

***PJM Generator Interconnection
V3-006 Linglestown 1.0 MW
Feasibility / Impact Study***

December 2009

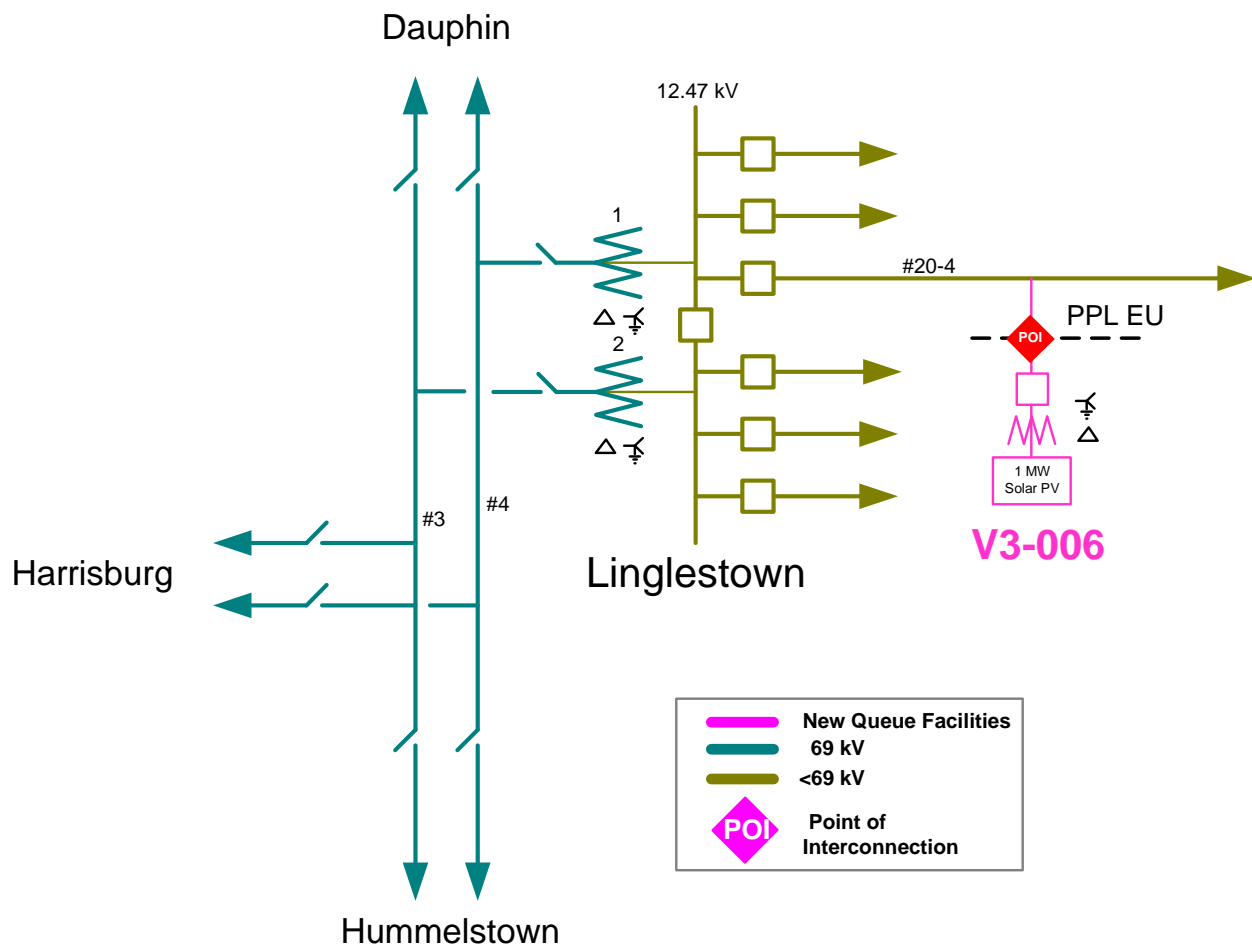
Docs # 572111

General

Queue V3-006 is a Dauphin County Industrial Development Authority request to interconnect a 1.0 MW Capacity Resource consisting of a 1 MW ground array of photovoltaic panels. The new generation will be located at 210 Hetrick Lane, Harrisburg, Dauphin County, Pennsylvania. Queue V3-006 has requested a December 31, 2009 in-service date. **This study does not imply a PPL EU commitment to this in-service date.**

Direct Connection

Queue V3-006 generation can be connected to the Linglestown 12 kV line #20-4 as shown on the single line diagrams below and Attachment 1.



