

***Generation Interconnection
Feasibility Study Report***

For

***PJM Generation Interconnection Request
Queue Position Y2-101***

Freemansburg #2 12kV

February 2013

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 landfill gas generating facility located in Bethlehem, Pennsylvania. The installed facilities will have a total capability of 3.2 MW with 3.2 MW of this output being recognized by PJM as capacity. This means that the remaining 0.0 MW will be curtailable should a system reliability constraint occur. The proposed in-service date for this project is December 31, 2013. **This study does not imply a PPL Electric Utilities (PPL EU) commitment to this in-service date.**

Point of Interconnection

Y2-101 will interconnect with the PPL EU system at one of two options. Option 1 is to connect to an existing 12kV circuit (#15-6) from the Freemansburg substation. Option 2 is to connect to a new 12kV circuit from the Freemansburg substation.

Cost Summary

The Y2-101 project will be responsible for the following costs for Option 1:

Description	Total Cost
Transmission Owner facilities	\$ 350,000
Transmission Upgrades	\$ 0
Total Costs	\$ 350,000

The Y2-101 project will be responsible for the following costs for Option 2:

Description	Total Cost
Transmission Owner facilities	\$ 1,050,000
Transmission Upgrades	\$ 0
Total Costs	\$ 1,050,000

Option 1 – Transmission Owner Scope of Work

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

1. Distribution work at Freemansburg Substation. (Estimated cost =\$100,000)

Review protection scheme on the Freemansburg 15-6 line with the addition of Queue Y2-101 Interconnection Customer. Replace any necessary protection equipment and adjust relay settings in order to maintain proper line protection.

2. Quarry Substation Modifications (Estimated cost =\$250,000)

- Install and configure telephone based DTT equipment.
- Modify the Quarry-Hosensack 69kV protection scheme to include DTT relaying logic.
- Install three phase 69kV line PT's, metering, indication, etc and modify reclosing circuit.
- Tie alarms to SCADA.

DTT Relaying Requirements

Direct Transfer Trip (DTT) protection will be required for the proposed Queue Y2-101 interconnection. Queue Y2-101 generation will be tripped from Quarry 230-69 kV Substation for any condition that would cause the Quarry-Hosensack #2 69kV line breaker to open. Additionally, Queue Y2-101 generation will be tripped from Freemansburg 69-12kV Substation for any condition that would cause the Freemansburg 15-6 12kV line breaker to open.

Queue Y2-101 Interconnection Customer will be required to install telephone based Direct Transfer Trip equipment (matching PPL Electric Utilities equipment) to PPL EU Quarry Substation. Additionally, Queue Y2-101 Interconnection Customer will be required to install a fiber link connection to Queue Y2-098 Interconnection Customer's Direct Transfer Trip equipment so that a trip signal is received for any condition that causes the Freemansburg 15-6 12kV line breaker to open.

If the need arises for PPL to transfer Y2-101 to an alternate source, for maintenance, restoration of service, or any other reason, Y2-101 will be required to isolate from PPL's system temporarily. This is required as only the Freemansburg 15-6 12kV line breaker has been modified to accept Y2-101 generation.

Telephone 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:

1. DTT communication path between Quarry 230-69 kV substation and the IPP (Type PRDA, protective relay-grade telephone circuit).
2. DTT communication path between Queue Y2-098 and Queue Y2-101 (Fiber).

3. SCADA communication path between the IPP and the PPL Lehigh Service Center (Type FDDA, 4-wire telephone circuit).
4. 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.

Telephone

If this is the chosen alternative, Y2-101 must contact the local telephone company High Voltage Protection Group to begin the engineering review and to initiate the process for establishing service at Y2-101'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.

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 Freemansburg Substation, the Y2-101 generator must operate such that, at the point of interconnection as shown on the single line diagram, the voltage is maintained at 12.57kV (121 volts on 120 volt base). If conditions change on PPL's distribution system in the future, Y2-101 may be required to operate at a different power factor as specified by PPL.

Option 2 – Transmission Owner Scope of Work

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

1. Freemansburg Substation Modifications (Estimated cost =\$530,000)
 - Install a new 12kV line and terminal.
 - Install and configure telephone or fiber based DTT equipment.
 - Design the 15-NEW 12kV protection scheme to include DTT relaying logic.
 - Install three phase 12kV line PT's, metering, indication, etc and modify reclosing circuit.
 - Install alarms to SCADA.
2. New 12kV Distribution Circuit (Estimated cost =\$520,000)
 - Install a new 3 Phase 12 kV circuit from the 15-NEW circuit breaker to the Y2-101 point of interconnection.

DTT Relaying Requirements

Direct Transfer Trip (DTT) protection will be required for the proposed Queue Y2-101 interconnection. Queue Y2-101 generation will be tripped from Freemansburg 69-12 kV Substation for any condition that would cause the Freemansburg 15-NEW 12kV line breaker to open.

