# *Generation Interconnection Facility Study Report*

# *for*

# *PJM Generation Interconnection Request Queue Position AD1-143*

# *Hauto-Siegfried 69 kV*

# *90 MW Energy / 11.84 MW Capacity*

**December 2019**

# General

Broad Mountain Power, LLC, the Interconnection Customer (IC), has proposed combined wind and battery storage generating facility located in Carbon County, Pennsylvania. The installed facilities will have a total capability of 90 MW with 11.84 MW of this output being recognized by PJM as Capacity. The breakdown of the project capability is as shown below:

| Fuel | MFO | CIR |
|---|---|---|
| Wind | 80 MW | 11.44 MW |
| Battery | 10 MW | 0.40 MW |
| **Total** | 90 MW | 11.84 MW |

The proposed in-service date for this project is as stated in the Attachment N is December 4, 2019. However, the calculated in service date based on the Transmission Owner's construction schedule is **June 30, 2021**. **This study does not imply a PPL EU commitment to this in-service date.**

## Point of Interconnection

AD1-143 will interconnect with the PPL EU transmission system via the double circuit section of the PA Solar Park 69 kV line which is interconnected to the Hauto-Siegfried #1 and #4 69 kV lines. The Point of Interconnection (POI) will be where the PPL EU tap line terminates (with insulators) at the first dead-end structure inside the IC substation at approximate GPS coordinates 40°52'36.72"N, 75°53'59.20"W.

## Cost Summary

AD1-143 will be responsible for the following estimated costs:

| Description | Total Cost |
|---|---|
| Attachment Facilities | $ 1,102,000 |
| Direct Connection Network Upgrades | $ 0 |
| Non-Direct Connection Network Upgrades | $ 1,823,000 |
| Allocation for New System Upgrades | $ 0 |
| Contribution to Previously Identified Upgrades | $ 0 |
| **Total Cost** | $ 2,925,000 |

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

AD1-143 is requesting to connect a new 90 MW wind and battery storage generating facility in Carbon 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 December 31, 2019. Attachment Facility and Network Upgrade construction is estimated to be **13 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

AD1-143 IC changed the customer facility wind turbine generator model to Siemens-Gamesa SG 4.5-145 and SG 2.625-114.

A re-tool of the stability analysis based on the updated data indicated that the AD1-143 project does not meet the 0.95 leading and lagging reactive power requirement at the high side of the facility transformers. The estimated required additional capacitive reactive power is 8.19 MVAR to fulfill the power factor requirement.

## 3. Interconnection Customer's Submitted Milestone Schedule

- Substantial site work completed: September 30, 2020
- Delivery of major electrical equipment: January 30, 2021
- Commercial Operation: June 30, 2021

## 4. Scope of Customer's Work

Customer Facilities

IC is installing a 90 MW wind and battery storage generating facility in Carbon County, Pennsylvania. The AD1-143 customer facility will consist of:

- 80 MW of wind generation from 16 x Siemens-Gamesa 4.2 MW SG 4.5-145 and 5 x Siemens-Gamesa 2.625 MW SG 2.625-114 Wind Turbines and
- 10 MW Battery Storage from 40 x Siemens Sinacon DC/AC Hybrid converters with 4 MWh LG Chem Battery Storage

The AD1-143 IC is connecting each half of the generation, 40 MW of wind generation and 5 MW of battery storage to separate 34.5/69 kV transformers and 69 kV circuit breakers in a new collector substation. The IC will construct dead-end structures inside the collector substation to which the new PPL EU Attachment Facilities will terminate.

Attachment Facilities

PPL EU will own the Attachment Facilities from the PA Solar Park 69 kV Tap line to the Point of Interconnection at the dead-end structures in the IC collector substation. The IC will construct the approximately 2.7-mile double circuit 69 kV transmission line Attachment Facilities from the Point of Interconnection to the new Motor Operated Load Break Air Break (MOLBAB) structure near the PA Solar Park 69 kV Tap line pursuant to Option to Build. The IC shall perform all siting, permitting, and land procurement activities up to the PPL EU Right of Way (ROW) for the Attachment Facilities. After construction is complete, the IC shall transfer ownership of the Attachment Facilities to PPL EU per the processes in PJM Manual 14C and the Open Access Transmission Tariff (OATT).

