Generation Interconnection Combined Feasibility/System Impact Study Report

For

PJM Generation Interconnection Request Queue Position X3-078

Harrisburg 12kV

February 2012

Preface

The intent of the Combined Feasibility/System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

In some instances an Interconnection Customer may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection or merchant transmission upgrade, 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, if any, is included in the System Impact Study.

The 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 associated with them will be addressed when seeking an Interconnection Agreement as outlined below. . Developer will also be responsible for providing and installing metering equipment in compliance with applicable PJM and Transmission Owner standards.

General

NRG Thermal, LLC, the Interconnection Customer (IC), has proposed a 4.0 MW (3.0 MW capacity) gas turbine generating facility (6.5 MW generator nameplate). The new generation will be located at the Harrisburg Hospital Energy Plant on South Second Street, Dauphin County, Harrisburg, Pennsylvania. Harrisburg Hospital is a two line supply customer with normal supply sources from Harrisburg 69-12 kV and Cedar 69-12 kV substations. In the event of a loss of either source, the customer may transfer all load to the alternate supply under System Operator supervision.

Queue X3-078 has requested an August 15, 2014 in-service date. **This study does not imply a PPL Electric Utilities (PPL EU) commitment to this in-service date.**

This study assumes that the proposed generation will only be allowed to operate when the distribution system is in a normal operating arrangement in which the X3-078 generation is served solely by the Harrisburg #01-5 12 kV distribution line.

Point of Interconnection

X3-078 will interconnect with the PPL EU distribution system to the 12kV line #01-5 from Harrisburg substation (see Attachment 1).

Direct Connection Requirements

The total estimated cost for PPL EU to construct the Queue X3-078 Direct Connection facilities is $240,618 and the estimated construction time is 9 months.

Interconnection Customer

Scope of Work

Queue X3-078 Interconnection Customer is responsible for design, construction, and costs for all facilities associated with X3-078 on the Interconnection Customer side of the POI (Point of Interconnection) shown on the single line diagram on the previous page.

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.

All IPR drawings are subject to review by PPL EU. The elementary drawings (potential, current, and control) and the physical layout drawing must be accepted by PPL EU. **The generator will need to include an interlock in their protection scheme to ensure that the generation is not supplied from the Cedar 12kV source**

The PPL EU web site links for the full list of IPR and POC requirements are shown below. NOTE: The preferred IPR relay is the Beckwith M3520.

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_r1.pdf

DTT Relaying Requirements:

Direct Transfer Trip (DTT) protection will be required for the proposed Queue X3-078 interconnection. Queue X3-078 generation will be tripped from Harrisburg 69-12 kV Substation for any condition that would cause the Harrisburg 01-5 12kV line breaker to open.

Queue X3-078 Interconnection Customer will be required to install telephone or fiber based Direct Transfer Trip equipment (matching PPL Electric Utilities equipment) to PPL EU Harrisburg Substation.

If the need arises for PPL to transfer X3-078 to an alternate source, for maintenance, restoration of service, or any other reason, X3-078 will be required to isolate from PPL's system temporarily. This is required since only the Harrisburg 01-5 12 breakers are being modified to

accept X3-078 generation. If X3-078 transfers internally to the Cedar 12 kV supply, the generation must trip off automatically until the Harrisburg 12 kV supply is reestablished.

SCADA Requirements:

PPL EU will require the installation of a PPL EU approved SCADA equipment that will connect to its existing SCADA system. PPL Electric Utilities will supply suitable drawings and a material list for the generator to provide this equipment. The current PPL Electric Utilities design uses commercially available microprocessor based equipment from NovaTech, with the software provided by PPL Electric Utilities.

Telephone and Fiber Circuit Requirements:

PPL EU will require a communication path for DTT, SCADA, and voice. PPL EU anticipates that telephone circuits will be required to establish these paths.

