Generation Interconnection Facilities Study Report

For

PJM Generation Interconnection Request Queue Positions AB1-162/AB2-063

"Price 69 kV"

May 2019

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A. Transmission Owner Facilities Study Summary

1. Description of Project

Casper Solar Center, LLC, the Interconnection Customer (IC), has proposed two solar projects, AB1-162 and AB2-063 to be located in Church Hill, Maryland. AB1-162 is a 16.7 MW Maximum Facility Output (6.34 MW Capacity) solar generating facility. AB2-063 is a 20 MW MFO (7.6 MW Capacity) solar generating facility. PJM studied AB1-162/AB2-063 as a combined 36.7 MW (13.94 MW Capacity) injection into the Delmarva Power & Light Company's (DPL) system and evaluated it for compliance with reliability criteria for summer peak conditions in 2019.

The AB1-162/AB2-063 project will require a 69 kV Point of Interconnection (POI) off DPL's Price Substation in Queen Anne's County, Maryland. To accomplish this new interconnection, the existing Price Substation will need to be expanded from its present transmission line tap configuration to a five-position ring bus. The new configuration will have one terminal for Line 6710 (to Church Substation), one terminal for Line 67XX (to Wye Mills Substation), one terminal for existing Price Transformer T1, one mobile substation terminal, and one terminal for the AB1-162/AB2-063 interconnection. The existing Line 6710 will be reconfigured to loop in and out of the new ring bus at Price Substation.

The IC is required to construct a switching station within 500 feet of the Price Substation yard. This station will contain a circuit breaker and the revenue metering equipment and will act as the POI. A short line/bus will connect the POI station to the terminal in the Price Substation yard (see Attachment #1).

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

A more detailed substation layout and additional site evaluations have been completed since the Impact Study was submitted in September 2016. This more detailed investigation has caused the scope to change as follows:

- Previously, approximately one acre of land was going to be purchased to the east of the existing substation yard to accommodate the expansion. This land is no longer available for purchase. As a result, all expansion will need to be completed on DPL's existing land. Portions of the substation fence will need to be moved out (closer to the property lines) to accommodate the ring bus. Significant grading work on the east side of the substation property will also be required.
- Previously, it was assumed that the existing control enclosure at Price Substation could accommodate all new equipment for this project. Upon further investigation, it was determined that this is not possible and that a new pre-fabricated control enclosure will now be required, replacing the existing one. The pre-fabricated control enclosure manufacturer will install and wire all relay panels in the factory to reduce field work and outage duration.
- The previous scope was for a four-position ring bus. The scope has been revised to a five-position ring bus, with the added position being for a mobile substation connection point. The existing mobile substation connection point cannot remain in its present location due to space constraints in the yard.

- For the AB2-063 project, the overloads identified in the System Impact Study Report (MIDLTNTP-MT PLSNT 138 kV; AND TOWNSEND-MIDLTNTP 138 kV) are no longer required due to prior queue projects dropping from the queue.

3. Interconnection Customer's Milestone Schedule

The planned in-service date, as requested by the IC during the project kick-off call, was July 1, 2017. This date was not attainable due to the need for required PJM studies and the Transmission Owner's construction schedule. The calculated in-service date, based on the Transmission Owner's construction schedule below, is August 26, 2023. It will take approximately 36-48 months following an executed Interconnection Service Agreement (ISA) and Construction Service Agreement (CSA) for DPL to place its facilities in service for this project. This is assuming a standard land use and environmental permitting and approval process.

4. Customer's Scope of Work

The Interconnection Customer (IC) is responsible for all design and construction related activities on their side of the Point of Interconnection. Site preparation, including grading and an access road, as necessary, will be by the IC. 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 access road design must be approved by DPL to ensure it provides adequate access to the substation to support construction and maintenance activities. Protective relaying and metering design and installation must comply with DPL's applicable standards. 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 Interconnection Customer Scope of Direct Connection Work Requirements:

- DPL requires that an IC circuit breaker is located within 500 feet of the DPL substation to facilitate the relay protection scheme between DPL and the IC at the Point of Interconnection (POI).

Special Operating Requirements

1. 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, or other method depending upon the specific circumstances and the evaluation by DPL.
2. 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.

