Generation Interconnection Facilities Study Report

for

PJM Generation Interconnection Request Queue Position AE2-046

Harwood – East Hazleton 69 kV

24 MW Capacity / 50 MW Energy

November 2021

General

This Facilities Study has been prepared in accordance with the PJM Open Access Transmission Tariff §207, as well as the Facilities Study Agreement between Vistra Operations Company LLC as the Interconnection Customer (IC) and PJM Interconnection, LLC as the Transmission Provider (TP). The Interconnected Transmission Owner (TO) is PPL Electric Utilities Corporation (PPL EU).

The IC has proposed a hybrid AC coupled solar and battery storage generating facility located in Schuylkill County, Pennsylvania. The installed facilities will have a total capability of 50 MW (20 MW from solar and 30 MW from battery storage) with 24 MW (12 MW each from solar and battery storage) of this output being recognized by PJM as capacity.

This project is claiming Capacity Interconnection Rights (CIRS) from the deactivated Northeastern Power Company (NEPCO) facility. The proposed in-service date for this project is March 15, 2021. **This study does not imply a PPL EU commitment to this in-service date.**

Point of Interconnection

AE2-046 will interconnect with the PPL EU Transmission System via NEPCO 69 kV tap line off the Harwood – East Hazleton #1 69 kV line. The Point of Interconnection (POI) will be where the PPL EU line tap terminates (with insulators) at the first dead-end structure inside the IC substation.

Cost Summary

AE2-046 will be responsible for the following estimated costs:

Description	Total Cost
Attachment Facilities	$ 22,250
Direct Connection Network Upgrades	$ 0
Non-Direct Connection Network Upgrades	$ 122,494
Allocation for New System Upgrades	$ 0
Contribution to Previously Identified Upgrades	$ 0
Total Cost	$ 144,744

These estimates are applicable based on the assumptions listed in Section 8 of this report. The estimate also excludes any applicable state or federal taxes. If at a future date Federal CIAC (Contribution In Aid of Construction) payments are deemed necessary by the IRS or other governing taxing authority for this project, both PJM and PPL EU shall be reimbursed by the IC for such payments.

A. Transmission Owner Facilities Study Summary

1. Description of Project

AE2-046 is requesting to connect a new AC coupled 20 MW solar and 30 MW battery storage generating facility in Schuylkill County, Pennsylvania. The scope of work includes all necessary Network Upgrades and Attachment Facilities required to connect the new generation to the PPL EU Transmission System. The requested in-service date is March 15, 2021. Attachment Facility and Network Upgrade construction is estimated to be **6 months. This study does not imply a PPL EU commitment to this in-service date.**

2. Amendments to the System Impact Study data or System Impact Study Results

None.

3. Interconnection Customer's Submitted Milestone Schedule

- Substantial site work Completed: 7/1/2022
- Delivery of major electrical equipment: 9/1/2022
- Commercial Operation: 12/31/2022

4. Scope of Customer's Work

The IC is interconnecting at the same POI as the deactivated Northeastern Power Company (NEPCO) facility. AE2-046 will use the NEPCO interconnection substation and Generator Step Up Transformer (GSU). The IC facilities will consist of:

- Solar Generation
    - Thirteen (13) 2.5 MVA TMEIC central inverters (for the solar generation)
    - Each inverter has a 2.5 MVA 13.8 kV / 550 V transformer
- Battery Storage
    - Sixteen (16) 1.98 MVA Parker Inverters (for the battery storage)
    - Each inverter has a 2.2 MVA 13.8 kV / 480 V transformer
- One (1) 50/62.5 MVA 69 kV / 34.5 kV grounded wye / delta Generator Step Up (GSU) transformer
- One (1) fully rated, fault-interrupting circuit breaker on the high-side of the GSU transformer.

AE2-046 will use the existing PPL EU Attachment Facilities for this interconnection. PPL EU owns the tap line up to the dead-end structure inside the IC substation.

