Generation Interconnection Facilities Study Report

For

PJM Generation Interconnection Request Queue Position AB1-141/AB1-142

"Church-Wye Mills 138 kV"

January 2019

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A. Transmission Owner Facilities Study Summary

1. Description of Project

Bluegrass Solar, LLC, the Interconnection Customer (IC), has proposed two solar projects, AB1-141 and AB1-142. Each is 19.8 MW Maximum Facility Output (MFO) and 13.5 MW Capacity solar generating facility to be located in Sudlersville, Maryland. PJM studied AB1-141/AB1-142 as a combined 39.6 MFO and 27 MW Capacity injection into the Delmarva Power and Light Company's (DPL) system and evaluated it for compliance with reliability criteria for summer peak conditions in 2019.

The AB1-141/AB1-142 projects will require a common Point of Interconnection (POI) adjacent to DPL's 138 kV circuit 13723 between Church Substation and Wye Mills Substation in Queen Anne's County, Maryland to connect to the PJM/DPL network. The connection off circuit 13723 will require the construction of a new substation with a 138 kV three-position ring bus. Two of the positions on the ring bus will be transmission line terminals for the tie-in of circuit 13723 to the substation. The third position will be a terminal configured for the interconnection of the AB1-141/AB1-142 generation. The installation of the new substation will require modifications to circuit 13723 to loop it in and out of the new ring bus. The exact location of this new ring bus substation is not yet known, but it is assumed to be adjacent to or very close to the circuit 13723 ROW in the Sudlersville, MD area.

The IC is required to construct a switching station within 500 feet of the new ring bus substation's 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 new ring bus substation's yard. See Attachment #1.

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

The scope of the project as stated in the System Impact Study, submitted in September 2016, has remained relatively unchanged. In addition, the estimates herein provided were performed in more detail than those provided in the Impact Study. The project schedule has also changed due to anticipated permitting requirements.

3. Interconnection Customer's Milestone Schedule

The planned in-service date, as requested by the IC, is December 31, 2023. This date should be attainable based on the current Interconnected Transmission Owner's schedule.

Delmarva Power & Light Company's (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). This is assuming a standard land use and environmental permitting and approval process. The longer schedule is due largely to the requirement to obtain a CPCN from Maryland for modification of 138 kV circuit 13723 in the vicinity of the new ring bus substation.

4. Customer's Scope of Work

The Interconnection Customer (IC) is responsible for all design and construction related to activities 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. 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: Build a new 138 kV substation with a three-position ring bus off the right-of-way for circuit 13723 in Queen Anne's County, Maryland. Two of the positions on the ring bus will be transmission line terminals for the tie-in of circuit 13723 to the substation. The third position will be a terminal configured for the interconnection of the AB1-141/AB1-142 generator. (PJM Network Upgrade Number n5119)

Estimate: $7,647,222

Major Equipment Included in Estimate:

- Prefabricated Control Enclosure, 16' x 38' (complete with AC panels, DC panels, batteries, charger, auto-transfer switch, HVAC, auxiliary systems & lights, cable tray, terminal cabinets, relay & control panels, etc.)
- Gas Circuit Breaker, 138 kV, 2000 A, 40 kA, 3-Cycle
- Disconnect Switch, 138 kV, 2000 A, Manual Worm Gear (Three-Phase)

- Disconnect Switch, 138 kV, 1200 A, Manual Worm Gear (Single-Phase)
- CVT, 138 kV Class, Single-Phase
- Surge Arrester, 138 kV Station Class, Polymer
- Station Service Voltage Transformer (SSVT), Single-Phase, 100 kVA, 80,500V-240/120V
- Control Panel, 138 kV Circuit Breaker (10")
- Relay Panel, Transmission Line Protection, FL/BU (20")
- Relay Panel, 138 kV Bus Differential, FL/BU (20")
- Supervisory & Alarm Panel (20")
- Telecommunications Equipment Panels (20")
- Physical Security Panel (20")
- Revenue Grade Meter

Substation Estimate Assumptions:

- Land purchase for the substation is not included. The IC is responsible for purchasing the required land (approximately 3 acres in a roughly square or rectangular shape).
- Site development, including but not limited to clearing and grading, will be by the IC.
- All permitting for the site will be by the IC.
- 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 cost of up to four lightning masts is included in this estimate.

