Generation Interconnection Combined Feasibility/System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AB2-012

Paupack 69kV

August 2016

Preface

The intent of the Combined Feasibility/System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

In some instances an Interconnection Customer may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection or merchant transmission upgrade, 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, if any, is included in the System Impact Study.

The 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 associated with them will be addressed when seeking an Interconnection Agreement as outlined below. . Developer will also be responsible for providing and installing metering equipment in compliance with applicable PJM and Transmission Owner standards.

General

IMG Development, LLC, the Interconnection Customer (IC), has proposed a natural gas generating facility located in Wayne County, Pennsylvania. The installed facilities will have a total capability of 19.9 MW with 19.9 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is June 1, 2018. **This study does not imply a PPL Electric Utilities (PPL EU) commitment to this in-service date.**

Point of Interconnection

AB2-012 will interconnect with the PPL EU transmission system from a 69kV line from the Paupack substation.

Cost Summary

The AB2-012 project will be responsible for the following costs:

Description	Total Cost	
Attachment Facilities	$	1,900,000
Direct Connection Network Upgrades	$	0
Non Direct Connection Network Upgrades	$	316,000
Transmission System Upgrades	$	0
Total Costs	**$**	**2,216,000**

Overview

The AB2-012 project is located near Skycrest Road in Hawley, Wayne County, PA approximately at coordinates 41.55956°N, 75.18698°E, which is part of the PPL EU Northeast Region. In order to interconnect with the PPL EU 138/69kV transmission system, PPL EU will tap the existing Blooming Grove-West Damascus 138/69kV line and extend approximately 600 feet northwest before entering the IC substation. The POI will be the first deadend structure inside the IC substation fence.

The 69kV connection estimate is based on the assumptions stated in the following Transmission Attachment Facilities and Non-Direct Connection Work sections. This estimate may vary depending upon the Queue AB2-012 substation location and orientation.

The transmission and substation costs given above exclude any applicable state or federal taxes. If at a future date, Federal CIAC (cost in aid of construction) taxes are deemed necessary by the IRS for this project, both PJM and PPL EU shall be reimbursed by the IC for such taxes.

Note: Before the Impact Study stage, the exact location and orientation of the Interconnection Substation must be identified by the AB2-012 IC in order to refine the cost estimate.

Attachment Facilities ($1,900,000)

PJM Network Upgrade Number n5093

The AB2-012 project is located near Skycrest Road in Hawley, Wayne County, PA approximately at coordinates 41.55956°N, 75.18698°E. In order to interconnect with the PPL EU 138/69kV transmission system, PPL EU will tap the existing Blooming Grove-West Damascus 138/69kV line between the tap to Bohemia and Indian Orchard Substation near grid 70135n51787 (#53) and extend approximately 600 feet northwest before entering the IC substation. To do this, a new 100’ future double circuit custom steel pole tap structure will have to be installed at existing grid location 70135n51787 (#53). The adjacent structure at grid location 70043n51752 (#52) will have to be replaced with a new tension structure in order to avoid issues due to the change in framing from the structure at grid location 70135n51787 (#53).

From the tap location (#53), a single circuit will be brought down to a new 60’ (low) custom steel pole (#55) to cross under the existing Blooming Grove-West Damascus 138/69kV line and attach to a new motor operated load break air break (MOLBAB) switch (#56). After the new MOLBAB, a new LD4 90’ heavy angle guyed structure (#57) will be used to bring the circuit into the IC substation. Refer to Figure 1, “Proposed Layout” for further details.

Existing Line Detail

- Line Name: Blooming Grove-West Damascus 138/69kV
- Existing conductor/OHGW: 3-556.6 kcmil 24/7 ACSR, 3/8” HS Steel OHGW
- Existing structures:
    - 75ft at grid location 69987n51729

- 85ft at grid location 70043n51752 (#52)
- 85ft at grid location 70135n51787 (#53)
- 80ft & 75ft at grid location 70184n51805 (#54A & #54B respectively)

- Existing Right of Way (ROW): 100’

Design & Location Details

Nearest Address: Skycrest Rd, Hawley, Wayne County, PA

Work will be performed on the Blooming Grove-West Damascus 138/69kV line between grid locations 70184n51805 (#54A & #54B) and 69987n51729.