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

Substation Interconnection Estimate

Scope: The Price Substation presently consists of a single 69/25 kV transformer (T1) with one high-side 69 kV circuit breaker tapped off the 6710 Church – Wye Mills 69 kV transmission line. The 69 kV bus

arrangement will be converted to a five-position ring bus to accommodate the AB1-162/AB2-063 interconnection. The ring bus will consist of positions for existing T1, a terminal for Line 6710 to Church Substation, a terminal for Line 67XX to Wye Mills Substation, a terminal for AB1-162/AB2-063, and a terminal for a mobile substation connection point. To accommodate this expansion, the substation's east fence must be moved approximately 24 feet further east, and a portion of the south fence must be moved approximately 24 feet further south. To accommodate all new relays, controls, and AC and DC auxiliary systems, a new pre-fabricated control enclosure is also required and will replace the existing one. Upgrades to the substation's AC and DC auxiliary systems will also be required. (PJM Network Upgrade Number n5118)

Estimate: $5,640,911

Major Equipment Included in Estimate:

- Gas Circuit Breaker, 69 kV, 2000 A, 40 kA, 3-cycle
- Disconnect Switch, 69 kV, 2000 A, Vertical Break, Manual Worm Gear
- Revenue Grade Meter
- Relay Panel, Transmission Line Protection, FL/BU (20")
- Relay Panel, 69 kV Bus Differential, FL/BU (20")
- Relay Panel, Mobile Transformer Protection, FL/BU (20")
- Supervisory & Alarm Panel (20")
- Control Panel, 69 kV Circuit Breaker (10")
- Relay Panel, Transformer Protection, FL/BU (20")
- Relay Panel, Feeder Protection, FL/BU (10")
- Physical Security Panel (20")
- Surge Arrester, 69 kV Station Class, Polymer
- CVT, 69 kV Class, Single-Phase
- Station Service Transformer, Single-Phase, 100 kVA, 14.4 kV – 240/120 V
- Prefabricated Control Enclosure, 16' x 36' (complete with AC panels, DC panels, batteries, charger, auto-transfer switch, HVAC, auxiliary systems & lights, cable tray, terminal cabinets, the above relay & control panels, etc.):

Substation Estimate Assumptions:

- Soil conditions are normal for this area such that driven piles will not be required, and standard drilled piers can be used. If soil borings reveal poor soil conditions, more expensive types of foundations may be required.
- The soil is not contaminated and does not require special handling and disposal.
- The installation of up to three lightning masts is included in this scope.

- The 69 kV line connecting the IC's switching station to the new take-off tower in the Price Substation yard will be overhead construction and will be constructed by DPL. It will be a single span between the Price Substation take-off tower and the IC's take-off tower (no additional transmission structures required between the two take-off towers).

Required Relaying and Communications:

The following are the relaying and communications requirements for this project:

- The AB1-162/AB2-063 line/bus will use an SEL-487B relay for front line protection and an SEL-387 relay for back-up protection.
- Each of the two new transmission line terminals will use an SEL-421 relay for front line protection and an SEL-311C relay for back-up protection.
- The new mobile substation terminal will use one SEL-451 relay for front line protection and one SEL-451 relay for back-up protection.
- Each of the four new 69 kV circuit breakers will use an SEL-451 relay for breaker control and stuck breaker protection.
- The breaker control and stuck breaker protection relaying for existing CB 60 will be replaced with a new SEL-451 relay.
- The relaying for Transformer T1 will be replaced with three new SEL-787 relays for front line protection and a SEL-487E relay for backup protection.
- The relaying for each of the two 25kV feeders will be replaced with a SEL-451 relay for front line protection and a SEL-751A relay for backup protection.
- A new supervisory/alarm panel will be installed in the new control enclosure and will consist of an Orion LX RTU, an Ethernet switch, GPS clock, and station annunciator.
- Current and control cables will need to be installed between the IC's control enclosure and the Price Substation trench system. These will be installed in underground conduit.

DPL reserves the right to review the electrical protection design and relay settings for interconnecting customer facilities to ensure that the protective relaying equipment will be compatible with that installed at the remote substations. DPL personnel must be present at the time of commissioning to witness proper function of the protection scheme and related coordination.

Transmission Line Estimate

Scope: PJM Queue Project AB1-162/AB2-063 requires that the 69 kV side of Price Substation be converted from its present tapped configuration to a ring bus configuration. Modifications must be made to the 6710 Church – Wye Mills 69kV transmission line near Price Substation to loop it in and out of the new Price ring bus. The line from Price to Church will remain as #6710, while the line from Price to Wye Mills will need a new number (called 67XX for purposes of this document).

The two motor operated disconnect switches (6710-L2 and 6710-L3) and their associated dead-end steel poles and the dead-end tap pole structure will be removed along with all conductors/OPGW spanning between them, the Price substation take-off tower, and the two double-circuit dead-end structures (one

span away in each direction). Two new dead-end tap poles will be installed, and new conductor and OPGW will be installed between the two double-circuit dead-end structures and the new tap pole structures, and between each new tap pole structure and its associated new take-off tower in Price Substation.