Required Relaying:

The following are the relaying requirements for this project:

- The AB1-141/AB1-142 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.
- Each of the three new 138 kV circuit breakers will use an SEL-451 relay for breaker control and stuck breaker protection.
- A supervisory/alarm system consisting of an Orion LX RTU, an Ethernet switch, GPS clock, and station annunciator will be required.
- The relays at the remote ends (at Church and Wye Mills substations) were previously upgraded. Only relay settings changes will be needed at those substations.

- Current and control cables will need to be installed between the IC's control enclosure and the new ring bus substation's 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: Modify circuit 13723 near the new substation to loop it in and out of the new ring bus. The line from the new ring bus to Church will remain as #13723, while the line from the new ring bus to Wye Mills will be named 137XX. The exact location of this new ring bus substation is not yet known, but it is assumed to be adjacent to or very close to the circuit 13723 ROW. Two new dead-end monopoles will be installed to allow the line to be broken and routed into the two new ring bus positions. Relabeling of the pole numbers / circuit numbers for the New Substation – Wye Mills segment will also be required since its line number will change.

Install a new short transmission line (no longer than 500 feet) to connect the IC's POI station to the new ring bus substation.

Estimate: $693,380

Major Equipment Included in Estimate:

- Dead-End Monopole 138 kV Structures, Galvanized Steel
- 1590 ACSR Lapwing 45/7 or equivalent
- Optical Ground Wire
- Static Wire
- 138 kV Dead-End Insulator Assembly

Transmission Line Estimate Assumptions:

- The new ring bus substation will be constructed close enough to the circuit 13723 ROW such that only two new dead-end monopole structures will be needed; no other structures will be required between these dead-end structures and the substation's take off towers.
- The new ring bus substation will be constructed on the east side of DPL's circuit 13723 right-of-way. This estimate will need to be re-evaluated if it is located on the west side of the right-of-way.
- The new 138 kV line connecting the IC's switching station to the take-off tower in the new ring bus substation's yard will be overhead construction and will be constructed by DPL. It will be a single span between the ring bus take-off tower and the IC's take-off tower (no additional transmission structures required between the two take-off towers).
- The IC is responsible for obtaining any new ROW and permits (including Maryland CPCN) for routing the transmission lines to the new substation.
- Any required tree / vegetation clearing will be the responsibility of the IC.

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

Item	*Total Cost*
Substation	$7,647,222
Transmission Line	$693,380
Total Cost	**$8,340,602**

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

Due to the Maryland CPCN requirement for the 138 kV transmission line modifications, it will take 36 to 48 months to place this project in service from the start of detailed design activities.

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

B. Transmission Owner Facilities Study Results

This section describes facilities identified to be installed (attachment facilities), 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 the ring bus substation's take-off tower (includes two sets of dead-end insulator assemblies)

2. Transmission Lines – Upgrade

- Install drilled piers for dead-end monopole structures
- Install galvanized steel dead-end monopole structures
- Install dead-end insulator assemblies
- Remove the phase and static/OPGW wires between the dead-end monopoles after attaching the incoming circuit 13723 phase and static/OPGW wires
- Install phase, static, and OPGW wires between each dead-end monopole and its associated substation take-off tower

3. New Substation/Switchyard Facilities

- Install substation fence and gates
- Install substation ground grid
- Install cable trench, conduit, and pull boxes as required
- Install substation roadways and yard stone