Transmission Design Considerations

- Do not alter loading or line angles on existing structures at grid locations 70184n51805 (#54A & #54B) and 69987n51729.
- Replace structures at grid locations 70043n51752 (#52) and 70135n51787 (#53).
- Install a new 60’ (low) custom steel pole (#55) to redirect the circuit off of structure at grid location 70135n51787 (#53) under the existing Blooming Grove – West Damascus line and towards the IC substation.
- Install new customer interruption device (i.e., MOLBAB) (#56).
- Install new MOLBAB (#58) between replaced structure at grid location 70135n51787 (#53) and existing structure at grid location 70184n51805 (#54A & #54B).
- Install a new 90’ LD4 heavy angle guyed structure (#57).

Steel Poles

- One (1) new 100’ future double circuit custom steel pole to replace structure at grid location 70135n51787 (#53). Approximate weight 13,700# per pole.
- One (1) new 60’ (low) custom steel pole (#55). Approximate weight 8,000# per pole.
- One (1) new 85’ future double circuit custom steel pole to replace structure at grid location 70043n51752 (#52). Approximate weight 11,000# per pole.
- One (1) new customer interruption device (i.e., MOLBAB) (#56). Approximate weight 7,000# per pole.
- One (1) MOLBAB 80’ (#58). Approximate weight 7,000# per pole.
- One (1) LD4 90’ heavy angle guyed structure (#57). Approximate weight 6,000# per pole.

Conductor & OHGW

Conductor: 2000’ - 556.5 kcmil bare 24/7 ACSR (conductor length at 60˚ F for all phases)

OHGW: 1,350’ - 0.567” diameter OPGW (OPGW length at 60˚ F)

Guy: 550’ - ½” 7/0 strand EHS OHGW (Includes enough for one guy per phase)

