Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AE1-225

Milton - Sunbury 69 kV

19.8 MW Energy / 9.4 MW Capacity

February 2019

Introduction

This Feasibility Study has been prepared in accordance with the PJM Open Access Transmission Tariff, 36.2, as well as the Feasibility Study Agreement between the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is PPL Electric Utilities (PPL EU).

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 IC has proposed a solar generating facility located in Snyder county, Pennsylvania. The installed facilities will have a total capability of 19.8 MW with 9.4 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is September 30, 2020. **This study does not imply a PPL EU commitment to this in-service date.**

Point of Interconnection (POI)

AE1-225 will interconnect with the PPL EU transmission system via the Milton-Sunbury 69 kV line. The Point of Interconnection will be where the Customer Interconnection Facilities interconnect with the Transmission Owner Interconnection Facilities. POI specifications can be found below under the Interconnection Customer Requirements.

Cost Summary
AE1-225 will be responsible for the following estimated costs:

Description	Total Cost
Attachment Facilities	$ 1,092,000
Direct Connection Network Upgrades	$ 0
Non Direct Connection Network Upgrades	$ 482,000
Total Costs	**$ 1,574,000**

In addition, the AE1-225 project may be responsible for a contribution to the following costs:

Description	Total Cost
New System Upgrades	$ 0
Previously Identified Upgrades	$ 0
Total Costs	**$ 0**

Cost allocations for these upgrades will be provided in the System Impact Study Report.

Estimated Schedule
The estimated time to complete the scope of work is 12 - 18 months after the PJM three-party Interconnection Service Agreement (ISA) and Interconnection Construction Service Agreement (ICSA) are signed and PPL EU receives Notice to Proceed from the IC.

Assumptions
- Availability of optimal transmission line route
- Outage feasibility not assessed until Facilities Study
- No major environmental, real estate, or permitting issues

Attachment Facilities

The Attachment Facilities will interconnect with the Milton-Sunbury 69 kV line 1.35 miles from the Sunbury Substation and 9.11 miles from the Milton Substation. This scope of work is based on the IC collector substation GPS Coordinates: 40°51'17.43"N, 76°50'18.65"W.

- Replace existing tower with new two pole tap structure. Note that while the Milton-Sunbury line is operated at 69 kV, it is built to 230 kV specifications.
- Extend tap to customer substation dead-end. Design tap for initial and final single circuit.
- Install new MOLBAB (Motor Operated Load Break Air Break switch) on customer tap.

The total preliminary cost estimate for the Attachment Facilities is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
Attachment Facilities	$ 1,092,000

Direct Connection Cost Estimates

None.

Non Direct Connection Cost Estimates

- Model IC in CAPE and conduct a wide area short-circuit study two busses away from the IC facilities. Identify affected relays and revise settings as needed.
- Conduct a review of the IC relay settings and engineering package (submitted by IC to PPL EU).
- The Sunbury-Milton 69 kV line is operated in network and thus scope of work is required at both remote end substations
- The following upgrades are required at **Milton S**ubstation Remote End
    - Install new telephone-based DTT equipment
    - Add telephone facilities accordingly to accommodate the new DTT telephone circuit.
    - Modify the existing Sunbury 69kV #14L circuit breaker protection and control scheme.
    - Modify the existing SCADA for new alarms
    - Modify the existing Alarm Management System (AMS).
    - Install new cables and modify control wiring for the above.
    - Perform system checks and test equipment before placing in service.

- The following upgrades are required at the **Sunbury** Substation Remote End:
    - Install new telephone-based DTT equipment
    - Add telephone facilities accordingly to accommodate the new DTT telephone circuit.

- Modify the existing Milton 69kV #2S circuit breaker protection and control scheme.
- Modify the existing Fairview Tie 69kV #2T circuit breaker protection and control scheme.
- Modify the existing SCADA for new alarms.
- Modify the existing Alarm Management System (AMS).
- Install new cables and modify control wiring for the above.
- Perform system checks and test equipment before placing in service.

