Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position X4-048

Lackawana

May 2012

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 natural gas generating facility located in Lackawanna County, Pennsylvania. The installed facilities will have a total capability of 1000 MW with 1000 MW of this output being recognized by PJM as capacity. This means that the remaining 0 MW will be curtailable should a system reliability constraint occur. The proposed in-service date for this project is June 1st, 2017. **This study does not imply a PPL EU commitment to this in-service date.**

Point of Interconnection

X4-048 will connect with the PPL Electric Utilities (PPL EU) transmission system at one of two options:

Option 1 is to connect via a new 230 kV overhead line which will terminate at the PPL EU Lackawanna 230-69 kV substation.

Option 2 is to connect to via a new 500 kV overhead line which will terminate at the PPL EU Lackawanna 500-230 kV substation.

Cost Summary

X4-048 will be responsible for the following costs:

Type	Cost
Attachment Facilities	$ 12,020,000

Direct Connection Facilities	$ 0
Non Direct Connection Facilities	$ 4,300,000
Total	**$ 16,320,000**

In addition, X4-048 will be responsible for the following network reinforcements:

Type	Cost
New System Reinforcements	$ 450,000
Previously Identified System Reinforcements	$ 0
Total	**$ 450,000**

Note: These reinforcements may be subject to cost allocations which will be confirmed during the System Impact Study phase.

These costs do not include CIAC (Contribution in Aid of Construction) Federal Income Tax Gross Up charge.

Attachment Facilities Cost Estimate

Attachment facilities include the new 230 kV transmission line built from the point of interconnection and spanning approximately 3.6 miles and terminating at Lackawanna substation in a new position on the 230 kV bus. The single line is shown in Attachment 1. The costs shown below do not include CIAC Tax Gross-up. The 230 kV connection estimate is based on the assumption that the new transmission line to the customer will span approximately 3.6 miles.

Description	Total Cost
Transmission Tap Connection Work	$ 11,500,000
Siting Work	$ 520,000
Total Attachment Facilities	**$ 12,020,000**

230 kV Transmission Tap Direct Connection Work

- $11,500,000 - Transmission work for the direct connection (not including siting and right of way)

The X4-048 IPP can be interconnected to the Lackawanna 230 kV substation, which is currently designed to accommodate future 230 kV line expansions in this area of northeast Pennsylvania.

The transmission direct connection cost shown in Attachment 1 includes:

- Rebuilding the Lackawanna-Peckville #3 230 kV line (3 miles) to triple-circuit design, from Lackawanna to Peckville substation. The line should be able to support a single-circuit (s/c) 230 kV line using triple-bundle 1590 ACSR conductor, or equivalent and a double-circuit (d/c) 138/69 kV line using 556 ACSR conductor, or equivalent. The line will initially be built as a s/c 230 kV line with a s/c 138/69 kV line that will extend the Peckville-Varden 69 kV line into the Lackawanna 69 kV yard. The 230 kV line will terminate into the Lackawanna 230 kV substation in bay position 4E.
- From Peckville substation (Grid Block 598N487) to Grid Block 602N485, rebuilding a segment of the existing Blooming Grove-Peckville 230 kV line for approximately 0.5 miles. The line should be able to support a s/c 230 kV line using triple-bundle 1590 ACSR conductor, or equivalent.
- From Grid Block 602N485 to the IPP's switchyard (602-N-484), building a new 230 kV line for approximately 0.1 miles. The line should be able to support a s/c 230 kV line using triple-bundle 1590 ACSR conductor, or equivalent.
- Installing optical ground wire (OPGW) from the Lackawanna 230 kV yard to a dead-end structure in the new X4-048 customer-owned substation for approximately 3.6 miles. PPL EU intends to have all major substation facilities connected to its fiber optic system. A splice point will be necessary to tie the new customer 230 kV substation to PPL EU's fiber optic system.

Note: Before the Impact Study stage, the exact location of the Interconnection Switchyard and the exact location and orientation of the dead-end structure must be identified by the X4-048 IC in order to refine the cost estimate.

230 kV Environmental, Real Estate, and Permitting Issues

- $520,000 – Siting Work

PPL EU is assuming that sufficient right-of-way will be provided by the developer to PPL EU for the construction of the connection to the X4-048 substation. A 150 ft right-of-way width is PPL EU's standard for a 230 kV line. The estimated cost of the 230 kV substation siting work is **not included** in this study.

A "Full Siting Application" (FSA) filing would be required for PUC approval. The estimated time to obtain PUC approval is approximately 12 to 24 months, with an estimated cost of $520,000. Neither the costs nor the schedule include time or money to litigate interveners to the filing. It also does not include extraordinary permitting, threatened and endangered species, or archaeological/historical mitigation.