The Interconnection Customer will be responsible to procure the following:

a) DTT communication path between Harrisburg 69-12 kV substation and the IPP (fiber or type PRDA, protective relay-grade telephone circuit).

b) SCADA communication path between the IPP and the PPL Harrisburg Service Center (fiber or type FDDA, 4-wire telephone circuit).

c) A normal dialup telephone line for voice communication.

Phone lines tend to be long lead-time items and must be in place and operational for equipment testing. Therefore once the preferred communication path is known, the Interconnection Customer should secure the necessary fiber paths and/or phone lines as soon as possible.

Fiber:

There are two options for fiber communication.

a) Zayo Bandwidth is the fiber provider in the Harrisburg Metro Loop. The developer could contact Zayo to sequester dark fibers through lease between the required locations. There may be a short fiber build near some of the locations to tie new fiber to available fibers in the Metro Loop.

b) Another option would be to build new fiber along the existing distribution from the developer to Harrisburg substation and into the Harrisburg Service Center. The Interconnection Customer would be responsible for the costs associated with this new fiber build.

Telephone:

If this is the chosen alternative, X3-078 must contact the local telephone company High Voltage Protection Group to begin the engineering review and to initiate the process for

establishing service at X3-078's high voltage facility. Be aware that the DTT (PRDA type telephone lines) are NOT a tariff service, therefore the Interconnection Customer may experience difficulty in obtaining this service.

All installation, maintenance, and monthly lease or billing charges for communications facilities are the responsibility of the Interconnection Customer.

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 X3-078 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.

Isolation Breaker Requirement:

X3-078 Interconnection Customer will need its own isolation breaker that is capable of separating the X3-078 generation from the PPL EU system. This breaker will be operated by the PPL EU Controlled IPR/POC relaying and DTT. 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.

Voltage Regulation Requirements

As required by the PJM Tariff, the Interconnection customer shall design its facility to maintain a composite power factor delivery at continuous rated power output at the point of interconnection at a power factor of at least 0.95 leading (absorbing VARs) to 0.95 lagging (supplying VARs). In order to maintain acceptable voltage regulation on the 12 kV system fed from Harrisburg Substation, studies indicate the X3-078 generation must operate at or below 0.99 leading power factor (absorbing Vars) at the point of interconnection as shown on the single line diagram. If conditions change on PPL's distribution system in the future, X3-078 may be required to operate at a different power factor as specified by PPL.

Interconnected Transmission Owner (PPL EU) Direct Connection Scope of Work

The following distribution and substation modifications will be required in order to accommodate the generation:

a) Distribution work at Harrisburg Substation. (Estimated cost =$67,572)
Replace two existing three phase reclosers on the Harrisburg #1-05 12 kV distribution line with electronic models. Modify devices to sense voltage and block reclosing on an energized line.

b) Harrisburg Substation Modifications (Estimated cost =$173,045)

- Install and configure telephone based DTT equipment.
- Modify the 1-5 12kV protection scheme to include DTT relaying logic.
- Install three phase 12kV line PT's, metering, indication, etc and modify reclosing circuit.
- Tie alarms to SCADA.
- At Harrisburg Substation, a bus differential operation trips both the transformer 12 kV breaker and the bus tie breaker. If an IPP is supplied from one of the 12 kV lines, that 12 kV line breaker is also tripped for the bus differential operation. The reclosing circuit may need to be modified and a DTT signal should be sent to the IPP.

Network Impacts (Transmission)

The Queue Project #X3-078 was studied as a(n) 4.0MW(Capacity 3.0MW) injection at Harrisburg 69-12kV substation in PPL area. Project #X3-078 was evaluated for compliance with reliability criteria for summer peak conditions in 2015. Potential network impacts were as follows:

Generator Deliverability

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

No problems identified.

Multiple Facility Contingency

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

No problems identified.

Short Circuit

(Report Overdutied breakers here)

Not required for the transmission level protection system.

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.)

Steady-State Voltage Requirements

(Results of the steady-state voltage studies should be inserted here)

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.

Delivery of Energy Portion of Interconnection Request

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.

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 will study all overload conditions associated with the overloaded element(s) identified.

None.

Attachment 1
Single Line Diagram