Revised
Generation Interconnection
Feasibility Study Report

For

PJM Generation Interconnection Request
Queue Position X4-021

Peach Bottom-Three Mile Island #2 500kV

August 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 York County, Pennsylvania. The installed facilities will have a total capability of 800 MW with 760 MW of this output being recognized by PJM as capacity. This means that the remaining 40 MW will be curtailable should a system reliability constraint occur.

Point of Interconnection

X4-021 will connect to the PPL Electric Utilities transmission system via a 500 kV switchyard near the 500kV line between PECO Energy's Peach Bottom substation and FirstEnergy's Three Mile Island substation.

Cost Summary

X4-021 will be responsible for the following costs:

Type	Cost
Attachment Facilities	$ 0
Direct Connection Facilities	$ 2,380,250
Non Direct Connection Facilities	$ 250,000
Total	**$ 2,630,250**

In addition, X4-021 will be responsible for the following network reinforcements:

Type	Cost
New System Reinforcements	$ 0
Previously Identified System Reinforcements	$ 10,780,000
Total	**$ 10,780,000**

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

None.

Direct Connection Cost Estimate

Queue X4-021 is responsible for design, construction and costs for all facilities associated with X4-021 shown in Attachment 1 and Attachment 2.

X4-021 will have a 50% allocation for the Direct Connection Facilities that will be constructed to support X4-020. If the X4-020 with withdrawn from the PJM Interconnection Queue, X4-021 will be responsible for all costs associated with the new Direct Connection Facilities.

The total preliminary cost estimate for the X4-020 Direct Connection work along with the allocation for the X4-021 project is given in the table below:

Description	X4-020 Allocation	X4-021 Allocation	Total Cost
New 500 kV switchyard work (includes engineering review, testing and commissioning)	$ 552,500	$ 552,500	**$ 1,105,000**
Installation of 12 miles of OPGW between the new switchyard and TMI	$ 780,000	$ 780,000	**$ 1,560,000**
TMI-Peach Bottom 500 kV line retermination to accommodate X4-020	$ 975,000	$ 975,000	**$ 1,950,000**
Siting/ROW for connecting into the Three Mile Island-Peach Bottom 500 kV line	$ 22,750	$ 22,750	**$ 45,500**
PPL EU Review of drawings and other X4-021 equipment specifications, PPL EU interface in commissioning of X4-021	$	$ 50,000	**$ 50,000**
Total Direct Connection	**$ 2,330,250**	**$ 2,380,250**	**$ 4,710,500**

The transmission and substation costs given exclude any applicable state or federal taxes. If at a future date Federal CIAC taxes are deemed necessary by the IRS for this project, both PJM and PPL EU shall be reimbursed by the Interconnection Customer for such taxes.

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

After the PJM three-party Interconnection Service Agreement (ISA) and Construction Service Agreement (CSA) are signed and PPL EU receives written authorization by PJM to begin work, PPL EU will commence the transmission line siting, engineering design, material purchase and construction of the 500 kV transmission line retermination into the new switchyard described above. The estimate above assumes that X4-021 will do all the siting work and provide all the necessary right-of-way for the new 500 kV switchyard. The time required for siting and right-of-way acquisition for the transmission line work is estimated to be 6-9 months assuming X4-021 is the only landowner involved and is willing to provide the necessary right-of-way. This work

could take longer than expected if X4-021 is not the only landowner involved or if unforeseen complications arise.

The typical time needed to complete the transmission design and construction work is estimated to be approximately 15-18 months. All right-of-way will need to be acquired prior to the start of construction. The scope, schedule and cost of the substation work at Three Mile Island and Peach Bottom will be determined by FirstEnergy and PECO.

500 kV Transmission Tap Direct Connection Work

$ 975,000 TMI-Peach Bottom 500 kV line retermination to accommodate X4-020 (allocation for X4-021)

The transmission direct connection work includes breaking the Three Mile Island-Peach Bottom 500 kV line and reterminating it into a new 500 kV switchyard. The cost estimate for this work is included with the cost of direct connection for X4-020. It is assumed that X4-021 will connect to the same new substation constructed by X4-020. The lead time required for the transmission line direct connection work is approximately **15 to 18 months** (6-9 months for the siting/right-of-way work and 15-18 months for the transmission engineering/construction work, where both can be done concurrently). This estimate assumes that suitable line outages can be scheduled as required to terminate the new tap onto the existing transmission lines. Failure to meet a scheduled line outage may result in project delays. All right-of-way must be acquired prior to construction of the new transmission line.