The total estimated cost for PPL EU to construct the Queue V2-027 Direct Connection facilities is **\$467,000** and the estimated construction time is **9 months**.

V3-006 Interconnection Customer (Dauphin County Industrial Development Authority) Scope of Work

1. Queue V3-006 Interconnection Customer is responsible for design, construction and costs for all facilities associated with V3-006 on the Interconnection Customer side of the POI (Point of Interconnection) shown on the single line diagram of the previous page.

2. Direct Transfer Trip:

PPL EU has reviewed the requirement for Direct Transfer Trip (DTT) on this installation. Normally DTT is required if there are other PPL EU customers involved that could be islanded with the generation. Normally with other customers on the line, inverter-based installations are required to have anti-islanding capability built in as part of the IEEE 1547 and UL 1741 requirements. This capability is to be certified and tested by an OSHA listed Nationally Recognized Testing Laboratory (NRTL). The inverters HAVE NOT BEEN IDENTIFIED. Therefore, PPL EU would require DTT in this instance unless proof is provided as listed in the following:

All inverters to be used for connecting generation to the PPL EU system are required to be certified to UL1741 and IEEE 1547. The term certified is understood to indicate a NRTL has tested the device to the appropriate standard, in this case UL1741 and IEEE 1547. Any inverter not meeting the NRTL certification either will not be allowed to connect to the PPL EU system, or will be required to install suitable external protection equipment to provide the same level of protection. Further, the inverter vendor must provide upon request copies of the certification of the inverter equipment from the NRTL. Self certification or certification by a third party that is not listed on the OSHA web site will not be accepted.

OSHA's website may be referenced for a listing of NRTL logos and qualifications:

http://www.osha.gov/dts/otpca/nrtl/faq_nrtl.html

PPL EU would be willing to eliminate the need for DTT **IF** the inverters utilized in this installation were certified by an OSHA certified NRTL.

Cost for telephone line based DTT, installed in conjunction with other work at Linglestown Substation is estimated to be \$100,000. However, if this work was done separately, the cost estimate is \$160,000. This does not include the cost of the telephone line that will be the responsibility of Queue V3-006 Interconnection Customer.

3. Metering and Telemetering Requirements for PJM:

The Interconnection Customer will be required to install the equipment necessary to provide revenue metering (KWH and KVARH hourly data sent once per day) and real time data (telemetry) for the Interconnection Customer's generating resource in compliance with PJM Manuals M-01 and M-14B, and the PJM Tariff. **Real time data (telemetry) is only required if Queue V3-006 is a Capacity Resource.**

For additional information regarding PJM metering requirements and the PJM internet-based telemetry alternative (Arcom Director) contact Ryan Nice at 610-666-4777 or nicer@pjm.com

Metering and telemetering requirements for PPL EU:

New metering equipment is required, it will be provided by PPL EU at no cost to the Interconnection Customer (Dauphin County Industrial Development Authority).

4. Protection Equipment:

The Interconnection Customer is required to install suitable protection and control equipment based on PPL EU's Applicable Standards for interconnection of parallel generation. This includes both Intertie Protective Relaying (IPR) and Point of Contact (POC) relaying. The PPL EU web site links for the IPR and POC requirements are shown below.

IPR Requirements:

<http://www.pplelectric.com/Business+Partners/Tools+and+Reference+Center/Customer-Owned+Generation/>

POC Requirements:

http://www.pplelectric.com/NR/ronlyres/B0937C7E-B6E9-40AD-AE8C-ED3C9558E528/0/point_of_contact_r1.pdf

The proposed protection is based in a WYE grounded high side, Delta low side transformer at the IPP site. Any other transformer configuration will alter the protection requirements.