The IC will follow PJM telemetry requirements to send real time, generation data to PJM. PPL EU will obtain this data directly from PJM. PPL EU will work with PJM and the IC to ensure the generation data provided to PJM meets PPL EU's needs. The IC must also install the applicable relaying facilities at the IC substation consistent with PPL EU requirements. The IC must procure

a 3rd party communication circuit from the IC substation to the Harwood 69 kV substation for Direct Transfer Trip (DTT) relaying.

5. Description of Facilities Included in the Facilities Study

The PPL EU scope of work consists of completing remote end relay work at the Harwood 69 kV substation and coordinating with the IC on engineering, testing, and commissioning of the facilities. PPL EU will also install new primary and backup revenue grade metering at the IC substation.

6. Total Costs of Transmission Owner Facilities included in Facilities Study

Work Description	Total Cost
Attachment Facilities Primary & Backup 69 kV Revenue Metering	$22,250
Total Attachment Facilities Cost	$22,250
Direct Network Upgrade	$0
Total Direct Network Upgrade Costs	$0
Non-Direct Network Upgrade Relay Modifications Scope of Work at Harwood 69 kV Substation (N7923)	$122,494
Total Non-Direct Network Upgrade Costs	$122,494
Total Network Upgrades	$122,494
Total Project Costs	$144,744

The estimated costs above are based on risks and assumptions listed in Section 8.

7. Summary of Milestone Schedules for Completion of Work Included in Facilities Study:

The estimated duration for the completion of the PPL EU scope of work is **6 months** after the ISA and ICSA are signed, and the Construction Implementation Kick-off Meeting is held. These durations are based on the risks and assumptions listed in Section 8.

8. Project Risks and Assumptions

The following assumption were made in preparing this Facilities Study:

- Suitable line/equipment outages can be scheduled as required. Failure to meet a scheduled facility outage may result in project delays.
- In the event of operational, governmental, and/or environmental regulatory delays, the use of additional resources, such as overtime, premiums for expedited material, and/or contractor labor, may enable PPL EU to decrease the estimated construction period. However, no guarantees can be made.

- The ISA/ICSA must be fully executed by the IC, PJM, and PPL EU, and the construction implementation meeting kick-off meeting must be held before PPL EU design and construction activities may commence.
- Cost estimates are based on conditions when the study is performed and are subject to change based on many factors, including but not limited to, union labor rates and commodity pricing.
- The existing NEPCO Tap 69 kV line does not need any reinforcements prior to interconnection of AE2-046.

B. Transmission Owner Facilities Study Results

1. Transmission Lines – New

None.

2. Transmission Line – Upgrades

None.

3. New Substation/Switchyard Facilities

Attachment Facilities

PPL EU will install, own, and operate new bi-directional primary and backup 69 kV revenue metering equipment at the IC substation.

4. Upgrades to Substation / Switchyard Facilities

Non-Direct Connection Network Upgrade

PJM Network Upgrade Number N7923

Relay Modification Work

The relay modification scope of work to interconnect the AE2-046 project will include the following:

Short Circuit Study

- 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.

Review IC Engineering Package

Conduct a detailed review of the IC relay settings and engineering packaged submitted by IC to the PPL EU. Review should include but not be limited to:

- CT, PT connections
- Trip Circuit

- Relay DC supply
- Check that no customer function logic is included in the Intertie
- IPR must directly trip the breaker, and not via any PLC or other programmable device
- DTT is mapped correctly to the trip

Remote End Work – Harwood 69 kV Substation

- Install new RFL-9745 DTT equipment cabinet next to panel 32R2.
- At a minimum, add a DTT blocking switch to panel 23R1 and DTT test switch into the design.
- Modify the existing 69kV 3S circuit breaker protection and control scheme to incorporate the DTT scheme.
- Modify the existing 69kV 3T circuit breaker protection and control scheme to incorporate the DTT scheme.
- Modify E HAZ1 SEL 2411 to incorporate additional RFL 9745.
- Overall Maintenance switch, 52b, and relay trip should send a DTT through RFL-9745.
- Modify the existing AMS SEL-2440 for new RFL-9745 relay and AMS alarms.
- Modify existing Orion settings.
- Install new cables and modify control wiring for the above.
- Install new telephone board.