OPGW Installation

$ 780,000 Installation of 12 miles of OPGW between the new switchyard and Three Mile Island (allocation for X4-021)

To accommodate X4-021, there will be protection equipment and settings changed at Three Mile Island and Peach Bottom Substations. The scope of the work for the affected PPL EU facilities is to install OPGW between Three Mile Island substation and the new switchyard. The cost estimate is included in the cost for X4-020 as it is assumed X4-021 will connect to the new switchyard constructed by X4-020. FirstEnergy and PECO will be providing estimates for the cost of the work which may be required at the terminal ends of the line. It is assumed that OPGW will be used to communicate between Three Mile Island and the new switchyard and that Power Line Carrier (PLC) will be used to communicate between the new switchyard and Peach Bottom Substation.

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 500 kV switchyard to PPL EU's fiber optic system. The estimate assumes that the new OPGW between the new switchyard and Three Mile Island will intersect with existing PPL EU fiber. The fiber path will need to be evaluated if this project proceeds to the Impact Study.

Siting, Right-of-Way Acquisition and Environmental Impact

$ 22,750 Siting/ROW for connecting into the Three Mile Island-Peach Bottom 500 kV line (allocation for X4-021)

PPL EU is assuming that sufficient right-of-way will be provided by the developer to PPL EU for the retermination of the Three Mile Island-Peach Bottom 500 kV line into the new X4-021 switchyard. A 200 ft right-of-way width is PPL EU's standard for 500 kV line construction.

The estimated cost of the siting work is included in with the estimate for X4-020 as it is assumed that X4-021 will connect to the new switchyard constructed by X4-020. It includes the cost of filing a Letter-of-Notification with the PUC for breaking in to the Three Mile Island-Peach Bottom 500 kV line and reterminating it into the new 500 kV switchyard. No condemnation costs are included. Costs for threatened and endangered species studies or environmental constraints are also not included. The estimated cost of the 500 kV switchyard siting work is **not included** in this study.

500 kV Substation Direct Connection Work

$ 552,500 New 500 kV switchyard work (includes engineering review, testing and commissioning) (allocation for X4-021)

The X4-021 developer has requested the option to build (i.e. to engineer and construct) the new 500 kV switchyard that will interconnect the Three Mile Island, Peach Bottom and X4-021 substations. **After the new switchyard is completed by X4-021, the switchyard and land ownership will be turned over to PPL EU.** The new switchyard will be located adjacent to the Three Mile Island-Peach Bottom 500 kV line. The switchyard footprint is expected to have a 1000 foot by 1000 foot fenced in area with additional space for drainage and grading. Approximately 30-50 acres will be required depending on the orientation of the new switchyard. The land should encompass the 500 kV line and PPL EU will require a 400 foot wide right-of-way on each side of the switchyard to allow for future 500 kV lines to terminate in the new yard. The switchyard must also meet all applicable PPL EU, NERC and FERC requirements.

PPL EU will perform engineering review and commissioning of the new 500 kV switchyard and install the necessary DME. Detailed lists of equipment and requirements will be provided during the Facilities Study.

To comply with the PRC-002-RFC-01 standard, PPL EU will install Disturbance Monitoring Equipment (DME) including a Digital Fault Recorder (DFR), a sequence of events recorder (AMS) and, if needed, a digital swing recorder (DDR) at the new 500 kV switchyard. The estimated cost given above is only for the PPL EU portion of the work. Please see the FirstEnergy and PECO sections for the costs associated with the work at Three Mile Island and at Peach Bottom Substations.

Transmission Owner Assumptions in Developing the Cost Estimates

- This magnitude estimate has been prepared without extensive research and field review.
- The estimate is based on the assumption that the Interconnection Customer will provide the required land for the new 500 kV switchyard and the required right-of-way to reterminate the Three Mile Island-Peach Bottom 500 kV line into the new 500 kV switchyard.

- After the 500 kV switchyard is constructed, the switchyard and the land on which the switchyard is placed will be turned over to PPL EU.

- No environmental, real estate, or permitting issues were reviewed for the estimate of this project.

Non-Direct Connection Cost Estimate

X4-021 will have a 50% allocation for the Non-Direct Connection Facilities that will be constructed to support X4-020. If the X4-020 with withdrawn from the PJM Interconnection Queue, X4-021 will be responsible for all costs associated with the new Non-Direct Connection Facilities.