Other Considerations

Per the Stability Study performed as a part of the System Impact Study, AD1-143 may not be able to meet PJM's reactive power requirements. This may require AD1-143 to install capacitor banks as a part of the customer facilities.

## 5. Description of Facilities Included in the Facilities Study

PPL EU will tap the existing double circuit 69 kV PA Solar Park Tap line and install a double circuit line parallel and to the west of the existing tap and install two MOLBAB switches. As a result, PPL EU will need to remove two existing manual switches and install two new MOLBABs north of the tap point on the existing PA Solar Park line. This new interconnection will also require remote end relay upgrades at Siegfried 230/69 kV substation, East Palmerton 230/69 kV substation and synchronous check at Palmerton 69/12 kV substation. PPL EU will also perform engineering and construction oversight of the Attachment Facilities to be built by the IC pursuant to Option to Build.

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

| Work Description | Total Cost |
|---|---|
| | |
| **Attachment Facilities (N6308)** | |
| 69 kV Line Tap | $922,000 |
| Transmission Fiber | $150,000 |
| Engineering and Construction Oversight | $30,000 |
| **Total Attachment Facilities Cost** | $1,102,000 |
| | |
| **Direct Network Upgrade** | $0 |
| **Total Direct Network Upgrade Costs** | $0 |
| | |
| **Non-Direct Network Upgrade**<br>Modifications to PA Solar Park Tap 69 kV #1 & #4 (N6309) | $601,000 |
| **Non-Direct Network Upgrade**<br>Relay modification work at remote end substations (N6310) | $1,222,000 |
| **Total Non-Direct Network Upgrade Costs** | $1,823,000 |
| | |
| **Total Network Upgrades** | $1,823,000 |
| **Total Project Costs** | $2,925,000 |

## 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 **13 months** after the ISA and ICSA are signed, and the Construction Implementation Kick-off is held. These durations are based on the risks and assumptions listed in Section 8.

| Activity | Start Month | End Month |
|---|---|---|
| Preliminary Engineering | 1 | 1 |
| Detailed Engineering | 2 | 8 |
| Construction Planning | 9 | 11 |
| Construction & Backfeed | 12 | 13 |

## 8. Project Risks and Assumptions

- No major environmental, geotechnical, real estate, or permitting issues
- Suitable line/equipment outages can be scheduled as required. Failure to meet a scheduled facility outage may result in project delays.
- IC completes construction of Option to Build Attachment Facilities prior to PPL EU Attachment Facilities tie in.
- 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 before and PPL EU design and construction activities may commence.
- Fiber optic communication path is available on the PPL EU Transmission System from the IC Collector Substation to the PPL EU Remote End Substations (Siegfried and East Palmerton) for DTT.
- AD1-143 has selected the option to be sourced from East Palmerton Substation which requires DTT
- The construction timing of Supplemental Projects s0524, s0525, and s0526 with AD1-143 backfeed may impact the project scope and schedule. Status updated on the above supplemental projects are available on the Transmission Construction Status page on the PJM website.

# B. Transmission Owner Facilities Study Results

## 1. Transmission Lines – New

**Attachment Facilities**

*PJM Network Upgrade Number N6308*

Complete all Attachment Facilities scope of work outlined below:

69 kV Line Tap

- Install new 69 kV double circuit line tapping the existing PA Solar Tap using 556 ACSR conductor and dual OPGW.
- Install two MOLBABs (Motor Operated Load Break Air Break) switches on foundation poles. The MOLBABs are to be installed by PPL EU. The transmission lines from the MOLBABs to the AD1-143 substation will be built by the IC.