5. Metering & Communications

Metering Ownership and Location

PPL EU will own the revenue grade Bi-directional Metering Equipment. It will be located inside the fence of the IC collector substation.

PPL EU Metering 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.

PJM Metering 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.

6. Environmental, Real Estate and Permitting Issues

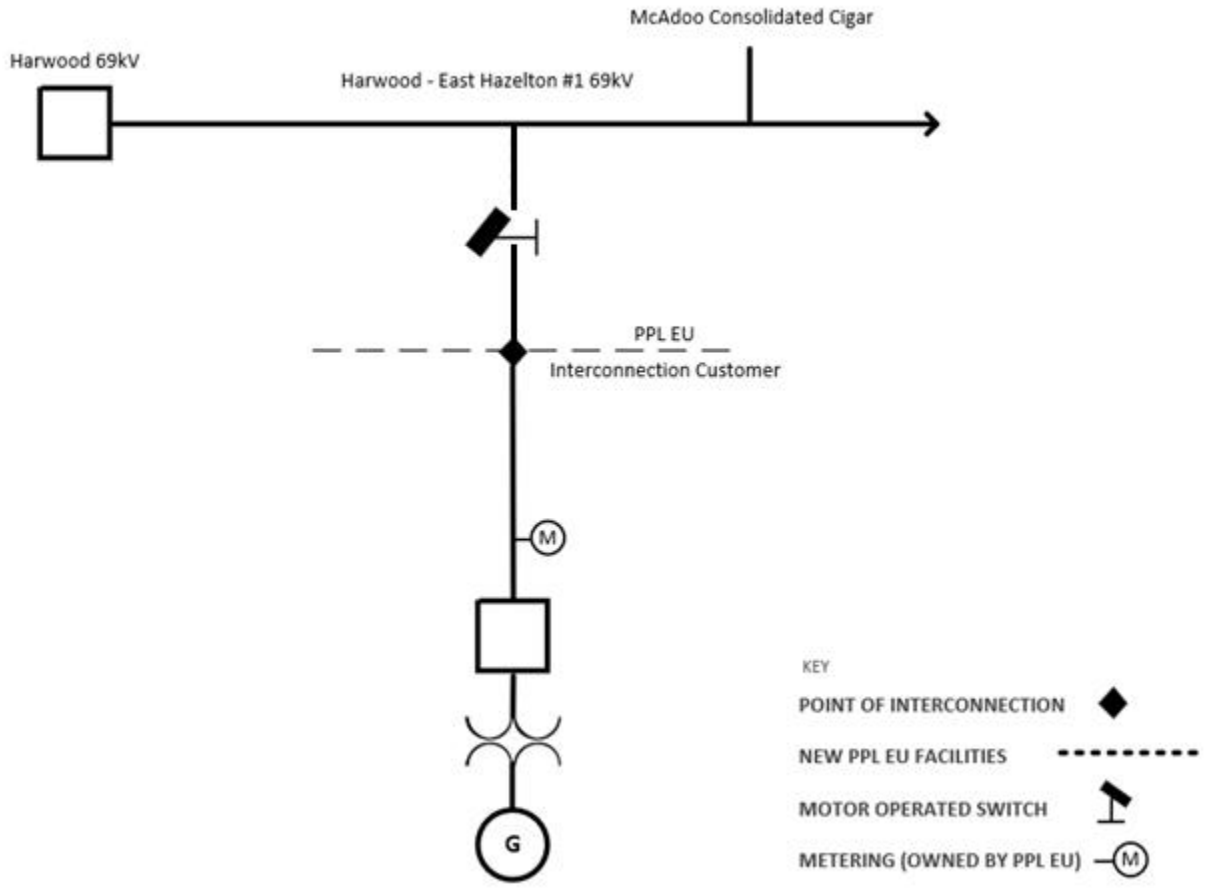
None.