Direct Connection Facilities Cost Estimate

None

Non-Direct Connection Facilities Cost Estimate

The total magnitude cost of Non-Direct Connection Facilities needed to connect to the Lackawanna 230 kV switchyard is $4,300,000 (excluding any applicable state or federal taxes).

The total preliminary cost estimate for Non-Direct Connection work is given in the following tables below:

For PPL EU building Non-Direct Connection cost estimates:

Description	Total Cost
230 kV Substation w/Metering Non-Direct Connection Work	$ 4,300,000
Total Non-Direct Connection	**$ 4,300,000**

230 kV Substation W/ Metering Non-Direct Connection Work

- $4,300,000 - Substation work at PPL EU Lackawanna 230-69 kV substation

Refer to the information below for direct connection work related to each bay of the Lackawanna 230 kV substation.

At Lackawanna 230 kV Yard - Bay 4 Non-Direct Connection Work

- Install the 4T 230 kV circuit breaker, 3000 amp rating.
- Replace circuit breaker 4E (currently 2000 amp) with a 3000 amp breaker.
- Replace circuit breaker 4W (currently 2000 amp) with a 3000 amp breaker.

- Replace (2) bus disconnect switches (currently 2000 amp) with a 3000 amp rated switches.
- Replace (2) tandem disconnect switches (currently 2000 amp) with a 3000 amp rated switches.
- Replace (3) sections of 2 ips aluminum tube 1623 amp rating with 3000 amp tubing.
- Replace ALL dual 795 conductor (2166 amp) with dual 1590 conductor.
- Review the diagonal insulator support for the heavier tube and conductors.
- Replace (1) set of downcommers with dual 1590, or similar high capacity line conductor.
- Install fiber optic equipment for OPGW on the new line to get to the control cubicle.
- Install fiber optic based DTT equipment.
- Install new line terminal relaying for the new IPP 230 kV line.
- Change, SCADA, AMS, Nameplates, Description of R&C, etc. to reflect the new line arrangement.

At Lackawanna 230 kV Yard - Bay 3 Non-Direct Connection Work

This work may or may not be required, depending on the fault duty and continuous current calculations. This will be determined in the Impact Study.

- Rebuild Bay 3 to 3000 amp capability. This would require replacing all of the 230 kV circuit breakers, all of the disconnect switches (2 bus disconnects, 2 tandem disconnects), and all of the bus conductor and tubing.

At Lackawanna 230 kV Yard - East/West Bus Non-Direct Connection Work

This work may or may not be required, depending on the fault duty and continuous current calculations. This will be determined in the Impact Study.

- Install two new bus structures between bays 2 and 3 to increase the bus fault duty.
- Upgrade the 230 kV yard grounding

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 EU Requirements

SCADA Requirements

PPL EU will require the installation of PPL EU approved SCADA equipment that will connect to its existing SCADA system. PPL EU will provide detailed specifications and design drawings for this equipment.

Metering Equipment Installation at the POI (Point of Interconnection)

Installation of revenue grade Bi-directional Metering Equipment will be required at the Queue X4-048 Point of Interconnection (POI) to measure KWh and KVARh.

PPL EU will review the design of the high voltage metering equipment. PPL EU will supply the required metering equipment but the installation would be borne by the developer including CT/PTs. All metering equipment must meet applicable PPL EU tariff requirements as well as being compliant with all applicable requirements of the PJM agreements. The revenue meters should be housed in a control cabinet or similar enclosure (per PPL EU specification) and must be accessible to PPL EU metering personnel.

Interconnection Customer Facility Requirements

Protection Equipment

At 230 and 500 kV levels, the protection equipment necessary are based on PJM, NERC, FERC, etc, requirements and PPL EU does not use POC or IPR relaying, as this is more like a base load plant. The protection must be suitable for the proposed system and the surrounding or connected lines. This relaying is determined on a case by case basis.

The Interconnection Customer will need to install suitable protection and control equipment based on PPL EU Parallel generation requirements. The new 230 kV customer substation protection must meet all applicable PPL EU, NERC and FERC requirements. The protection equipment and schemes will be identified during the Facilities Study. Relaying requirements for 230 kV and above are not posted, however Intertie Protective Relaying (IPR) and Point of Contact (POC) relaying documents for voltages below 230 kV can be referred to on the PPL EU website. 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

Telephone Circuit Requirements

PPL EU will require a communication path for SCADA and voice circuits. PPL EU anticipates that telephone circuits will be required to establish these paths. The Interconnection Customer will be responsible to procure the following:

a) A 4-wire dedicated FDDA-type phone line for SCADA.
b) 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. The Interconnection Customer should investigate with the local phone company the possibility of obtaining this type of service at their facility.