5. Isolation Breaker Requirement:

V3-006 Interconnection Customer will have its own isolation breaker that is capable of separating the V3-006 generation from the PPL EU system. This breaker will be operated by the PPL EU Controlled POC and/or IPR relaying. The Interconnection Customer may also operate this breaker by its own protection and control equipment. As per PPL EU design requirements, sharing of IPR/POC equipment within the IPR cabinet with the Interconnection Customer is not allowed.

Interconnected Transmission Owner (PPL EU)

Direct Connection Scope of Work

The following distribution modifications will be required on the Linglestown #20-4, 12 kV line in order to accommodate the generation:

1. 12 kV line tap (Estimated cost = \$150,000)

Construct a 12 kV line (approx 2,000 ft.) from the tap point on #20-4 line, to the V3-006 Point of Interconnection at the Dauphin County Industrial Development Authority Interconnection Customer facility, using 477 kcmil Aluminum conductor or equivalent.

- The distance of 2,000 ft. was based on the approximate intertie point proposed by the V3-006 Interconnection Customer. If this proposed intertie point is to be changed, PPL EU will need to be informed and the cost may change accordingly.
- The estimated cost is based on receiving Right of Way for overhead distribution conductors along an access road. This cost can escalate if the rights can not be secured and the scope changes.

Queue V3-006 generation will be interconnected to the PPL EU 12 kV distribution system as shown in Figures 1 and 2. No reinforcement of the 12 kV distribution system is required for Queue V3-006.

2. Voltage check capability will need to be installed on Linglestown Substation circuit breaker.
3. PPL EU will also review point of interconnection IPP drawings, commissioning work at the IPP site etc.
(Estimated cost for 2 and 3 = \$167,000)
4. We will require voltage sensing on the two circuit reclosers if the provided anti-islanding protection on the inverters operates in greater than 1.5 seconds.
(Estimated cost = \$50,000)

Network Impacts

Queue V3-006 was studied as a 1.0 MW Capacity injection into the Linglestown 12 kV line #20-4. Project V3-006 was evaluated for compliance with reliability criteria for summer peak conditions in 2013. Potential network impacts were as follows:

NETWORK IMPACTS

Local System Impacts

(Impacts to PPL EU's lower voltage distribution system based on reliability criteria commonly applied to these facilities)

There are no overloads expected as a result of the V3-006 connection. PPL EU studies found that voltage remained within acceptable limits for the operation of V3-006's generator. However, if customers on the Linglestown #20-4 12 kV line begin to experience unacceptable voltage fluctuations due to the Dauphin County Industrial Development Authority's operations, Dauphin County Industrial Development Authority will be required to take all necessary corrective action to mitigate the problem. An instantaneous voltage variation of greater than 5% at the Point of Interconnection is generally not acceptable. In addition, the frequency and severity of voltage variations are also considered when determining compliance with PPL EU's flicker guidelines. These guidelines are based upon the General Electric flicker-irritation curve and will be used to determine if the system is operating within acceptable limits.

Queue V3-006 should also be aware of PPL EU's harmonic distortion guidelines. PPL EU allows up to a 3% total harmonic voltage distortion level. In addition, no single harmonic is allowed to exceed 1.7% of the system fundamental voltage. If PPL EU discovers that objectionable harmonics in excess of the stated limits are being injected into the system from V3-006's equipment, Queue V3-006 Interconnection Customer will be responsible for taking corrective measures to mitigate harmonic currents and may be required to curtail operation until such corrective measures are implemented.

Preliminary studies indicate that operating the V3-006 inverter based photovoltaic generator at unity power factor over all output conditions will not adversely affect system voltage. PPL EU reserves the right to change the power factor requirement for V3-006 as system conditions change.

Generator Deliverability

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

No problems identified.

Multiple Facility Contingencies

(Double Circuit Tower Line, Stuck Breaker and Bus Fault contingencies for the full energy output)

No problems identified

Contribution to Previously Identified Overloads

(This project contributes greater than the PJM cost allocation threshold loading to the following contingency overloads, i.e. “Network Impacts”, identified for earlier generation or transmission interconnection projects in the PJM Queue)

No problems identified

Stability Analysis

Not required because of size and location of proposed generation.

Short Circuit

No problems identified.

NETWORK UPGRADE REQUIREMENTS

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 will have a % allocation cost responsibility)

None required.

ATTACHMENT 1

(V3-006 Interconnection Single Line Diagram)