Transmission Fiber

- Install fiber optic cable splice boxes on new tap poles on PA Solar Tap. Install fiber optic cable on new AD1-143 tap. Install splice boxes and end fiber optic cable at the MOLBABs on the AD1-143 tap.

Engineering and Construction Oversight

PPL EU will perform engineering and construction oversight responsibilities for the construction of the portion of the Attachment Facilities to be built by the IC pursuant to Option to Build.

## 2. Transmission Line – Upgrades

**Non-Direct Connection Network Upgrade**
*PJM Network Upgrade Number N6309*

Modifications to PA Solar Park Tap 69 kV #1 & #4

- Remove switches 52078N25534 and 52072N25531 on the PA Solar Park Tap 69 kV #1 and #4 and install High-Low style tap poles (to be new AD1-143 tap pole).
- Install two MOLBABs between new AD1-143 tap and pole 52071N25552.

## 3. New Substation/Switchyard Facilities

None.

## 4. Upgrades to Substation / Switchyard Facilities

**Non-Direct Connection Network Upgrade**
*PJM Network Upgrade Number N6310*

Complete all relay modification work at remote end substations to interconnect the AD1-143 project:

Remote End Work – Siegfried (SIEG) 230/69 kV Substation

To ensure synchronization and to prevent islanding with the IPP, the following upgrades are required at the Siegfried substation:

- Install new SEL-2506 fiber optic-based DTT equipment.
- Modify the existing Hauto 69kV #1 circuit breaker (HAUTO 1 EAST CB) protection and control scheme to ensure that DTT is properly transmitted to IPP.
- Modify the existing Hauto 69kV #4 circuit breaker (HAUTO 4 EAST CB) protection and control scheme to ensure that DTT is properly transmitted to IPP.
- 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.

Remote End Work – East Palmerton (EPAL) 230/69 kV Substation

To ensure synchronization and to prevent islanding with the IPP, the following upgrades are required at the East Palmerton substation:

- Install new SEL-2506 fiber optic-based DTT equipment. Fiber optic cable will be installed on Siegfried-East Palmerton 1&2 lines including the new tie to the Hauto-Siegfried 1&4 lines under s0525.
- Modify the existing Siegfried 69kV #1 circuit breaker (SIEG 1 CB) protection and control scheme to ensure that DTT is properly transmitted to IPP.
- Modify the existing Siegfried 69kV #2 circuit breaker (SIEG 2 CB) protection and control scheme to ensure that DTT is properly transmitted to IPP.
- Install three (3) new PTs on SIEG 1 breaker line side. Wire secondaries into SIEG 1 SEL-451 relay and set it up for sync checking.
- Install three (3) new PTs on SIEG 2 breaker line side. Wire secondaries into SIEG 2 SEL-451 relay and set it up for sync checking.
- Set up Tie breaker SEL-451 for sync checking.
- 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.

Remote End Work – Palmerton (PALM) 69/12 kV Substation

To ensure synchronization with the IPP, the following upgrades are required at the Palmerton substation:

- Install new SEL-751 sync check relays for 32-1 CB, 32-2 CB and 32-Bus Tie CB.
- Wire existing T1 low side PT secondaries (only 1 phase is needed) into each SEL-751 sync check relay.
- Wire existing T2 low side PT secondaries (only 1 phase is needed, but make sure it is the same phase as T1) into each SEL-751 sync check relay.
- Wire each SEL-751 sync check relay into the closing control schemes of 32-1 CB, 32-2 CB and 32-Bus Tie CB.
- DTT is not required at Palmerton to prevent islanding with the IPP.

Additional Notes

Note that the remote end relay work at East Palmerton and Palmerton Substations described above is only required if the IC in service date is during the construction of PPL EU Supplemental Projects s0524, s0525, and s0526. During these projects, the substation source for AD1-143 may not be in the normal radial configuration from Siegfried Substation. Performing the scope of work at East Palmerton and Palmerton Substations below would enable AD1-143 to

generate when sourced radially from East Palmerton which may occur during construction of s0524, s0525, s0526, and during maintenance activities. The final outage sequence of the supplemental projects is not final and is subject to change at PPL EU discretion.