Relabeling of the pole numbers / circuit numbers for the Price – Wye Mills segment will be required since its line number will change.

Estimate: $971,666

Major Equipment Included in Estimate:

- Dead-End tap pole structure, 69 kV, galvanized steel — Qty. 2
- OPGW slack mangers / splice cases — Qty. 2
- 1590 ACSR Lapwing 45/7 — Length. 3,800'
- Optical Ground Wire — Length. 1,300'
- 69 kV Dead-end toughened glass insulator assembly — Qty. 24

Transmission Line Estimate Assumptions:

- The new take-off towers in the substation will be designed to take the tension of the entire span between the tap poles and the take-off towers (no additional transmission line dead-end structures are required except for the new tap poles).
- The existing transmission line right-of-way as shown on the property plat for Price Substation is sufficient for routing the transmission lines to the take-off towers within the substation. No new rights are required for this project.

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

Item	*Total Cost*
Substation Attachment Facilities	$5,640,911
Transmission Line Attachment Facilities	$971,666
Total Cost	**$6,612,577**

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

DPL's portion of the project is projected to be completed approximately 36-48 months following an executed Interconnection Service Agreement (ISA) and Construction Service Agreement (CSA).

Attachment Facility	*Timeframe*
Engineering, Procurement, and Construction	36 - 48 months

B. Transmission Owner Facilities Study Results

This section describes facilities identified to be installed, replaced, and/or upgraded (upgrade facilities) 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

- Install phase and static wires between the IC's take-off tower and Price substation's take-off tower (includes two sets of dead-end insulator assemblies)

2. Transmission Lines – Upgrade

- Remove spans between double-circuit dead-end towers, switch pole structures, dead-end tap pole structure, and substation take-off tower
- Remove motor-operated disconnects and related equipment
- Remove dead-end steel switch pole structures
- Remove dead-end tap pole structure
- Remove foundations for dead-end tap pole and dead-end switch poles
- Install Dead-End galvanized steel tap pole structures
- Install drilled piers
- Install 1590 ACSR Lapwing 45/7 or equivalent
- Install Optical Ground Wire
- Install 69 kV dead-end toughened glass insulator assembly

3. New Substation/Switchyard Facilities

Not applicable

4. Substation/Switchyard Facility Upgrades

- Expand the substation to the east and south to include fencing, ground grid, site work, yard stone, roadways, and lightning protection. Expansion area is approximately 9950 square feet.
- Install storm water management features as required due to yard expansion
- Remove existing H-frame take-off tower and its foundations
- Remove 69 kV switches and their structures

- Remove fiber optic cables and power cables running to the motor-operated switches on the transmission line since those switches will be removed
- Remove the two 50 kVA station service transformers
- Remove the existing control enclosure, including all equipment inside (batteries, charger, cables, panels, auto-transfer switch, AC & DC distribution panels and switches, etc.)
- Install pre-fabricated control enclosure complete with all new relay & control panels, batteries, and other auxiliary equipment.
- Install Gas Circuit Breakers, 69 kV, 2000 A, 40 kA, 3-cycle
- Install Disconnect Switches, 69 kV, 2000 A, Manual Worm Gear
- Install CVT's, 69 kV Class, Single-Phase
- Install concrete slabs for 69 kV Breakers
- Install drilled piers for switch stands, bus supports, CVT supports, etc.
- Install drilled piers for H-Frame Take-off Structures
- Install drilled piers for new control enclosure
- Install drilled piers for Lightning Masts
- Install Disconnect Switch Stands, 69 kV, Steel
- Install three-phase CVT supports, 69 kV, Steel
- Install Take-off Structures, H-Frame, 69 kV
- Install Bus Support Structures, 69 kV, Steel
- Install Digital Revenue Grade Meters
- Install Surge Arresters, 69 kV Class, Polymer, Single-Phase
- Install new 100 kVA station service transformers onto existing 25 kV box structures and connect to new auto-transfer switch in new control enclosure
- Install cable trench between existing main trench and new control enclosure
- Install new cables between the new control enclosure and all existing and new field equipment; remove field cables to equipment from old control enclosure.
- Install 60' tall Lightning masts
- Make relay settings changes at remote ends (Church and Wye Mills) as required; also update affected substation drawings and documentation at remote ends.
- Test and commission all new relay, control, and communications systems

5. Telecommunications Facilities – Upgrades

- The new relays will need to be connected to the station's new Orion LX communications processor, GPS clock, and Ethernet switches.
- The new transmission line relays (both front line and backup) will use a POTT pilot scheme to communicate to the relays at Church and Wye Mills. Stuck Breaker Transfer Trip must also be implemented between Price, Church, and Wye Mills. This will require reconfiguration of existing communications paths between Church and Wye Mills.
- The 6710 Church – Wye Mills line presently has OPGW installed. Since the line must be broken to loop it in and out of the new Price ring bus, reconfiguration of the OPGW will be required at the Price Substation location.

