Generation Interconnection Facility Study Report

for

PJM Generation Interconnection Request Queue Position AE1-226

Face Rock – Kinzer #13 69 kV

9.4 MW Capacity / 19.8 MW Energy

Revision 2: November 2020

Revision 1: October 2020

Initial Issue: June 2020

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 **Holtwood Solar 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 solar generating facility located in Lancaster 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 as stated in the Attachment N is September 30, 2020. The updated in-service date to account for the Transmission Owner construction schedule is July 1, 2022. **This study does not imply a PPL EU commitment to this in-service date.**

Revision History:

Revision 1: This October 19, 2020 Facility Study report is a revision to the June 2020 issued report to update the Interconnection Customer entity name and Interconnection Customer Milestone Schedule in section A.3.

Point of Interconnection

AE1-226 will interconnect with the PPL EU Transmission System via a tap of the Face Rock – Kinzer #13 69 kV line between the Face Rock and Wakefield buses. The Point of Interconnection (POI) will be where the IC generator lead line attaches to the PPL EU line tap dead-end structure.

Cost Summary

AE1-226 will be responsible for the following estimated costs:

Description	Total Cost
Attachment Facilities	$ 928,664
Direct Connection Network Upgrades	$ 0
Non-Direct Connection Network Upgrades	$ 204,578
Allocation for New System Upgrades	$ 0
Contribution to Previously Identified Upgrades	$ 0
Total Cost	$ 1,133,242

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) taxes 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 taxes.

A. Transmission Owner Facilities Study Summary

1. Description of Project

AE1-226 is requesting to connect a new 19.8 MW solar generating facility in Lancaster 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 as stated in the Attachment N is September 30, 2020. Attachment Facility and Network Upgrade construction is estimated to be **15 months.** The updated in-service date to account for the Transmission Owner construction schedule is July 1, 2022. **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: December 1, 2021
- Delivery of major electrical equipment: December 1, 2021
- Commercial Operation: July 1, 2022

4. Scope of Customer's Work

The IC is installing a 19.8 MW solar generating facility consisting of:

- Six (6) 3.3 MVA Power Electronics central inverters.
- One (1) 16 MVA 69/34.5 kV grounded wye/grounded wye Generator Step Up (GSU) transformer
- One (1) fully rated, fault-interrupting circuit breaker on the high-side of the GSU transformer.

The IC will own and operate the revenue metering in the substation between the collector bus and the incoming generator lead line. The IC will install a dead-end structure as the POI where the PPL EU 69 kV tap line will terminate from the Face Rock – Kinzer #13 69 kV line. The IC will construct a generator lead line with Optical Ground Wire (OPGW) up to the PPL EU owned dead-end structure on the new line tap. The IC must follow all interconnection requirements including but not limited to protection and control requirements at the IC substation.

The IC will install SCADA per PPL EU standards and specifications. A SCADA point assignment sheet and single line diagram is to be submitted at least 4 months prior to the requested in-service date. The IC will interface with PPL EU SCADA team and follow standard DNP protocol.

The IC will be responsible for all site preparation for the Attachment Facilities, including but not limited to, acquiring all rights-of-way, easements, vegetation clearing, access roads, civil work, and acquiring environmental and local. PPL EU requires a 100 ft. width easement for the 69 kV Attachment Facilities.

5. Description of Facilities Included in the Facilities Study

PPL EU will tap the existing Face Rock – Kinzer #13 69 kV line (FARO-KINZ 13) and install a new single circuit 69 kV line with OPGW to the new dead-end structure outside the IC's substation. PPL EU will also install a Motor Operated Load Break Air Break Switch (MOLBAB) on the tap.

The Face Rock – Kinzer #13 69 kV line is normally operated radially from the with the Face Rock 69 kV substation, thus remote end relay work is required at the Face Rock 69 kV substation. The relays will communicate via existing OPGW on the transmission line.

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

Work Description	Total Cost
Attachment Facilities (N6688) 69 kV Tap line, MOLBAB Switch, Poles, structure and foundations	$835,798
Total Attachment Facilities Cost	$835,798
Direct Network Upgrade	$0
Total Direct Network Upgrade Costs	$0
Non-Direct Network Upgrade Modifications to the Face Rock - Kinzer 69 kV line to tie in the AE1-226 Attachment Facilities (N6689)	$92,866
Non-Direct Network Upgrade Relay Modifications Scope of Work (N6690)	$204,578
Total Non-Direct Network Upgrade Costs	$297,444
Total Network Upgrades	$297,444
Total Project Costs	$1,133,242

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 **15 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.

