Generation Interconnection Facilities Study Report

for

PJM Generation Interconnection Request Queue Position AB1-176

"Price 25 kV II"

December 2019
Revised: February 2021

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A. Transmission Owner Facilities Study Summary

1. Description of Project

Cedar Lane Solar Farm, the Interconnection Customer (IC), has proposed a 4.0 MWE (1.51 MWC) solar generating facility to be located on Cedar Lane in Church Hill, MD. PJM studied AB1-176 as a 4.0 MW injection into the Delmarva Power & Light Company's (DPL) system at the Price 69/25kV Substation and evaluated it for compliance with reliability criteria for summer peak conditions in 2019.

The subject generation will require one (1) Point of Interconnection (POI) as a tap off of existing circuit MD#2290 which is fed from Transformer T1 at DPL's 69/25kV Price Substation. This tap line will be of 3-phase overhead construction to the POI location. A fiber optic path between the Price Substation control house and the IC's POI will also be established. A DPL-operated recloser equipped with relaying and communications and utility grade primary metering will be installed at the POI location.

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

The IC has elected to reduce their aggregate generation to 4.0 MWE. As a result, the scope of the project as stated in the Facilities Study, dated December 2019, has changed as follows:

- Previously, two (2) express distribution feeders were required. The reduction in generation capacity will allow the IC's facility to be connected as a 3-phase tap off of an existing DPL circuit.
- Previously, significant substation expansion and upgrades were required to accommodate the connection of two (2) new express feeders. The reduction in generation capacity limits this scope of work to establishing a fiber path between the Price Substation control house and the feeder # MD2290 getaway.

In addition, the estimates herein were performed in more detail than those provided in the Impact Study.

DPL's portion of the project is projected to be completed approximately 12-18 months following receipt of a fully executed interconnection agreement. This schedule assumes standard land use and environmental permitting and approval processes.

3. Interconnection Customer's Milestone Schedule

Substation Work Complete: 6 months prior to ISD
Commercial Operation: March 1, 2024

4. Customer's Scope of Work

The IC assumes full responsibility for the design, permitting, and construction of all facilities associated with the AB1-176 generating station on their side of the Point of Interconnection (POI). Site preparation, including clearing, grading and an access road, as necessary, is assumed to be by the IC. The access road design must be approved by DPL to ensure it provides adequate access to the substation to support construction and maintenance activities. Route selection, line design, and right-of-way acquisition for the

IC's facilities are not included in this report and are the responsibility of the IC. The IC is also required to provide revenue metering and real-time telemetering data to PJM in conformance with the requirements contained in PJM Manuals M-01 and M-14 and the PJM Tariff.

DPL reserves the right to charge the Interconnection Customer operation and maintenance expenses to maintain the Interconnection Customer attachment facilities, including metering and telecommunications facilities, owned by DPL.

This proposed interconnection will be required to satisfy the requirements outlined in IEEE 1547, including but not limited to over/under voltage, over/under frequency and anti-islanding requirements. DPL's system protection group will need to receive the proposed settings for review to ensure compliance with this standard.

The proposed interconnection will be required to satisfy the requirements outlined in DPL's "Technical Considerations Covering Parallel Operations of Customer Owned Generation" document for units greater than 1 MW. DPL's system protection group will need to receive the proposed settings and associated schemes for review to ensure compliance with this standard.

Step-up Transformer Requirements

If the IC elects to use a step-up transformer with a delta high side winding, additional measures are required in order to prevent Temporary-Over-Voltage (TOV) during abnormal conditions. Three phase voltage sensing must be installed on the high side (25 kV) of the generator's transformer. Potential Transformers (PT's) cannot be installed on lower voltage bus. This requirement can be avoided by using a grounded-wye/grounded-wye step-up transformer.

Inverter Requirements

The inverters at the DG location shall have the following capabilities:

- Voltage flicker reduction through dynamic VAR or fixed PF response
- Ramp rate control
- SCADA communications
- Curtailment or other mitigation ability if high voltage were to occur
- Disturbance ride through for both voltage and frequency
- Ability to receive and respond to a transfer trip signal
- Ability to adjust PF or VARs based on utility signal
- Ability to adjust real power output based on utility signal
- Ability to operate on a Volt/VAR schedule
- Ability to maintain a voltage schedule

The inverter shall operate in accordance with the IEEE 1547 series of standards that have been approved and use default settings except when specified otherwise by DPL. The PV owner/operator shall cooperate with DPL to implement these capabilities with settings acceptable to DPL. DPL reserves the right to request setting changes in the future if needed to maintain electrical system integrity. The inverters shall be capable of operating at a fixed power factor value between 0.95 lead and 0.95 lag. The value is supplied below:

1. Operate inverters at leading power factor ("PF") of (**0.95**), absorbing Volt-amps-reactive ("VARs") continuously

Note: In the future, DPL reserves the right to issue new fixed power factor setting requirements (0.95 lead to 0.95 lag) if necessary.