Additionally, as a part of the s0524, s0525, and s0526, PPL EU is planning to install optical ground wire (OPGW) on the transmission lines from the PA Solar Park Tap to both East Palmerton and Siegfried Substations. For DTT, PPL EU requires an independent pathway between the IC collector substation and the PPL EU substation. If the fiber optic communication path between the IC and Siegfried and/or East Palmerton Substations is not complete when the AD1-143 intends to come in service, the IC will need to procure a 3rd party communication circuit from the IC substation to the PPL EU Substation(s). If a 3rd party communication circuit is required, the relays and equipment specified for DTT will change.

## 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

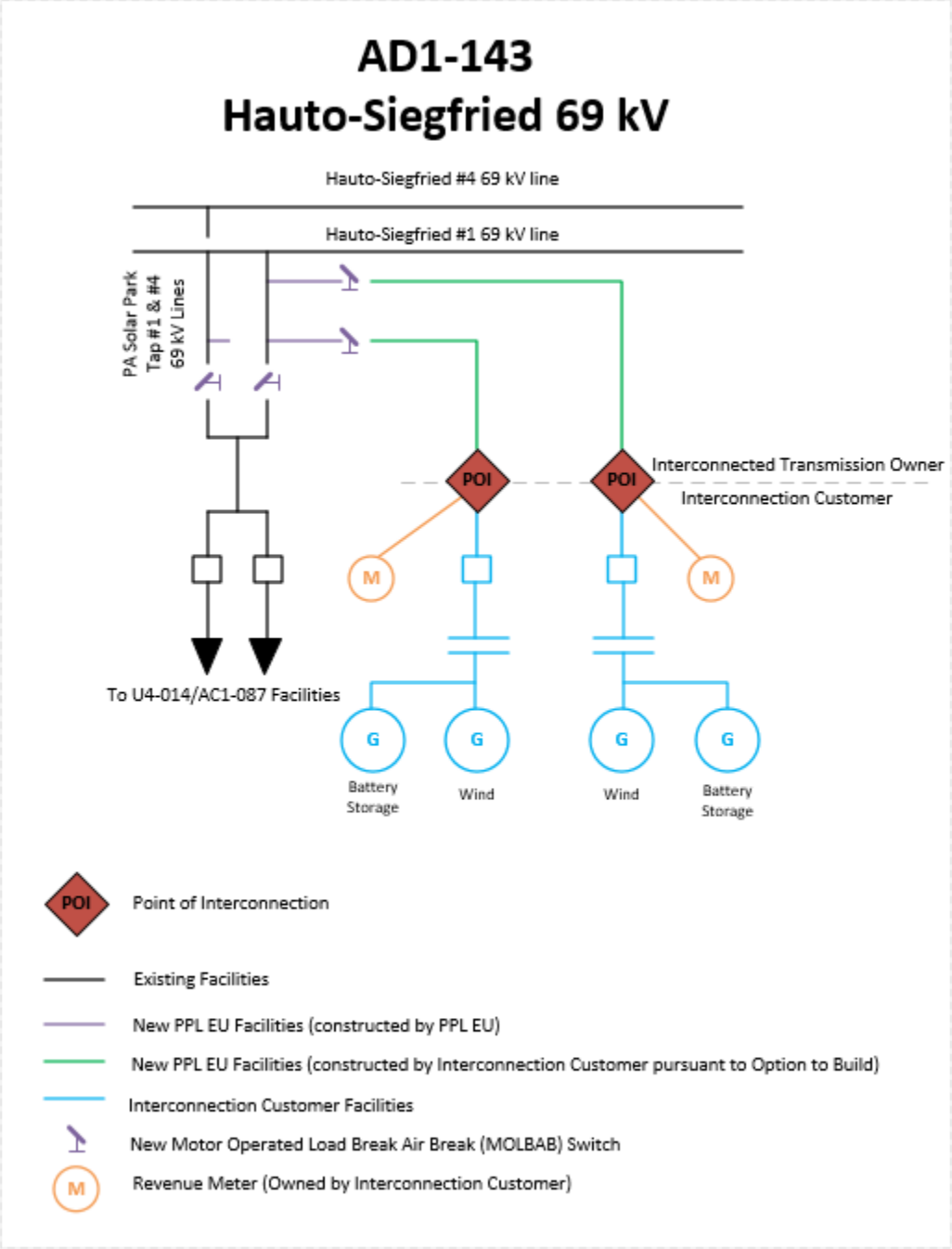
The IC must follow these requirements for the AD1-143 Attachment Facilities.