Activity	Start Month	End Month	Duration
Preliminary Engineering	1	3	3
Detailed Engineering	4	9	6
Construction Planning	10	13	4
Construction & Backfeed	14	15	2

8. Project Risks and Assumptions

The following assumption were made in preparing the AE1-226 Facilities Study:

- There are no major environmental, geotechnical, real estate, or permitting issues.
- There is no cost to PPL EU for easements and real estate acquisition.
- The IC will obtain all permits and approvals necessary for PPL EU owned Attachment Facilities.
- The IC will perform all site preparation for the Attachment Facilities.
- The IC will construct all access roads required for PPL EU's MOLBAB (Motor Operated Load Break Air Break) Switch to PPL EU standards and specifications.
- 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.

B. Transmission Owner Facilities Study Results

1. Transmission Lines – New

Attachment Facilities

PJM Network Upgrade Number N6688

69 kV Line Tap

The IC substation will be installed to the south of the FARO-KINZ 13 line. PPL EU will extend a new 69 kV tap to the new dead-end structure, assumed to be at or near GPS coordinates: 39.832618°, -76.318098°.

PPL EU will tap the existing Face Rock – Kinzer # 13 69 kV (FARO-KINZ 13) line by replacing existing steel monopole 40211S18548 with a new custom steel monopole with a foundation framed as a double-circuit tap structure. PPL EU will tie in the new single circuit conductor off the new DC tap structure arms on the FARO-KINZ 13 side of the structure and extend the conductor to the new PPL EU dead-end structure outside the IC substation. The tap will be designed for initial and final single circuit operation. PPL EU will install a SCADA operated Motor Operated Load Break Switch (MOLBAB) on the tap.

PPL EU will also establish an OPGW fiber path from the existing splice box located at structure 40139S18514 (FARO-KINZ 13 side of structure) to a new splice box located on the PPL EU dead-end structure. The fiber path will consist of 48-ct fiber OPGW strung underbuilt from structure 40139S18514 to new tap pole grid 40211S18548 and continue underbuilt to the first LD pole after the new tap pole. From the first LD pole, the fiber OPGW will transition to overhead as it runs into the PPL EU dead-end and ties into the new splice box. This scope assumes the required ground clearances of the underbuilt OPGW will be able to meet PPL EU internal standards. If maintaining clearances is not possible, the alternative is to install a splice box on the new tap structure and perform a fiber section throw.

2. Transmission Line – Upgrades

Non-Direct Connection Network Upgrade

PJM Network Upgrade Number N6689

Face Rock – Kinzer #13 69 kV line modifications to tie in the new AE1-226 Attachment Facilities. This includes replacement of existing steel monopole 40211S18548 with a new custom steel monopole with a foundation framed as a double-circuit tap structure.

3. New Substation/Switchyard Facilities

None.

4. Upgrades to Substation / Switchyard Facilities

Non-Direct Connection Network Upgrade

PJM Network Upgrade Number N6690

Relay Modification Work

The relay modification scope of work to interconnect the AE1-226 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 – Face Rock 69 kV Substation

- Install new fiber based DTT equipment SEL-2506. There is a 4RU space on Fiber optic panel swing rack which is not enough space to install the required relay, test switches, and the control switches. There is a 10-inch space on Panel 8R (FARO-KINZ 13 line primary panel), which is panel mount style. If this space is not enough for the selected relay, a new panel may be required.
- At a minimum add a DTT blocking switch and DTT test switch into the design.
- Modify the existing Kinzer #13 69 kV 5B circuit breaker protection and control scheme to incorporate the DTT scheme.
- Overall Maintenance switch, 52b, and relay trip should send a DTT through SEL-2506.
- Modify the existing SCADA & annunciator for new SEL-2506 relay and AMS alarms. This requires revising SEL-2533 setting and SCADA files.
- Install new cables and modify control wiring for the above.
- Perform system checks and test equipment before placing in service.

5. Metering & Communications

Metering Ownership and Location

The IC 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

The IC will be required to follow the technical standards, requirements, and procedures for the acquisition and permitting of real estate and right-of-way (ROW). These requirements must be followed if the IC is to acquire real estate or ROW to be owned by PPL EU.