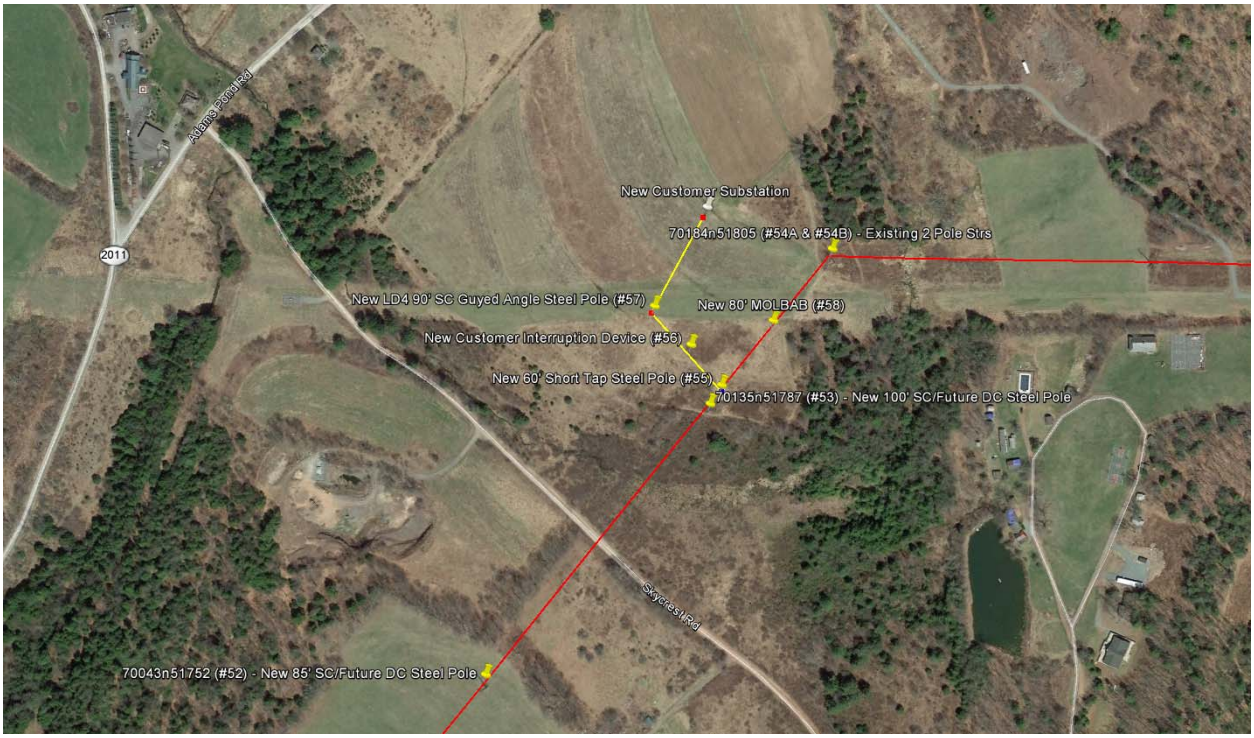

Figure 1: Proposed Layout

Siting/PUC Letter of Notification (LON)

The existing Blooming Grove-West Damascus 138/69kV line is designed and certified as a 138kV line. Therefore, this project will require a PA PUC LON for the new tap to the POI. The lead time required from filing preparation to PA PUC approval is approximately 8 months. The approved filing is needed before construction can start. PPL EU will determine environmental impacts and mitigation strategies of the facilities being certified (i.e. - the transmission lines). These costs to address environmental impacts are not included in this estimate.

Direct Connection Cost Estimate

There are no Direct Connection facilities required to support this request.

Non-Direct Connection Cost Estimate ($316,000)

Two (2) Direct Transfer Trip (DTT) schemes shall be installed; one with the Blooming Grove substation, and another with the Paupack substation. The scope of this work is based on the request of the IC to accommodate both a normal (Blooming Grove) and alternate (Paupack) outlet for DTT.

Required Work at Blooming Grove Substation

PJM Network Upgrade Number n5094

- Install the following equipment in a new DTT cabinet at the Blooming Grove Substation control cubicle:
    - Install fiber-based DTT – One (1) SEL 2440 Discrete Programmable Automation Controller (DPAC) with fuses and test switches.
    - Install one (1) SEL 2830M single-mode fiber optic transceiver/modem.
    - Install new control switches for testing and blocking.
    - Install one (1) new selector switch to initiate DTT from either the normal 69kV West Damascus breaker protection and control scheme or the alternate 69kV Bus Tie breaker protection and control scheme.
    - Run one (1) duplex patch cord fiber optic cable from the new SEL 2830M transceiver/modem to the existing fiber optic patch panel.
    - Install status indication lights.
    - Install associated AC/DC wires with terminal blocks.
    - Install two (2) fiber optic jumper cables inside the existing fiber optic patch panel to continue the Paupack Substation DTT path to the IC substation.
- Tie the DTT scheme into the 69kV West Damascus and the 69kV Bus Tie circuit breaker protection and control schemes, to transmit DTT for tripping of the IC Point of Contact (POC) Fault Interrupting Device (FID).
- Modify SCADA (program new alarms in SCADA for IC).
- Modify Alarm Management System (program new alarms in AMS for IC).

Required Work at Paupack Substation

PJM Network Upgrade Number n5095

- Install the following equipment in a new DTT cabinet at the Paupack Substation control cubicle:
    - Install fiber-based DTT – One (1) SEL 2440 DPAC with fuses and test switches.
    - Install one (1) SEL 2830M single-mode fiber optic transceiver/modem.
    - Install new control switches for testing and blocking.
    - Run one (1) duplex patch cord fiber optic cable from the new SEL 2830M transceiver/modem to the existing fiber optic patch panel. The DTT path will continue on to the IC substation via the Blooming Grove Substation fiber optic patch panel.
    - Install status indication lights.
    - Install associated AC/DC wires with terminal blocks.
- Tie the DTT scheme into the 69kV Honesdale #1 breaker 4T & 4S protection and control schemes, to transmit DTT for tripping of the IC POC FID.
- Modify SCADA (program new alarms for IC).
- Modify AMS (program new alarms for IC).

Assumptions

- New DTT cabinets are operational at both the Blooming Grove and Paupack Substations prior to the IC 's backfeed date.

Schedule

The estimated PPL EU elapsed time to complete the 69kV transmission line Attachment Facilities and Non-Direct Connection substation work is approximately 14 months after the receipt of a fully executed ISA/CSA. The transmission and substation work can be completed concurrently. PPL EU will commence siting, engineering design, material purchase and construction of the facilities identified in this study after receiving written authorization by PJM to begin work.

