area could have a significant impact on these values.

Three phase: 6,780 amperes (X/R ratio: 6.3)
 Line-to Ground: 5,070 amperes (X/R ratio: 5.6)

The Interconnection Customer will also be responsible for installing all project facilities beyond the point of interconnection and at its generation substation in compliance with the FE and regional requirements. This includes breaker protection, unit over/under voltage protection, over/under frequency protection and zero sequence voltage protection as may be required. The Interconnection Customer will also be responsible for all leasing costs for the circuits that may be required for the communication of data to PJM. FE will not provide a cost estimate for these facilities as a part of this report.

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

Metering

The Interconnection Customer will be required to comply with all FE Revenue Metering Requirements for Generation Interconnection Customers. These FE requirements are detailed on Attachment 5 to this report.

Compliance Issues

The 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 5.9 MVAR) and .90 lagging (producing 8.7 MVAR). If this capability cannot be provided by the solar units, a STATCOM or SVC device must be installed at the W1-128 Project substation at the Interconnection Customer's cost.

FE Facility Upgrades and Costs

The results of the FE analysis shows that no planning criteria violations are attributable to the addition of the W1-128 Project for the conditions studied. Therefore the conclusion is that no transmission or distribution reinforcements will be required to provide the requested service.

The following is a summary of the FE facilities that will be required for the direct connection of the W1-128 Generation Project:

1. Construct new Brainards Road 115 kV Substation in 3 beaker ring bus configuration for the project attachment. This includes the design and engineering, acquisition of materials and construction of the required facilities.
(Cost Estimate \$4,765,700)
2. Replace carrier relaying on the 115kV S919 line at Gilbert Substation.
(Cost Estimate \$120,900)
3. Construct the 115 kV dead-end structures and other transmission facilities required for the looped connection of the Atlantic – Oceanview (J36) 115 kV line to the new Brainards Road substation.
(Cost Estimate \$2,471,700)

All cost data contained in this document should be considered estimated. 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.

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 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 115 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 the W1-128 interconnection to measure the power delivered in compliance with the FE standards.
4. A compliance with the FE and PJM generator power factor and voltage control requirements. Note that the generators may need to absorb reactive power at the point of interconnection during off peak periods to minimize the voltage change should the W1-128 Project units trip off line when at full output.
5. The execution of a back-up service agreement to serve the customer load supplied from the Brainards Road 115 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.
6. 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.
7. 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.
8. The following status and metering points will be required:
 - a. Interconnection breaker position.
 - 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.
9. An installation of two independent high-speed zones of protection to sense and clear faults on the interconnection transformer.

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 W1-128 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 W1-128 was studied as a(n) 20MW (7.6MW of which was Capacity) injection into JCPL's system at a tap of the Morris Park – Meril Creek 115kV line. Project W1-128 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.

However, there are voltage regulation issues that may require a curtailment of the energy portion of the project at times.

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 problems identified.

Contribution to Previously Identified Overloads

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have % allocation of cost responsibility which will be calculated and reported for the Impact Study.)

No problems 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.

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.

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 problems identified.

Short Circuit

No problems identified.

Stability Analysis

Not required.

Summary

The connection of the W1-128 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 W1-128 Project to the Jersey Central transmission system. As shown on Attachment 4, the estimated cost of these facilities is \$7,358,300.

Based on the extent of the FE direct connection and system upgrades required to support this project, it is estimated that it will take one (1) year from the date of a fully executed Interconnection Construction Service Agreement to complete the upgrades required for the W1-128 Project. This includes the requirement for the Interconnection Customer to make a preliminary payment to FE that funds the first three months of engineering design that is related to the construction of the Direct Connection facilities. It further assumes that the Interconnection Customer will provide the property for the attachment and right-of-way facilities 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 115 kV transmission system outages 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 Facilities 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
Local Site Plan