Queue Y2-101 Interconnection Customer will be required to install telephone or fiber based Direct Transfer Trip equipment (matching PPL Electric Utilities equipment) to PPL EU Freemansburg Substation.

If the need arises for PPL to transfer Y2-101 to an alternate source, for maintenance, restoration of service, or any other reason, Y2-101 will be required to isolate from PPL's system temporarily. This is required since only the Freemansburg 15-NEW 12kV breaker is being modified to accept Y2-101 generation.

Telephone and Fiber Circuit Requirements

PPL EU will require a communication path for DTT, SCADA, and voice.

The Interconnection Customer will be responsible to procure the following:

1. DTT communication path between Freemansburg 69-12 kV substation and the IPP (fiber or type PRDA, protective relay-grade telephone circuit).
2. SCADA communication path between the IPP and the PPL Lehigh Service Center (fiber or type FDDA, 4-wire telephone circuit).
3. 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.

1. The developer could contact the area fiber provider to sequester dark fibers through lease between the required locations. There may be a short fiber build near some of the locations in which to tie new fiber to available fibers in the required path.
2. Another option would be to build new fiber along the existing distribution from the developer to Freemansburg substation and into the Lehigh Service Center. The Interconnection Customer would be responsible for the costs associated with this new fiber build.

Telephone:

If this is the chosen alternative, Y2-101 must contact the local telephone company High Voltage Protection Group to begin the engineering review and to initiate the process for establishing service at Y2-101'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.

Voltage Regulation Requirements for Option 2:

In order to maintain acceptable voltage regulation on the 12 kV system fed from Freemansburg Substation, the Y2-101 generation must operate at essentially 100% power factor at the point of interconnection as shown on the single line diagram. If conditions change on PPL's distribution system in the future, Y2-101 may be required to operate at a different power factor as specified by PPL.

Interconnection Customer Requirements

Queue Y2-101 Interconnection Customer is responsible for design, construction, and costs for all facilities associated with Y2-101 on the Interconnection Customer side of the POI (Point of Interconnection).

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 PPL EU website links for the full list of IPR and POC requirements are shown below.

NOTE: The preferred IPR relay is the Beckwith M3520 or SEL-351.

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

Isolation Breaker Requirement:

Y2-101 Interconnection Customer will need its own isolation breaker that is capable of separating the Y2-101 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.

Revenue Metering and SCADA Requirements

PJM Requirements

The Interconnection Customer will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Sections 24.1 and 24.2.

PPL Electric Utilities Requirements

SCADA Requirements:

PPL EU will require Queue Y2-101 to install PPL EU approved SCADA equipment at the Y2-101 generation location that will connect to PPL EU's 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 EU.

Metering and Telemetry Requirements for PPL EU:

New metering equipment is required. It will be provided by PPL EU at no cost to the Interconnection Customer.

Network Impacts

Option 1

The Queue Project #Y2-101 was studied as a 3.2MW (Capacity 3.2MW) injection at the N-031 12.5 kV substation in the PPL area. Project #Y2-101 was evaluated for compliance with reliability criteria for summer peak conditions in 2016. Potential network impacts were as follows:

Generator Deliverability

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

None

Multiple Facility Contingency

(Double Circuit Tower Line contingencies were studied for the full energy output. The contingencies of Line with Failed Breaker and Bus Fault will be performed for the Impact Study.)

None

Short Circuit

(Summary of impacted circuit breakers)

None

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)

None

Steady-State Voltage Requirements

(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

None

Stability and Reactive Power Requirement for Low Voltage Ride Through

(Summary of the VAR requirements based upon the results of the dynamic studies)

None

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

Potential Congestion due to Local Energy Deliverability

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.

Note: Only the most severely overloaded conditions are listed below. 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 shall study all overload conditions associated with the overloaded element(s) identified.

None

Option 2

The Queue Project #Y2-101 was studied as a 3.2MW (Capacity 3.2MW) injection at the FREE 1 12.5 kV substation in the PPL area. Project #Y2-101 was evaluated for compliance with reliability criteria for summer peak conditions in 2016. Potential network impacts were as follows:

Generator Deliverability

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

None

Multiple Facility Contingency

(Double Circuit Tower Line contingencies were studied for the full energy output. The contingencies of Line with Failed Breaker and Bus Fault will be performed for the Impact Study.)

None

Short Circuit

(Summary of impacted circuit breakers)

None

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(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

None

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(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

None

Stability and Reactive Power Requirement for Low Voltage Ride Through

(Summary of the VAR requirements based upon the results of the dynamic studies)

None

New System Reinforcements

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

None

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(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

Potential Congestion due to Local Energy Deliverability

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.

Note: Only the most severely overloaded conditions are listed below. 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 shall study all overload conditions associated with the overloaded element(s) identified.

None

Attachment 1. Single Line Diagram for Option 1

Attachment 2. Single Line Diagram for Option 2