Transmission Owner Assumptions in Developing the Cost Estimates

- For the custom-designed steel transmission poles, the lead time is approximately 32-42 weeks. It is expected that custom steel poles will be needed for this project.
- During construction, if extreme weather conditions or other system safety concerns arise, field construction may need to be rescheduled, which could possibly delay the schedule.
- This magnitude estimate has been prepared without extensive research or field review.
- Appropriately sized storage laydown area in close proximity to work areas shall be provided by IMG Development, LLC at no cost to PPL.
- Access road to the proposed generation facility shall be provided by IMG Development, LLC – to be utilized by PPL for access to work areas.
- Foundation excavation material has been assumed to be soil as core boring information is not available at this time.
- For the new 69kV tap line, from the existing Blooming Grove-West Damascus 138/69kV line to the POI, the IC will provide sufficient ROW and the line would be owned by PPL EU. It is also assumed that the IC is the landowner.
- No environmental, real estate, or permitting issues were reviewed for the estimate of this project.
- The developer will purchase the property needed for PPL EU's facilities and transfer the rights to PPL EU.
- This schedule assumes that suitable line/equipment outages can be scheduled as required. Failure to meet a scheduled facility outage may result in project delays.
- Excepting any 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 this construction period but no guarantees can be made. It is also assumed that all rights-of-way and easements are secured by the anticipated construction start dates.
- PPL EU recommends that an Interim ISA (IISA) be completed during the Facilities Study stage to address critical path items, such as long lead-time purchases and any other compressed project schedule issues.
- The ISA/CSA/IISA must be signed by the AB2-012 IC, PJM, and PPL EU before any PPL EU design and construction activities may commence.

- Contingency 30% - For this level of study (Feasibility) and size of project, the contingency has been set at 30%.

Interconnection Customer Requirements

Requirement from the PJM Open Access Transmission Tariff:

1. The Interconnection Customer may be required to install and/or pay for metering as necessary to properly track real time output of the facility as well as installing metering which shall be used for billing purposes. See Section 8 of Appendix 2 to the Interconnection Service Agreement as well as Section 4 of PJM Manual 14D for additional information.

IC Generation and Transformation

The following parameters were used in the modeling of the IC facilities:

Generation

- Total Number of Machines: 3 (6.65MW each)
- Total Output: 19.9MW
- MVA Base: 9.071MVA
- Nominal Power Factor: 0.80
- Terminal Voltage: 13.8kV

Transformation

- Total Number of Transformers: 1 (3 Machines per Transformer)
- High / Low Type: 69kV Wye Grounded / 13.8kV Delta
- MVA Base: 20MVA
- Impedance (R + jX) on Base: 0.0079 + j0.0464

IC RTU/SCADA and Voice Communication Circuit Requirements

PPL EU will require independent communication paths for RTU/SCADA and voice circuits. In this case, PPL EU anticipates that either telephone circuits or an IP interface will be required to establish these paths. The IC would be responsible to procure a 4-wire dedicated FDDA-type phone line or DNP over IP (DNP/IP) for SCADA. It is at PPL EU's discretion as to which SCADA (4-wire or DNP/IP) is required to be provided. The IC would also be responsible for establishing a voice circuit via an independent phone line or IP interface.

Phone lines tend to be long lead-time items and must be in place and operational for equipment testing. The IC should investigate with the local phone company the possibility of obtaining this type of service at their facility.

All installation, maintenance, and monthly lease or billing charges for communications facilities are the responsibility of the IC.

IC DTT Requirements

PPL EU will require an independent communication path, for DTT of the IC POC FID, consisting of one fiber optic circuit with the Blooming Grove substation and another with the Paupack substation. The scope of this work is based on the request of the IC to accommodate both a normal (Blooming Grove) and alternate (Paupack) outlet for DTT.

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 independent communication path. The IC would be responsible for splicing to the corresponding fibers inside the OPGW cable attached to the first deadend structure inside the IC substation fence. All DTT relaying equipment should reside within the same location as the Intertie Protective Relaying (IPR) and POC relaying equipment.

