PJM Generator Interconnection V3-040 Hauto-Siegfried 10 MW Feasibility / Impact Study

December 2009

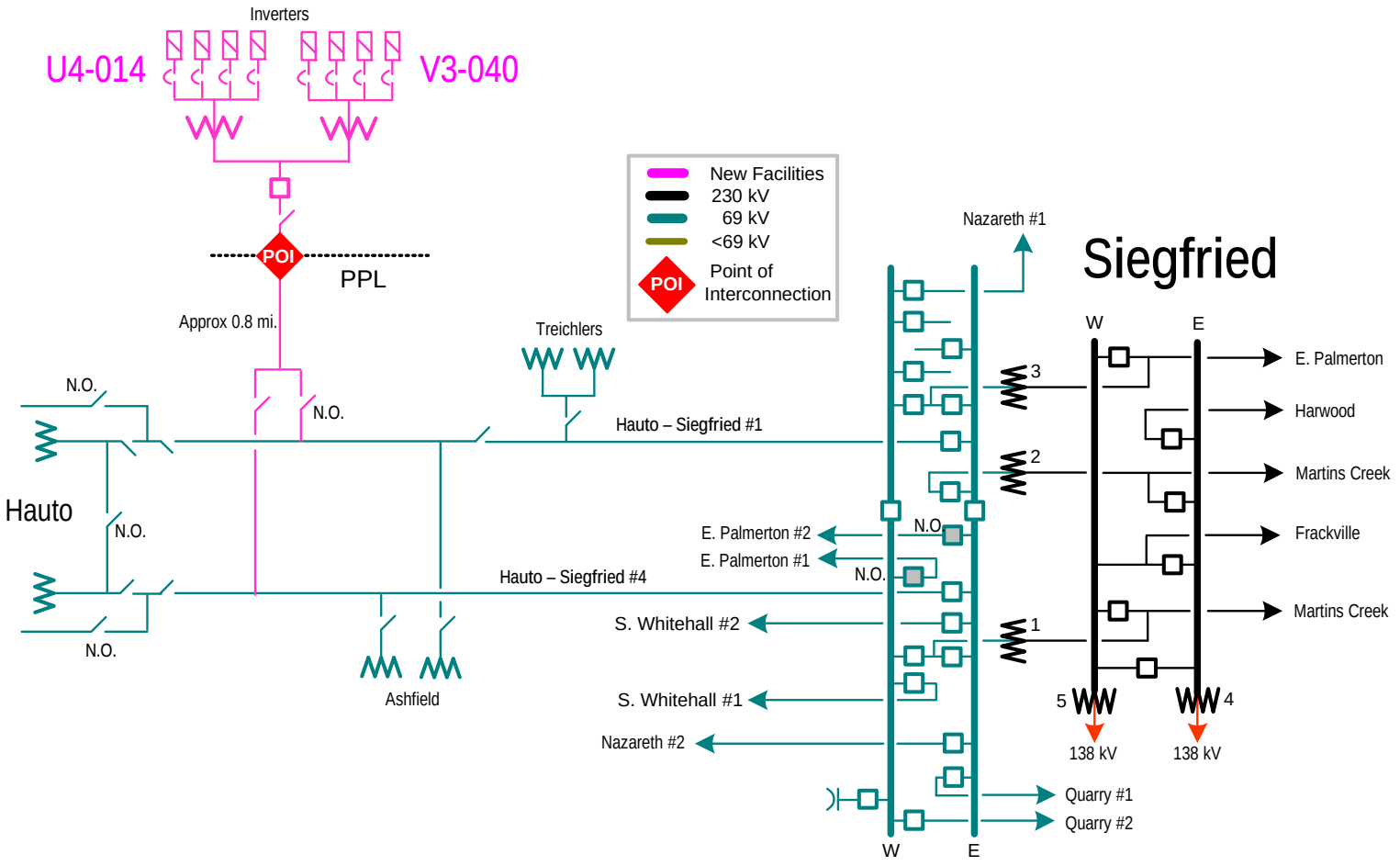
Docs #570533

General

Queue V3-040 is a Green Energy Capital Partners, LLC request to interconnect a 10 MW (3.8 MW Capacity) solar PV park located in Nesquehoning Borough, Carbon County, PA approximately 2.5 miles northeast of PPL Electric Utilities' (PPL EU's) Hauto 69/12 kV Substation. Queue V3-040 is a 10 MW increase to existing Queue U4-014. Queue U4-014 / V3-040 generation interconnection desires commercial operation in 4Q 2010. **This study does not imply a PPL EU commitment to this in-service date.**

Direct Connection: Hauto-Siegfried #4 69 kV Line

Queue U4-014 / V3-040 can be connected to PPL EU's 69 kV system by tapping both the Hauto-Siegfried #1 & #4 69 kV lines, through two load sectionalizing air break switches (LSABs) to a common point and extending a single 69 kV circuit for approximately 1.0 mile to a new Queue U4-014 / V3-040 Interconnection Customer-owned substation in grid 523-N-257 as shown on the one line diagram below. The normal outlet will be the Hauto-Siegfried #4 69 kV line and the alternate outlet will be the Hauto-Siegfried #1 69 kV.



Interconnection Customer Scope of Direct Connection Work

Queue V3-040 / U4-014 Interconnection Customer will be responsible for the construction of all generating station facilities on the V3-040 / U4-014 side of the POI (Point of Interconnection) as shown on the one line diagram of the previous page.