7. Information Required for Interconnection Service Agreement

Description	Direct Labor	Direct Material	Indirect Labor	Indirect Material	Total Cost
Attachment Facilities	$9,247	$10,540	$1,003	$1,460	$22,250
Direct Connection Network Upgrades	$0	$0	$0	$0	$0
Non-Direct Connection Network Upgrades	$93,403	$16,650	$10,134	$2,306	$122,494
Allocation for New System Upgrades	$0	$0	$0	$0	$0
Contribution to Previously Identified Upgrades	$0	$0	$0	$0	$0
Total Cost	$102,650	$27,190	$11,138	$3,766	$144,744

Attachment 1

Single Line Diagram



The Point of Interconnection (POI) is where the PPL EU line tap terminates (with insulators) at the first dead-end structure inside the IC substation.

Attachment 2

Customer Interconnection Requirements

Applicable Technical Requirements and Standards

PPL EU applicable technical requirements and standards that address the 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

For this request, the following documents are applicable:

- PPL Electric Utilities Transmission Facility Interconnection Requirements Revision 0, dated September 18, 2020
- Real Estate, Right of Way Acquisition & Permitting Requirements and Procedures for Independent Power Producers, Revision 0, dated July 17, 2018

IC Substation Intertie Protective Relaying (IPR) and Point of Contact (POC) Fault Interrupting Device (FID) Requirements

IPR FIDs

Based on the latest conceptual single line diagram provided by the IC, the IPR FIDs, one (1) 69 kV rated circuit breakers in this case, shall be equipped with dual trip coils and capable of interrupting worst-case scenario fault currents with a rated speed of three (3) cycles or less. The IPR FID circuit breakers shall be operated by their respective IPR and DTT relaying equipment.

POC FIDs

Based on the latest conceptual single line diagram provided by the IC, the POC FIDs, one (1) 69 kV rated circuit breaker in this case, shall be equipped with dual trip coils and capable of interrupting worst-case scenario fault currents with a rated speed of three (3) cycles or less. The POC FID circuit breakers shall be operated by their respective POC relaying equipment.

IC Direct Transfer Trip (DTT) Requirements

PPL EU requires an independent communication path, for DTT of the IC Intertie Protective Relaying (IPR) Fault Interrupting Devices (FIDs), consisting of one communication circuit with the Harwood 69 kV substation. To ensure reliable communication, the IC shall also provide DTT relaying equipment identical to the PPL EU DTT relaying equipment. All DTT relaying equipment shall connect to the respective communication path. All DTT relaying equipment should reside within the same location as the IPR and POC relaying equipment.

The DTT relaying equipment will communicate via an IC procured 3rd party circuit from the IC substation to the Harwood 69 kV substation.

IC Generator Harmonic and Flicker Requirements

On the PPL EU 69 kV system, the total harmonic distortion to the fundamental voltage wave from a single customer is limited to 1.5% of nominal. In addition, no individual harmonic component can exceed 1.0% 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 the IC equipment, then the IC will be responsible for taking corrective measures to mitigate harmonic currents.

Concerning voltage flicker, the IC 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 POI is generally not acceptable. The frequency and severity of the voltage variation will be considered when determining whether the IC 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 IC 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.

IC Generator Regulation or Reactive Support Requirements

As specified in Part VI, Attachment O Appendix 2 at 4.7.1.1 of the PJM Open Access Transmission Tariff (OATT), the IC 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 high-side of the facility substation transformers.

Power Transformer Requirements

The IC must contact PPL EU prior to ordering or specifying the main power transformer. Depending on the size, location on the PPL EU system, and other concerns, an alternate winding configuration may be specified.

The IC's power transformers at < 200 kV (nominal high voltage values) must have wye-connected, grounded primary windings, with neutral insulation suitable for impedance grounding and delta-connected secondary windings. The IC’s power transformers > 200 kV must have wye-connected, grounded primary windings, with neutral insulation suitable for impedance grounding and wye-connected secondary windings. All three-phase generation must be isolated from PPL EU customers by a power transformer.

IC Generator Voltage Schedule Requirements

Not applicable.