- Fiber optic cable will be installed between the IC's switching station and the Price Substation control enclosure to support any necessary status, control, and metering functions. This will be installed in underground conduit.
- All telecommunications infrastructure must be relocated from the old control enclosure to the new one (fiber termination panels, multiplexers, modems, firewalls, phone equipment, etc.).

6. Metering & Communications

A three-phase 69 kV revenue metering point will need to be established within the IC's facility at the POI. The IC will purchase and install all metering instrument transformers (including one spare to be kept on site) as well as construct a metering structure per DPL's specifications. The secondary wiring connections both at the instrument transformers and at the metering enclosure will be completed by DPL's metering technicians. The metering control cable and meter cabinets will be supplied by DPL and installed by the IC's contractors. The IC will install conduit for the control cable between the instrument transformers and the metering enclosure. The location of the metering enclosure will be determined in the construction phase. The IC will provide 120V power to the meter cabinet. DPL will provide both the Primary and Backup meters. DPL's meter technicians will program and install the primary & backup solid state multi-function meters for the new metering position.

The primary meter will be equipped with load profile, telemetry, and DNP outputs. The IC will be provided with the Primary meter's DNP output via RS-485. The IC will be required to make provisions for a POTS line within approximately three feet of the DPL metering position to facilitate remote interrogation and data collection. It is the IC's responsibility to send the data that PJM and DPL require 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 interval MWH and MVARH.

7. Environmental, Real Estate and Permitting

All work to accommodate the interconnection of AB1-162/AB2-063 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.

8. Summary of Results of Study

Project Name: Price 69 kV	**Indirect Cost ($)**		**Direct Cost ($)**		**Total Cost ($)**
Substation work scope (n5118)	**Material**	**Labor/Fees/ Equip.**	**Material**	**Labor/Fees/ Equip.**	
Project & Construction Planning, Project Closing, Permitting, and Material Procurement				$305,674	$305,674
Engineering & Design				$322,885	$322,885
Project Oversight and Overhead Cost	$328,031	$353,157		$82,812	$764,000
Site Work			$436,900	$459,334	$896,234
Below Grade/Foundation Construction			$131,131	$351,064	$482,195
Above Grade/Primary Construction			$762,970	$587,453	$1,350,423
Secondary/P&C/Comm Construction			$71,418	$175,495	$246,913
Pre-Fabricated, Pre-Wired Control Enclosure			$757,900	$63,197	$821,097
Demolition and Salvage				$113,758	$113,758
Testing & Commissioning Activities				$337,732	$337,732
Total Cost	**$328,031**	**$353,157**	**$2,160,319**	**$2,799,404**	**$5,640,911**

Project Name: Price 69kV	Indirect Cost ($)		Direct Cost ($)		Total Cost ($)
Transmission Line work scope	**Material**	**Labor/Fees/ Equip.**	**Material**	**Labor/Fees/ Equip.**	
Project & Construction Planning & Coordination, Project Closing, Permitting, and Material Procurement				$57,133	$57,133
Engineering & Design				$174,935	$174,935
Line Foundations			$37,270	$115,260	$152,530
Structures and Fixtures			$116,600	$36,379	$152,979
OH Conductors, Insulators, Hardware, Fiber			$24,661	$123,941	$148,602
Project Oversight and Overhead Cost	$28,962	$86,771		$9,933	$125,666
Test and Energization				$2,434	$2,434
Demolition and Salvage				$157,387	$157,387
Total Cost	**$28,962**	**$86,771**	**$178,531**	**$677,402**	**$971,666**

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.

9. Schedules and Assumptions

The overall estimated timeline for DPL to place its direct connect facilities in service for this project is approximately 36 - 48 months after receipt of a fully executed Interconnection Service Agreement (ISA) and Construction Service Agreement (CSA).

Storm damage and restoration, time of year limitations, permitting issues, outage scheduling, system emergencies, and contractor and equipment availability could also impact the schedule. It is important to note that this project will be incorporated into the existing project work load at DPL at the time of contract execution. If the work load of existing projects is extensive, resource constraints may cause this project to be delayed beyond the projected in-service date.

Attachment #1