The total preliminary cost estimate for the X4-020 Non-Direct Connection work along with the allocation for the X4-021 project is given in the table below:

Description	X4-020 Allocation	X4-021 Allocation	Total Cost
FirstEnergy: Upgrade line relaying on the at the Three Mile Island terminal of the 500kV line.	$ 125,000	$ 125,500	**$ 250,000**
PECO: Upgrade line relaying on the at the Peach Bottom terminal of the 500kV line.	$ 125,000	$ 125,500	**$ 250,000**
Total Direct Connection	**$ 250,000**	**$ 250,000**	**$ 500,000**

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

Revenue Metering Equipment Installation at the Point of Interconnection

Installation of revenue grade Bidirectional Metering Equipment will be required at the Queue X4-021 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 all the installation cost 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.

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.

Interconnection Customer Facility Requirements

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.

Protection Equipment

The Interconnection Customer will need to install suitable protection and control equipment. The new 500 kV switchyard protection must meet all applicable PPL EU, NERC and FERC requirements. The protection must be suitable for the proposed system and the surrounding or connected lines. This relaying is done on a case by case basis. The protection equipment and schemes will be identified during the Facilities Study.

X4-021 Generator Harmonic and Flicker Requirements

On the PPL EU 500 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 X4-021's equipment, the Queue X4-021 Interconnection Customer will be responsible for taking corrective measures to mitigate harmonic currents.

Concerning voltage flicker, the X4-021 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 X4-021 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.

X4-021 Generator and GSU Modeling for the New 500 kV Switchyard Connection

Per the X4-021 supplied data, the following was used in modeling the generators and GSUs.

Generator 1 & 2:
MVA Base: 240 MVA
Power Factor: 0.85
Saturated sub-transient reactance: 0.1487 pu

Generator 3:
MVA Base: 411 MVA
Power Factor: 0.85
Saturated sub-transient reactance: 0.125 pu

Generators 1& 2 GSU:
MVA Base: 150 MVA
MVA Rating: 150/200/250 MVA
Voltage Levels:18-500 kV
Positive Sequence Impedance: R – 999 jX – 10

Generator 3 GSU:
MVA Base: 270
MVA Rating: 270/360/250 MVA
Voltage Levels: 22-500 kV
Positive Sequence Impedance: R – 999 jX – 10

Network Impacts

The Queue Project #X4-021 was studied as a(n) 800.0MW(Capacity760.0MW) injection as a tap into Peachbotton-ThreeMile 500kV line in the PPL area. Project #X4-021 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)

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)

New Overdutied Circuit Breakers

Bus No.	Bus	Breaker	Rating Type	Duty Without X4-021	Duty With X4-021	Difference
213906	Plymouth Meeting 230kV	698	S	100.10%	100.00%	0.10%

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)

1. The ROCKSPGS-KEENEY 500 kV line (from bus 200051 to bus 200010 ckt 1) loads from 109.42% to 111.08% (DC power flow) of its rating (3014 MVA) for the single line contingency ('PJM40'). This project contributes approximately 65.46 MW to the thermal violation.

```
CONTINGENCY 'PJM40'
  DISCONNECT BRANCH FROM BUS 200013 TO BUS 200024 CKT 1
     /* PEACHBTM LIMERICK 500 500
  END
```

2. The PEACHBTM-LIMERICK 500 kV line (from bus 200013 to bus 200024 ckt 1) loads from 122.8% to 124.86% (DC power flow) of its rating (2598 MVA) for the single line contingency ('PJM27'). This project contributes approximately 56.69 MW to the thermal violation.

```
CONTINGENCY 'PJM27'
  OPEN LINE FROM BUS 200010 TO BUS 200051 CIRCUIT 1
     /* KEENEY EHV - A29 COLL 500
  END
```

Steady-State Voltage Requirements

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

To be determined

Stability and Reactive Power Requirement

(Results of the dynamic studies should be inserted here)

To be determined.

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)

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

Please see Attachment 3 for a table summarizing all Contributions to Previously Identified System Reinforcements.

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 – IC owns Tie Lines

Attachment 2. System Configuration – TO owns Tie Lines

Attachment 3. Contributions to Previously Identified Reinforcements

Transmission Line Upgrades

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
1	Rock Springs – Keeney 500kV Line	Keeney substation: Replace line traps on the 5014 and 5025 lines and replace 500kV circuit breakers. ($2,160,000) Rock Springs substation: Replace the 5025 line disconnects as well as the 52-4 and 52-5 breaker disconnects with ones rated at 4000A. This work is expected to take 12 months to complete. ($1,370,000)	Pending	$ 3,530,000
2	Peach Bottom – Limerick 500kV Line	Limerick and Peach Bottom substations: Replace terminal equipment at each end. This work is expected to take 2 years to complete.	Pending	$ 7,250,000
			Total New Transmission Line Upgrades	**$ 10,780,000**

Circuit Breaker Upgrades

None