Refer to the link shown below to obtain these requirements:

https://pjm.com/-/media/planning/plan-standards/private-ppl/5474-re-row-acq-and-permit-req-proced-for-ipps.ashx?la=en

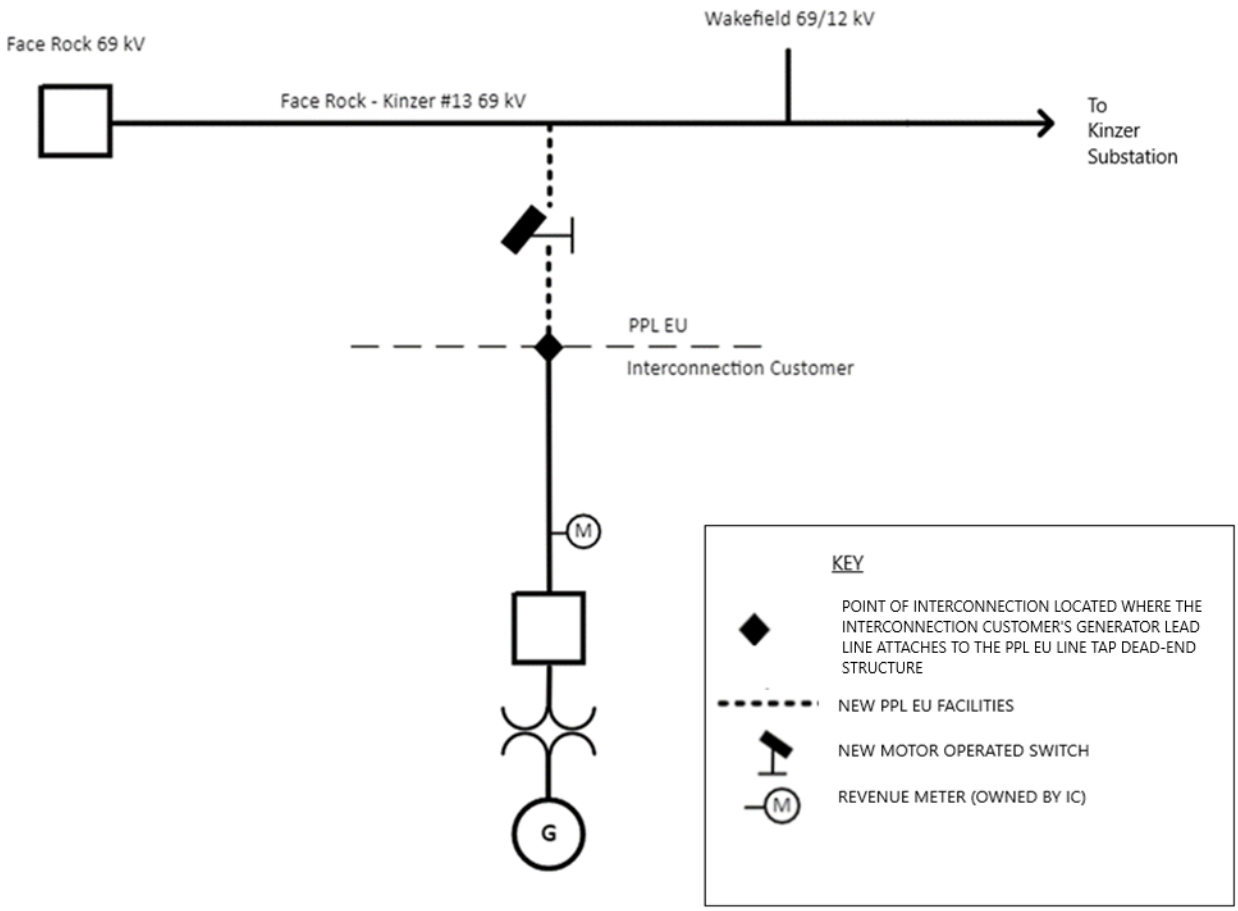
The requirements above apply to the AE1-226 Attachment Facilities.

