Generation Interconnection

Feasibility Study Report

for

Queue Project AF1-271A

GRATZ 69 KV

10.2 MW Capacity / 17 MW Energy

January, 2020

1 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. Cost allocation rules for network upgrades can be found in PJM Manual 14A, Attachment B. 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 Interconnection Customer seeking to interconnect a wind or solar generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per Schedule H to the Interconnection Service Agreement and Section 8 of Manual 14D.

PJM utilizes manufacturer models to ensure the performance of turbines is properly captured during the simulations performed for stability verification and, where applicable, for compliance with low voltage ride through requirements. Turbine manufacturers provide such models to their customers. The list of manufacturer models PJM has already validated is contained in Attachment B of Manual 14G. Manufacturer models may be updated from time to time, for various reasons such as to reflect changes to the control systems or to more accurately represent the capabilities turbines and controls which are currently available in the field. Additionally, as new turbine models are developed, turbine manufacturers provide such new models which must be used in the conduct of these studies. PJM needs adequate time to evaluate the new models in order to reduce delays to the System Impact Study process timeline for the Interconnection Customer as well as other Interconnection Customers in the study group. Therefore, PJM will require that any Interconnection Customer with a new manufacturer model must supply that model to PJM, along with a $10,000 fully refundable deposit, no later than three (3) months prior to the starting date of the System Impact Study (See Section 4.3 for starting dates) for the Interconnection Request which shall specify the use of the new model. The Interconnection Customer will be required to submit a completed dynamic model study request form (Attachment B-1 of Manual 14G) in order to document the request for the study.

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.

2 General

The Interconnection Customer (IC) has proposed a Solar generating facility located in Dauphin County, Pennsylvania. The installed facilities will have a total capability of 17 MW with 10.2 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is December 15, 2022. **This study does not imply a TO commitment to this in-service date.**

Queue Number	AF1-271A
Project Name	GRATZ 69 KV
State	Pennsylvania
County	Dauphin
Transmission Owner	PPL
MFO	17
MWE	17
MWC	10.2
Fuel	Solar
Basecase Study Year	2023

2.1 Point of Interconnection

AF1-271A will interconnect with the PPL transmission system tapping the Gratz to Gratz TP2 69 kV line.

2.2 Cost Summary

The AF1-271A project will be responsible for the following costs for the physical interconnection of the project:

Description	Total Cost
Attachment Facilities	$ 731,000
Direct Connection Network Upgrade	$ 0
Non Direct Connection Network Upgrades	$ 238,000
Total Costs	$ 969,000

In addition, the AF1-271A project may be responsible for a contribution to the following costs for Network Upgrades to mitigate any overloads identified in this report:

Description	Total Cost
System Upgrades	$ 0

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

3 Transmission Owner Scope of Work

PPL EU can accommodate this interconnection by constructing a transmission line tap with a motor operated switch off the Gratz 69 kV Tap. The PPL EU scope of work also includes remote end relay work at the Sunbury Substation.

Study Assumptions

- IC is responsible for siting and acquisition of easements of Attachment Facilities
- Outage feasibility not assessed until Facilities Study
- No major environmental, real estate, or permitting issues
- IC will procure 3rd party communication circuit for Direct Transfer Trip

3.1 Attachment Facilities

69 kV Transmission Line Tap

The Attachment Facilities will connect to the Gratz 69 kV Tap off the Dauphin – Pine Grove 69 kV line. This scope of work is based on the IC collector substation GPS Coordinates: 40.6148720, -76.7241950.

- Install 69kV tap off the existing Gratz Tap 69 kV line
- Install a single circuit Hi-Lo style tap pole between existing PPL structures 28709S46874 and 28749S46856
- Install Motor Operated Load Break Air Break switch (MOLBAB) and a single terminal tension steel pole as the POI on the tap line.
- Install 180 feet single circuit transmission tap line up to PPL POI terminal pole by utilizing 556 ACSR conductor and single overhead shield wire.

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

Description	Total Cost
69 kV Transmission Line Tap	$ 731,000
Total Attachment Facility Costs	$ 731,000

3.2 Direct Connection Cost Estimate

None

3.3 Non-Direct Connection Cost Estimate

Remote End Work – Sunbury Substation

- 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 following upgrades are required at the Sunbury Substation (SUNB) substation with the IC generating on the Sunbury-Dauphin Line (Gratz Tap) during normal system operation:
    - Install DTT equipment.
    - Connect DTT equipment to new communication path installed between the Sunbury substation and the IC facilities.
    - Modify the existing Sunbury-Dauphin 69kV circuit breaker 10S protection and control schemes.
    - Modify the existing protective relay settings.
    - 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.
    - Update all Sunbury-Dauphin line designations on equipment, panels, and drawings to reference the new IC

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

Description	Total Cost
Remote End Work – Sunbury Substation	$ 238,000
Total Non-Direct Connection Facility Costs	$ 238,000

4 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.

5 Interconnection Customer Requirements

5.1 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

5.2 IC Direct Transfer Trip (DTT) Requirements

PPL EU will require an independent communication path, for Direct Transfer Trip (DTT) of the IC Intertie Protective Relaying (IPR) Fault Interrupting Devices (FIDs), consisting of one communication circuit with the Sunbury Substation.

PPL EU does not have OPGW available on the Gratz Tap 69 kV line available for DTT to the Sunbury Substation. PPL EU assumes that the IC will procure the independent communication path through a third-party provider. Upon request, PPL EU will evaluate the feasibility of installing OPGW on the Gratz Tap 69 kV line for DTT.

6 Revenue Metering and SCADA Requirements

6.1 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 Section 8 of Attachment O.

6.2 PPL 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.

7 Network Impacts

The Queue Project AF1-271A was evaluated as a 17.0 MW (Capacity 10.2 MW) injection tapping the **Gratz to Gratz TP2 69 kV** line in the PPL area. Project AF1-271A was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-271A was studied with a commercial probability of 0.53. Potential network impacts were as follows:

Summer Peak Load Flow

8 Generation Deliverability

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

None

9 Multiple Facility Contingency

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

None

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)

None

11 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

Affected Systems

12 Affected Systems

12.1 LG&E

LG&E Impacts to be determined during later study phases (as applicable).

12.2 MISO

MISO Impacts to be determined during later study phases (as applicable).

12.3 TVA

TVA Impacts to be determined during later study phases (as applicable).

12.4 Duke Energy Progress

Duke Energy Progress Impacts to be determined during later study phases (as applicable).

12.5 NYISO

NYISO Impacts to be determined during later study phases (as applicable).

Short Circuit

13 Short Circuit

The following Breakers are over duty:

None