Protection equipment --
The Interconnection Customer will need to install suitable protection and control equipment based on PPL EU parallel generation requirements. This includes both Intertie Protective Relaying (IPR) and Point of Contact (POC) relaying. Please refer to the PPL EU web site for the IPR and POC requirements. The website addresses 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/rdonlyres/B0937C7E-B6E9-40AD-AE8C-ED3C9558E528/0/point_of_contact.pdf

DTT Relaying Requirements--
Matching phone line based DTT (Direct Transfer Trip) equipment is required. PPL EU expects that a combination of telephone and fiber will be required for a communications path between the V3-040 / U4-014 Substation and PPL EU's Siegfried substation (see 'Telephone Circuit Requirements' section of this Impact Study). However, the telephone line portion would originate from the V3-040 / U4-014 Substation. This is a special dedicated 4 wire analog telephone line, type PRDA.

PPL EU will need a signal from V3-040 / U4-014 that will indicate:

- The isolation breaker is open (a breaker 'b' switch) OR
- A contact that will indicate when ANY inverter is operating in parallel with the PPL system (contact is OPEN when any inverter is in parallel) - this contact will close when ALL inverters are OFF line (disconnected from the PPL system).

Note: PPL has not been able to confirm the impact of the inverters on the system or how multiple inverters are going to interact with each other on the system. Therefore, PPL EU will include the installation of Direct Transfer Trip (DTT) facilities for maximum protection of the transmission line in the Impact Study estimate. PPL EU has been trying to communicate with other utilities that have installed similar solar generation on their system to assist in determining the impact. Unless PPL is able to determine DTT is not required, it will be included in the project scope.

SCADA Requirements--
PPL EU will require the installation of a PPL EU approved SCADA equipment that will connect to its existing SCADA system. This connection will likely be a combination of a 4-wire dedicated FDDA-type phone line and fiber. PPL EU will provide detailed specifications and design drawings for this equipment.

Metering Equipment Installation at the Point of Interconnection--
Installation of revenue grade Metering Equipment will be required at the Queue V3-040 / U4-014 Point of Interconnection (POI). PPL EU will design and supply the required metering equipment but all the installation cost would be borne by the developer. All metering equipment must meet applicable PPL EU tariff requirements as well as being compliant with all applicable requirements of the PJM agreements. The equipment should be housed in a control cabinet or similar enclosure and must be accessible to PPL EU metering personnel.

Metering / Telemetry for PJM--
Interconnection Customer is also required to provide revenue metering and real-time telemetry data to PJM in compliance with the requirements listed in PJM Manuals M-01 and M-14.

Distribution Service Requirements--
The Interconnection Customer must submit a request for electric service through PPL EU's Industrial and Commercial Services (ICS) group if the V3-040 / U4-014 solar park requires back-up electric service at a voltage less than 13 kV. The ICS Help Desk can be reached at 1-888-220-9991. Cost for distribution electric service is NOT included in the PPL scope of work transmission or substation estimates below.

Isolation Breaker Requirement --
V3-040 / U4-014 Interconnection Customer will have its own isolation breaker. This breaker can be located on either the high or low side of the Interconnection Customer's transformer. It will be operated by the IPR relay and the DTT, and if it is located on the high side, the POC relaying. This device will NOT be used to synchronize or parallel operating generation to the PPL EU system.

Transmission Owner (PPL EU) Scope of Direct Connection Work

There is no additional Queue V3-040 PPL EU Direct Connection work over and beyond that which is required for Queue U4-014 and reported in the U4-014 Impact Study dated August 2009.

Direct Connection Issues

V3-040 Generator Harmonic and Flicker Requirements

On the 69 kV system, the total harmonic distortion to the fundamental voltage wave from a single customer is limited to 1.5% of nominal. In addition, no individual harmonic component can exceed 1.0% of the fundamental system voltage.

If PPL EU discovers that objectionable harmonics in excess of the stated limits are being injected into the system from Queue V3-040 / U4-014's equipment, the Queue V3-040 / U4-014 Interconnection Customer will be responsible for taking corrective measures to mitigate harmonic currents.

Maximum Allowable Harmonic Voltage Distortion Table (Tariff Rule 32)		
Voltage Level	**Distortion Factor (% System Voltage)**	**Individual Harmonic (% System Voltage)**
69 kV through 138 kV	1.5	1

Concerning voltage flicker, the V3-040 / U4-014 customer must limit the severity of their voltage variation to within a level which will not cause objectionable flicker to other customers. A voltage drop greater than 5% at the point of interconnection is generally not acceptable. The frequency and severity of the voltage variation must be considered when determining whether a customer's equipment is violating PPL EU flicker guidelines. PPL EU uses the General Electric flicker-irritation curve as a guideline to determine if the system is operating within acceptable limits. PPL EU will require corrective actions by the V3-040 / U4-014 customer if their operation causes flicker that exceeds PPL EU guidelines. One such correction could be the installation of static var compensators (SVC) to hold a constant voltage.

Other V3-040 Direct Connection Issues

All other direct connection issues are the same as those required for Queue U4-014 and reported in the U4-014 Impact Study dated August 2009.

Network Impacts

The Queue V3-040 project was studied as an additional 10 MW energy (3.8 MW Capacity) injection into the 69kV Hauto - Siegfried #1 or #4 line. The project was evaluated for compliance with reliability criteria for summer peak conditions in 2014. Potential network impacts were as follows:

NETWORK IMPACTS

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, location and technology 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.