- The following is optional, but will increase operational flexibility.
  - Install two new MOLBABs on the Milton – Sunbury 69 kV line on either side of the AE1-225 line tap.

The total preliminary cost estimate for the Non Direct Connection Network Upgrades is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
Remote End Work – Milton Substation	$ 77,000
Remote End Work – Sunbury Substation	$ 116,000
Install Two MOLBABs *(Optional)*	$ 289,000
Total Non-Direct Connection Facility Costs	**$ 482,000**

Interconnection Customer Requirements

Voltage Ride Through Requirements - The Customer Facility shall be designed to remain in service (not trip) for voltages and times as specified for the Eastern Interconnection in Attachment 1 of NERC Reliability Standard PRC-024-1, and successor Reliability Standards, for both high and low voltage conditions, irrespective of generator size, subject to the permissive trip exceptions established in PRC-024-1 (and successor Reliability Standards).

Frequency Ride Through Requirements - The Customer Facility shall be designed to remain in service (not trip) for frequencies and times as specified in Attachment 2 of NERC Reliability Standard PRC-024-1, and successor Reliability Standards, for both high and low frequency condition, irrespective of generator size, subject to the permissive trip exceptions established in PRC-024-1 (and successor Reliability Standards).

Reactive Power - The Generation Interconnection Customer shall design its non-synchronous Customer Facility with the ability to maintain a power factor of at least 0.95 leading to 0.95 lagging measured at the generator's terminals.

PPL EU Interconnection Requirements

PPL EU applicable technical standards that address requirements for interconnection of generation, transmission, and end user facilities can be found at the following link:

https://pjm.com/planning/design-engineering/to-tech-standards/private-ppl.aspx

PPL EU Point(s) of Interconnection (POI) Requirements

The IC will interconnect with the PPL EU transmission system on the Sunbury – Milton 69 kV line. The POI will be where the PPL EU tap line terminates (with insulators) at the first deadend structure inside the IC substation.

The scope of work provided in this Feasibility Study is for facilities to be constructed on the PPL EU side of the POI.

Revenue Metering and SCADA Requirements

PJM Requirements

The IC 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.

Meteorological Data Reporting Requirement

The solar generation facility shall provide the Transmission Provider with site-specific meteorological data including:

- Temperature (degrees Fahrenheit)
- Atmospheric pressure (hectopascals)
- Irradiance
- Forced outage data

PPL EU Requirements

Installation of revenue grade Bi-directional Metering Equipment will be required in the vicinity of the POI to measure kWh and kVARh. PPL EU will design and supply the required metering equipment; all installation costs would be borne by the IC including CTs/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 equipment must provide bidirectional revenue metering (kWh and kVARh) and real-time data (kW, kVAR, circuit breaker status, and generator bus voltages) for the IC's generating resource. The metering equipment should be housed in a control cabinet or similar enclosure and must be accessible to PPL EU metering personnel.

OPTION 1

Network Impacts

The Queue Project AE1-225 project was evaluated as a 19.8 MW (Capacity 9.4 MW) injection tapping the Sunbury-Milton 69kV line (between SELI TP and VIKI TP bus) in the ITO area. Project AE1-225 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE1-225 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis – 2022

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

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)

To be determined during Impact Study

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:
None

Contributions to previously identified circuit breakers found to be over-duty:
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 IC 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

Light Load Analysis

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B)

OPTION 2

Network Impacts

The Queue Project AE1-225 project was evaluated as a 19.8 MW (Capacity 9.4 MW) injection tapping the Lewisburg-Sunbury 69kV line (between SAMA and SUNB YD2 bus) in the ITO area. Project AE1-225 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE1-225 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis – 2022

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

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)

To be determined during Impact Study

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:
None

Contributions to previously identified circuit breakers found to be over-duty:
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 IC 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

Light Load Analysis

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B)