## 7. Information Required for Interconnection Service Agreement

| Description | Direct Labor | Direct Material | Indirect Labor | Indirect Material | Total Cost |
|---|---|---|---|---|---|
| Attachment Facilities | $718,000 | $275,000 | $77,000 | $32,000 | $1,102,000 |
| Direct Connection Network Upgrades | $0 | $0 | $0 | $0 | $0 |
| Non-Direct Connection Network Upgrades | $1,310,000 | $336,000 | $135,000 | $42,000 | $1,823,000 |
| Allocation for New System Upgrades | $0 | $0 | $0 | $0 | $0 |
| Contribution to Previously Identified Upgrades | $0 | $0 | $0 | $0 | $0 |
| **Total Cost** | $2,028,000 | $611,000 | $212,000 | $74,000 | $2,925,000 |

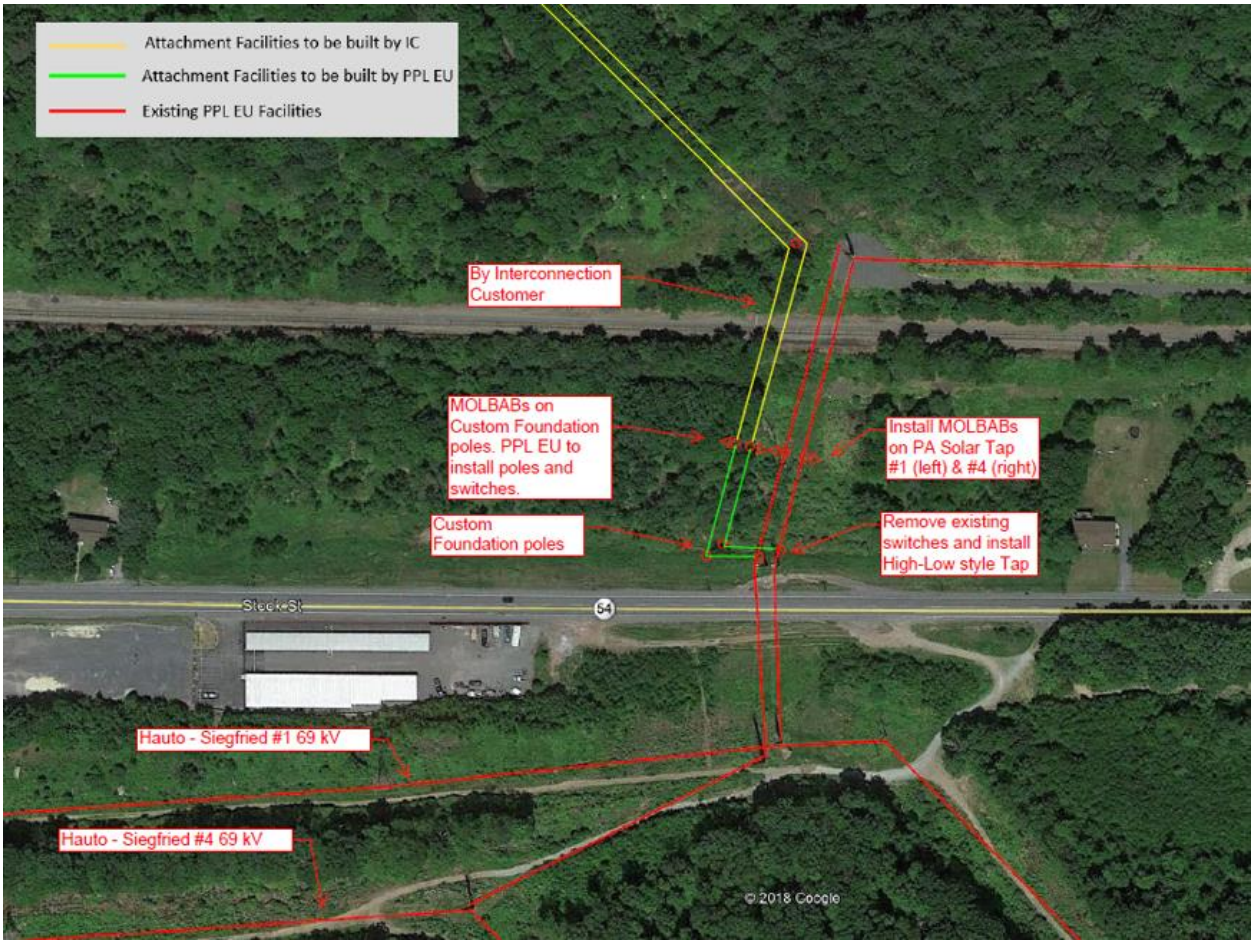
# Attachment 1

## Single Line Diagram



# Attachment 2

## Site Plan




The information provided above will be refined during the design and engineering phase of construction.

# Attachment 3

## Project Location

8 Tonoli Road
Nesquehoning, PA 18240

# Attachment 4

# Customer Interconnection Requirements

## 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, four (4) 34.5kV 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, two (2) 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 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 will require an independent communication path, for DTT of the IC Intertie Protective Relaying (IPR) Fault Interrupting Devices (FIDs), consisting of a fiber optic communication path with the Siegfried substation and potentially East Palmerton 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 fiber optic communication path. All DTT relaying equipment should reside within the same location as the IPR and POC relaying equipment.

Note that if fiber optic cable is not available on the PPL EU Transmission System to the remote source substations, the IC must procure a 3rd party communication circuit for DTT. If a 3rd party communication circuit is required, the relays and equipment specified for DTT will change.