7. Information Required for Interconnection Service Agreement

Description	Direct Labor	Direct Material	Indirect Labor	Indirect Material	Total Cost
Attachment Facilities	$467,343	$282,898	$49,256	$36,301	$835,798
Direct Connection Network Upgrades	$0	$0	$0	$0	$0
Non-Direct Connection Network Upgrades	$229,943	$38,883	$23,574	$5,044	$297,444
Total Cost	$697,286	$321,781	$72,830	$41,345	$1,133,242

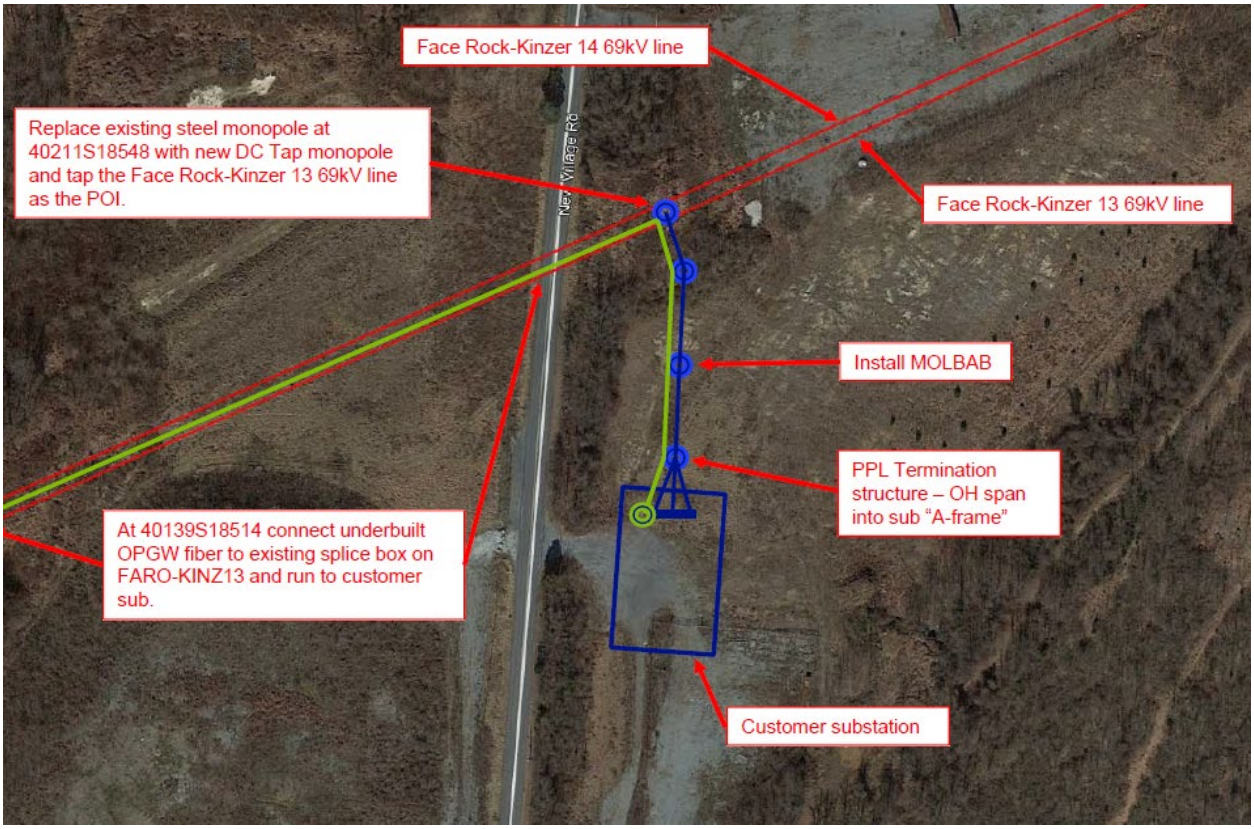
Attachment 1

Single Line Diagram



Attachment 2

Site Plan



The information provided above is not for construction and may be refined during the design and engineering phase of construction.

Attachment 4

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:

- Relay and Control Requirements for Parallel Operation of Generation (69 kV & 138 kV), Revision 0, dated January 31, 2018
- 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, six (6) 34.5 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 SCADA Equipment Requirements

PPL EU will require the installation of PPL EU approved SCADA equipment that will connect to its existing SCADA system to provide real time values of kW, kVAR, and kV metering data at the IC substation. SCADA equipment will also provide capability to trip and monitor the associated IC FID(s). PPL EU will provide detailed specifications and design drawings for this equipment should the IC proceed to an ISA/ICSA.

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 Face Rock 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 OPGW from the Face Rock Substation along the FARO-KINZ 13 line to the IC substation.

IC Generator Harmonic and Flicker Requirements

On the PPL EU 69kV 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.

IC Generator Voltage Schedule Requirements

Not applicable.