IC Protective Relaying Requirements

The IC will need to install suitable protection and control equipment at its facilities based on PPL EU parallel generation requirements. This includes DTT, IPR and POC relaying equipment. Refer to the PPL EU website addresses shown below for the IPR and POC requirements:

IPR Requirements
https://www.pplelectric.com/at-your-service/electric-rates-and-rules/customer-owned-generation.aspx

POC Requirements
https://www.pplelectric.com/at-your-service/electric-rates-and-rules/point-of-contact-requirements-for-high-voltage-facilities.aspx

IC Substation POC FID Requirements

The IC provided POC FID, a 69kV rated circuit breaker/switcher in this case, shall be capable of interrupting worst-case scenario fault currents with a rated speed of 3 cycles or less. The POC FID circuit breaker/switcher shall be operated by its respective DTT, IPR and POC relaying equipment.

IC Generator Harmonic and Flicker Requirements

On the 69kV system, the total harmonic distortion to the fundamental voltage wave is limited to 1.5% of nominal. In addition, no individual harmonic can exceed 1.0% of the fundamental. 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 a customer's 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 OATT, the Project AB2-012 generator shall design its "Facility" to maintain a composite power factor delivery at continuous rated power output at the generators terminals at a power factor of at least 0.95 leading (absorbing vars) to 0.90 lagging (supplying vars).

AB2-012 Generator Voltage Schedule Requirements

The PPL EU preliminary load flow studies have indicated that the AB2-012 generator will maintain the required voltage regulation within required regulations. A MW/MVAR schedule will be provided to the developer at the Facilities Study Stage.

Distribution Service Requirements

The IC must submit a request for electric service through PPL EU"s Industrial and Commercial Services (ICS) group if the queue AB2-012 requires back-up electric service at a voltage less than 69kV. The ICS Help Desk can be reached at 1-888-220-9991. Cost for distribution electric service is NOT included in the PPL scope of work transmission or substation estimates.

Future Conversion of Line to 138kV from 69kV

PPL EU presently has no plans to convert the Blooming Grove-West Damascus 138/69kV line to 138kV in the next 15-20 years. If the transmission system in this area is converted to 138kV in the future, the IC would be responsible for conversion of its substation to 138kV at that time.

PA PUC Certification & Environmental Issues

All required land and ROW will be made available to PPL EU at no cost from the IC developer. It is assumed here that the transmission tap would be owned by PPL EU.

PA PUC certification in the form of a LON will be required because the new 69kV tap is tapping a circuit designed for 138kV.

To avoid overlap of permitting boundaries and duplication of permitting efforts and costs, PPL EU recommends that the IC share pertinent detail with PPL EU during the permitting process.

Revenue Metering and SCADA Requirements

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 Sections 24.1 and 24.2.

PPL EU 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 POC. SCADA equipment will also provide capability to trip and the monitoring of the POC

isolating circuit breaker. PPL EU will provide detailed specifications and design drawings for this equipment should the IC proceed to an ISA/ICSA.

Metering Equipment Installation at the POI

Installation of revenue grade Bi-directional Metering Equipment will be required in the vicinity of the IC POI to measure kWh and kVARh. PPL EU will design and supply the required metering equipment, but all the installation cost would be borne by the developer including CT/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 bi-directional revenue metering (kWh and kVARh) and real-time data (kW, kVAR, circuit breaker status, and generator bus voltages) for the developer'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.

The developer is also required to provide revenue metering (kWh and kVARh) and real time telemetry data (kW, kVAR, and kV) to PJM in compliance with the requirements listed in PJM Manuals M-01 and M-14. Any data from the PPL EU revenue meters can be transferred by fiber optic link to the PJM RTU located at the IC facility.

Network Impacts

The Queue Project AB2-012 was evaluated as a 19.9 MW (Capacity 19.9 MW) injection tapping the Bohemian Tap-Indian Orchard 69kV line in the PPL area. Project AB2-012 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AB2-012 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Base Case Used

Summer Peak Analysis – 2020 Case

Generator Deliverability

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

None.

Multiple Facility Contingency

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

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

None.

Short Circuit

(Summary of impacted circuit breakers)

None.

Affected System Analysis & Mitigation

None.

Delivery of Energy Portion of Interconnection Request

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.

Light Load Analysis – 2020Case

None.

Attachment 1. Single Line Diagram