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

X4-048 Generator Harmonic and Flicker Requirements

On the PPL EU 230 kV system, the total harmonic distortion to the fundamental voltage wave from a single customer is limited to 1.0% of nominal. In addition, no individual harmonic component can exceed 0.7% 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 X4-048's equipment, the Queue X4-048 Interconnection Customer will be responsible for taking corrective measures to mitigate harmonic currents.

Concerning voltage flicker, the X4-048 Project must limit the severity of their voltage variation to within a level which will not cause objectionable flickers 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 will be considered when determining whether a customer's equipment is violating PPL EU flicker guidelines. PPL EU uses the General Electric flicker-irritation curves as a guideline to determine if the system is operating within acceptable limits. **PPL EU will require corrective actions by the X4-048 customer if their operation causes flickers that exceed PPL EU guidelines.** One such correction could be the installation of static var compensators (SVC) to hold a constant voltage.

Preliminary Schedule – 230 kV Option

After the PJM Interconnection Service Agreement and Interconnection Construction Service Agreement are signed, the typical time needed to complete the direct connection work is about 42 months for the transmission work, and 33 months for the substation work. The transmission work time includes acquiring necessary rights-of-way, engineering design, PUC filings, procurement, and construction. The transmission work can be done concurrently with the substation work. Therefore, the overall elapsed time to complete the direct connection work is about 42 months.

Estimate Assumptions for Option 1 Interconnection

- This magnitude estimate has been prepared without extensive research or field review.
- For the new 230 kV Tap from X4-048 to Lackawanna, it is assumed that no new R/W or siting study would be required and the tap would be owned by PPL EU. All required R/W for the tap would be made available to PPL EU by the X4-048 developer at no cost.
- No environmental, real estate, or permitting issues were reviewed for the estimate of this project.

Network Impacts

The Queue Project #X4-048 was studied as a(n) 1000.0MW (Capacity 1000.0MW) injection in to the PPL area. Project #X4-048 was evaluated for compliance with reliability criteria for summer peak conditions in 2015. Potential network impacts were as follows:

Option1: Lackawanna 230kV

Generator Deliverability

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

None.

Multiple Facility Contingency

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

None.

Short Circuit

(Summary form of Cost allocation for breakers will be inserted here if any)

PJM identified 1 new circuit breaker to be over-duty in the PPL area:

Bus No.	Bus	Breaker	Rating Type	Duty Percent With X4-048	Duty Percent Without X4-048	Duty Percent Difference
208052	PECK TR4 230kV	BLOOMING GRO	S	113.70%	95.50%	18.20%

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

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

To be determined during the System Impact Study phase.

Stability and Reactive Power Requirement

(Results of the dynamic studies should be inserted here)

Stability will be determined during the System Impact Study phase.

The PPL EU preliminary load flow studies have indicated that the X4-048 generator will maintain the required voltage regulation on the new substation 230 kV bus within its required range. A voltage schedule will be specified on the new substation 230 kV bus. This will be determined in a later study stage.

New System Reinforcements

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

Please see Attachment 3 for a table summarizing all New System Reinforcements.

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)

(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

1.The emergency rating of this line should be 612 MVA. Therefore, no upgrade is required.

2,3. These overloads will be relieved by applying the operating guides. Please refer to Manual 03 for more information on the operating guides.

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

Option2: Lackawanna 500kV

Generator Deliverability

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

None

Multiple Facility Contingency

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

None

Short Circuit

(Summary form of Cost allocation for breakers will be inserted here if any)

PJM identified 1 new circuit breaker to be over-duty in the PPL EU area:

Bus No.	Bus	Breaker	Rating Type	Duty Percent With X4-048	Duty Percent Without X4-048	Duty Percent Difference
208052	PECK TR4 230kV	BLOOMING GRO	S	100.10%	95.50%	4.60%

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

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

To be determined during the System Impact Study phase.

Stability and Reactive Power Requirement

(Results of the dynamic studies should be inserted here)

Stability will be determined during the System Impact Study phase.

The PPL EU preliminary load flow studies have indicated that the X4-048 generator will maintain the required voltage regulation on the new substation 500 kV bus within its required range. A voltage schedule of 1.05 or higher may be specified on the new substation 500 kV bus. This will be determined in a later study stage.

New System Reinforcements

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

Please see Attachment 4 for a table summarizing all New System Reinforcements.

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)

(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

1,2. These overloads will be relieved by applying the operating guides. Please refer to Manual 03 for more information on the operating guides.

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
System Configuration – Option 1

Attachment 2
System Configuration – Option 2

Attachment 3

New System Reinforcements – Option 1

Circuit Breaker Upgrades

Substation	Circuit Breaker	Upgrade Description	Network Upgrade Number	Upgrade Cost	X4-048 Allocation
Peckville	Blooming Grove	Replace breaker	Pending	$ 450,000	**$ 450,000**
				Total New Circuit Breaker Upgrades	**$ 450,000**