It is the responsibility of the owner to secure the inverter from any unauthorized access (including physical and remote access) which could alter settings or adversely affect the inverter's ability to operate as required. Security measures should include utilizing secure password settings and/or physical locks on cabinet doors.

DPL will require the capability to remotely disconnect the generator from the grid by communication from its System Operations facility. Such disconnection may be facilitated by a generator breaker, a line recloser, or other method depending upon the specific circumstances and the evaluation of DPL.

A mutually acceptable means of interrupting and disconnecting the generator with a visible break, able to be tagged and locked out, shall be worked out with DPL Distribution Engineering. When the trip command is sent to customer equipment rather than a utility owned recloser, the customer must have a circuit breaker capable of locking out, a lockout relay, or inverter logic that does not allow the inverters to automatically reconnect. The IC is responsible for calling DPL System Operations before manually reconnecting with the grid. The phone number to System Operations should be clearly displayed next to the circuit breaker or inverter controls.

As the study was performed with the generator on the transformer that it will be served from during normal conditions, the IC will not be allowed to generate when the feeder either is served by an alternate transformer or is in an alternate configuration.

5. Description of Facilities Included in the Facilities Study (DPL's Scope of Work)

This report describes the electrical interconnection facilities and upgrades to existing DPL facilities necessary to support the IC's generation. The IC's interconnection circuit construction and the IC's generation facilities are not included in this study.

Attachment Facilities – Substation

Scope: A new fiber optic transceiver will be connected to an available serial port on the existing digital relay for feeder # MD2290. This transceiver will interface with the new 48SM ADSS fiber optic cable installed as part of this project (see "Attachment Facilities – Telecommunications" for details of this installation).

<u>Major Substation Equipment to be Installed</u>

- None

Substation Assumptions

- The existing digital relay for feeder # MD2290 is acceptable for providing protection and relaying to the new recloser at the POI.

Attachment Facilities – Distribution

Scope: One (1) new approximately 0.15-mile long 25kV 3-phase tap with 477 AAC conductors will be constructed. This line will intercept the existing feeder # MD2290 as a tap between the existing dead-end and terminal poles to the west of Price Substation. A DPL-owned and -operated recloser equipped with relaying and communications will be installed at the POI location.

A three-phase 25 kV revenue metering point needs to be established on the IC side of the POI recloser. See Section B.7 of this report for a detailed scope of work.

Major Distribution Equipment to be Installed

- 3-phase pole-mounted recloser with disconnect and bypass switches, surge arresters, and transformer
- Recloser control cabinet with relay
- 3-phase pole-mounted revenue grade metering transformers with disconnect switches and surge arresters
- Revenue quality meters
- 477 AAC conductor
- Wood poles, 3-ph. cross-arm construction
- Insulators, connectors, fittings, grounding, etc.

Distribution Assumptions

- From the riser poles near Cedar Lane, the tap line will be of 3-phase overhead construction on one single-circuit pole line.
- No foundations are needed; all poles are direct-embedded wood poles.
- The tap line will cross under the existing 69kV Church – Wye Mills line, but transmission underbuild will not be required.

Attachment Facilities – Telecommunications

Scope: A 48SM ADSS fiber optic cable is to be installed on the poles along the new feeder tap. This cable will originate at the Price Substation control house and will exit the substation aerially alongside the existing feeder getaway, supported by messenger wire. This cable will support remote control and status of the POI recloser, control and status of the IC's equipment as required, telemetry, and direct transfer trip of the recloser.

Major Telecommunications Equipment to be Installed

- 48SM ADSS fiber optic cable

6. Total Cost of Transmission Owner Facilities Included in the Facilities Study

Item	*Total Cost*
Non-Direct Connect Facilities	$499,396
Total Cost	**$499,396**

7. Summary of the Schedule for Completion of Work for the Facilities Study

The overall estimated timeline for this project, including upgrades, is approximately 12-18 months after receipt of a fully executed interconnection agreement. This timeline assumes availability of required outages, TO resources, and optimal electric system conditions.

Attachment Facility	*Timeframe*
Engineering, Procurement, and Construction	12-18 months

B. Transmission Owner Facilities Study Results

This section describes facilities identified to be installed, replaced, and/or upgraded by DPL to accommodate the project. During detailed design and analysis other components may be identified for installation or replacement due to this interconnection.