## 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 generator shall 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 high-side of the facility substation transformers.

## IC Generator Voltage Schedule Requirements

The IC shall not alter the voltage along the Hauto-Siegfried #1 and Hauto-Siegfried #4 69kV lines. The 69 kV network voltage is regulated by the PPL EU Transmission Control Center (TCC), via Bulk Electric System power transformer load tap changer adjustments, to ensure that the distribution voltages delivered to PPL EU customers remain within the prescribed secondary bandwidth as mandated by the Pennsylvania Public Utilities Commission (PA PUC). The PPL EU distribution area supply substations, tapped to the 69 kV network, have power transformers that are fixed on particular taps to achieve acceptable voltage ranges on their low sides. Therefore, IC generation that alters the 69 kV voltage on the high side of the distribution area supply substation power transformers will result in voltages on their low sides that may not remain within mandated PA PUC limits.

In lieu of voltage schedules, power factor schedules ensure that PPL EU can maintain acceptable voltage ranges along the impacted 69 kV transmission lines. The expectation is that the 69 kV line voltage will not be altered by the injection of IC generation. Therefore, PPL EU may request an exemption from providing voltage schedules, in accordance with PJM Manual 3 section 3.3, to providing power factor schedules (i.e., MW/MVAR schedules) as an alternative to achieve the desired results on the PPL EU network.