Attachment 2
Aerial View

Attachment 3
Single Line Diagram

Attachment 4
Estimated Costs

Facility	Activities	Cost
Brainards Road 115kV Substation	<p>Construct new 115 kV substation for 3 breaker ring bus</p> <p>Include control building for relay panels, SCADA, etc.</p> <p>Install three 145kV circuit breakers – standard 3000 amp, 40kA interrupting capability each</p> <p>Install six new disconnect switches for radial generator attachment – standard 2000 amp each</p> <p>Install 795 ACSR substation conductor or bus-bar as needed</p> <p>Install three line termination structures for the two 115kV lines and generator attachment</p> <p>Install drop loops for the two attachment lines at the generator – 795 ACRS wire</p> <p>Miscellaneous protection, metering, RTU, SCADA</p>	\$4,765,700
Gilbert 115kV Substation	Replace carrier relaying on the 115kV S919 line	120,900
Morris Park – Merrill Creek 115kV Transmission Line	<p>Construct new double circuit line loop from the Morris Park-Merrill Creek Tap (S919) 115kV line to the Brainards Road Substation (1.25 miles)</p> <ul style="list-style-type: none"> • Replace pole with a double circuit turning structure along the Morris Park-Merrill Creek Tap (S919) 115kV line • Install a double circuit dead end structure for the connection to the new Brainards Road 115kV Substation • Install 115kV double circuit poles required for extension to the Brainards Road Substation • Install line conductor for 115kV loop – 795 kcmil 26/7 ACSR wire or better 	2,471,700
Total Cost Estimate		\$7,358,300

Attachment 5

FirstEnergy Revenue Metering Requirements for Generation Interconnection Customer

Interconnection Customer shall install, own, operate, test and maintain the necessary revenue quality Metering Equipment. This includes current transformers, voltage transformers, mounting structures, wiring, meters, communication circuits, and associated devices. The Metering Equipment must meet the specifications listed in the FirstEnergy and regional transmission organization (RTO) connection documents. The FirstEnergy “Requirements for Transmission Connected Facilities” are located at: <http://www.firstenergycorp.com/feconnect>

The Metering Equipment shall be located at the generation facility on the high voltage side of the generator step-up transformers or facility main step-up transformer and/or station service power transformers. Power flows to and from the facility shall be compensated to the Point of Interconnection.

FirstEnergy will provide revenue quality Metering Equipment for a station service power supply at a generation facility if the supply is from the local FirstEnergy distribution system.

The revenue quality Metering Equipment shall be capable of collecting and storing bidirectional billing data. The billing data shall be stored in intervals specified by FirstEnergy, typically fifteen minutes or thirty minutes. The Interconnection Customer must provide FirstEnergy with remote access to the billing data in the Metering Equipment via a dedicated voice-grade analog telephone circuit. The Interconnection Customer shall provide FirstEnergy with contact information for the person or persons responsible for meter programming and Metering Equipment maintenance.

The Interconnection Customer shall consult with FirstEnergy regarding the revenue quality metering system design and provide the following information:

- Facility one line and revenue metering installation drawings (schematics, wiring diagrams, etc.)
- Estimated power flows to and from the facility at all revenue metering points
- Current transformer and voltage transformer specifications, including manufacturer, type, nameplate drawings, and certified accuracy test reports
- Revenue meter specifications including manufacturer, type, model number, and accuracy
- Revenue meter program information including but not limited to billing data recorder channel assignments, recorder pulse weights (Ke), and read-only password for access to interval data by the FirstEnergy billing data collection system (MV-90)
- Revenue meter telephone number
- Revenue meter loss compensation data (if applicable)

The Interconnection Customer shall provide FirstEnergy with prior notification of any modifications at the facility that will affect the revenue meter measurements, including substation reconfigurations and meter program changes.

The revenue metering system at each location shall be tested for accuracy by the Interconnection Customer once every two years. The Interconnection Customer shall give reasonable notice to FirstEnergy of the time when the testing is scheduled so that FirstEnergy may have representatives present. FirstEnergy and the RTO shall have the right to audit the revenue metering equipment and/or related documents. The Interconnection Customer shall be given a reasonable period of time to comply with any requests associated with an audit.