1. Transmission Lines – New

Not applicable

2. Transmission Lines – Upgrade

Not applicable

3. Distribution Lines – New

- Install 3-phase pole-mounted recloser with switches, arresters, and transformer at the POI location
- Install recloser control cabinet with relay at the recloser location
- Install 3-phase pole-mounted revenue grade metering transformers with arresters and disconnect switches at the POI location
- Construct 3-phase single-circuit overhead 25kV tap line between the riser pole at Price Substation and the POI location (477 AAC)
- Install revenue meters at the POI location

4. New Substation/Switchyard Facilities

Not applicable

5. Substation/Switchyard Facility Upgrades

Not applicable

6. Telecommunications Facility Upgrades

- Install one (1) 4-inch PVC conduit below grade between the Price Substation control house to the feeder # MD2290 box structure.
- Install approximately 0.15 miles of 48SM ADSS fiber optic cable from the Price Substation control house to the POI. It will be routed below grade from the control house to the feeder # MD2290 box structure where it will then transition to overhead construction to reach the POI location.
- Connect fiber optic cables to the recloser's controls.

Drawing Review and Relay Test
DPL will review the IPR cabinet drawing PRIOR TO THE PURCHASE OF EQUIPMENT then test for proper relay operation after installation of the required protection equipment at IC site.

7. Metering & Communications

Metering
DPL will purchase all metering instrument transformers and related surge arresters and switches and will install them on a DPL-supplied wood pole at the POI location. All secondary metering wiring will be completed by DPL. The metering control cable and meter cabinet will be supplied and installed by DPL. DPL meter technicians will program and install two solid state multi-function meters (Primary & Backup) for the new metering position. The primary meter will be equipped with load profile, telemetry and DNP V3.00 communications protocol via serial ports (RS-485 for IC's use and RS-232 for DPL's use).

DPL will supply a wireless modem for MV90 interrogation. In the event that a wireless modem is unable to reliably communicate, the IC will be required to make provisions for a POTS (Plain Old Telephone Service) line or equivalent technology approved by DPL within approximately three feet of the DPL metering position to facilitate remote interrogation and data collection. The IC should submit this request as early as possible since it can take a substantial amount of time for the phone company to install this line.

The location of the metering cabinet will be determined in the construction phase. The IC will provide 120 VAC power to the primary meter location.

Telemetry
It is the IC's responsibility to send the data that PJM and DPL requires directly to PJM. The IC will grant permission for PJM to send DPL the following telemetry that the IC sends to PJM: real time MW, MVAR, volts, amperes, generator status, and generator breaker position. Meter interval data (MWH and MVARH) will be brought back to the DPL's System Operations facility via MV90.

High Voltage Warning
Typically, voltage received at the IC's meter from the utility can be up to 105% of nominal (without generation on). Normal operating procedures dictate that voltage at the substation be raised to the higher end of an acceptable bandwidth in order to provide adequate supply to distant customers. It is recommended that the IC use step-up transformers with no load taps at the POI to adjust secondary voltage to avoid the possibility of inverter trips. Failure to account for this may result in lost energy production.

8. Environmental, Real Estate and Permitting

Permitting and Real Estate
All work to accommodate the interconnection of AB1-176 is dependent upon the IC obtaining all necessary permits. Moreover, the IC shall be responsible for acquiring all necessary real property rights and acquisitions, including but not limited to: rights of way, easements, and fee simple, in a form approved by DPL. Any setbacks in obtaining the necessary real property rights, acquisitions and permits required for this interconnection may delay the construction schedule.

Environmental
Environmental permits will need to be secured in order to interconnect the generating facility to Price Substation along the path of the new feeder. This estimate assumes that all the applicable permitting will be obtained for the generating facility by the IC.

9. Summary of Results of Study

- Construction Oversight Estimate: $ 88,649
- Engineering, Procurement and Construction: $ 410,747

Generation projects meeting IRS "Safe Harbor" provisions generally do not incur "CIAC"(Contribution in Aid to Construction), a tax collected by the utility for the state or federal government. DPL does not expect to collect CIAC for this project. If for any reason, "CIAC" would be required for this project, it would be the responsibility of the party owning the generator to pay this cost.

DPL reserves the right to charge the Interconnection Customer operation and maintenance expenses to maintain the Interconnection Customer attachment facilities, including metering facilities, owned by DPL.

10. Schedules and Assumptions

The DPL schedule is based on a 12-18 month lead-time from receipt of a fully executed interconnection agreement, including the assumption that it would not be impacted by storm damage and restoration, time of year limitations, permitting issues, outage scheduling, system emergencies, and contractor and equipment availability.

It is important to note that this project will be incorporated into the existing project workload at DPL at the time of contract execution. If the workload of existing projects is extensive, resource constraints may cause this project to be delayed beyond the projected in-service date.

Attachment #1