- Install storm water management features as required
- Install landscaping features as required
- Install Gas Circuit Breakers, 138 kV, 2000 A, 40 kA, 3-cycle
- Install Disconnect Switches, 138 kV, 2000 A, Three-Phase, Manual Worm Gear
- Install Disconnect Switches, 138 kV, 1200 A, Single-Phase, Manual Worm Gear
- Install 138 kV Class Station Service Voltage Transformers (SSVT's)
- Install CVT's, 138 kV Class, Single-Phase
- Install concrete slabs for 138 kV Breakers
- Install concrete slabs for 138 kV SSVT Support Structures
- 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, 138 kV, Steel
- Install three-phase CVT supports, 138 kV, Steel
- Install Take-off Structures, H-Frame, 138 kV
- Install Bus Support Structures, 138 kV, Steel
- Install 138 kV SSVT Support Structures, Steel
- Install 138 kV SSVT Switch Support Structures, Steel
- Install Digital Revenue Grade Meters
- Install Surge Arresters, 138 kV Class, Polymer
- Install 70' tall Lightning masts
- Install 138 kV substation bus, insulators, connectors, etc. as required
- Install pre-fabricated control enclosure and make connections to yard equipment
- Install yard lighting as required
- Install physical security equipment as required
- Test and commission all new relay, control, and communications systems

4. Substation/Switchyard Facility Upgrades

- Make relay settings changes at remote ends (Church and Wye Mills) as required; also update affected substation drawings and documentation at remote ends.

5. Telecommunications Facilities – Upgrades

- New racks of communications equipment will be required at the new ring bus substation (multiplexers, fiber optic termination panels, routers, firewall, VOIP equipment, etc.). Communications with the DPL control center must be established for the new ring bus substation.
- 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 the new ring bus substation, Church, and Wye Mills. This will require reconfiguration of existing communications paths between Church and Wye Mills to include the new substation.

- The OPGW on circuit 13723 will need to be reconfigured since the line will now be broken into two separate lines by the new ring bus substation. The OPGW will now be routed into and out of the new ring bus substation. Connections between the two fiber segments (Church – New Substation and Wye Mills – New Substation) can be made inside the control enclosure at the new substation.
- Fiber optic cable will be installed between the IC's switching station and the new ring bus substation's control enclosure to support any necessary status, control, and metering functions. This will be installed in underground conduit.

6. Metering & Communications

A three-phase 138 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 AB1-141/AB1-142 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: Church – Wye Mills 138kV I	**Indirect Cost ($)**		**Direct Cost ($)**		**Total Cost ($)**
Substation Attachment Facilities	**Material**	**Labor/Fees/ Equip.**	**Material**	**Labor/Fees/ Equip.**	

Project & Construction Planning, Project Closing, Permitting, and Material Procurement				$132,220	$132,220
Engineering & Design				$524,670	$524,670
Project Oversight and Overhead Cost	$242,376	$316,414		$42,158	$600,948
Site Work			$253,664	$610,853	$864,517
Below Grade/Foundation Construction			$355,432	$1,077,860	$1,433,292
Above Grade/Primary Construction (includes control enclosure)			$1,029,344	$1,293,204	$2,322,548
Secondary/P&C /Comm Construction			$129,728	$517,392	$647,120
Pre-Fabricated, Pre-Wired Control Enclosure (with Relay & Control Panels)			$757,900	$4,608	$762,508
Testing & Commissioning Activities				$359,399	$359,399
Total Cost	**$242,376**	**$316,414**	**$2,526,068**	**$4,562,364**	**$7,647,222**

Project Name: Church – Wye Mills 138kV I	Indirect Cost ($)		Direct Cost ($)		Total Cost ($)
Transmission Line Attachment Facilities	**Material**	**Labor/Fees/ Equip.**	**Material**	**Labor/Fees / Equip.**	
Project & Construction Planning & Coordination, Project Closing, Permitting, and Material Procurement				$60,005	$60,005
Engineering & Design				$45,686	$45,686
Line Foundations			$57,076	$160,125	$217,201
Structures and Fixtures			$85,136	$72,015	$157,151
OH Conductors, Insulators, Hardware, Fiber			$45,880	$22,426	$68,306
Matting Costs			$14,575	$34,540	$49,115
Project Oversight and Overhead Cost	$34,588	$52,003		$4,100	$90,691
Test and Energization				$1,587	$1,587
Demolition and Salvage				$3,638	$3,638
Total Cost	**$34,588**	**$52,003**	**$202,667**	**$404,122**	**$693,380**

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). This duration is largely due to the need to obtain a CPCN from the State of Maryland for this work since it is above 100 kV.

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

Church-Wye Mills 138 kV
AB1-141/AB1-142