Generation Interconnection
Facilities Study Report

PJM Generation Interconnection Request
Queue Position AD2-076 "Carville 138 kV"

March 2021

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Transmission Owner Facilities Study Summary

1 Description of Project

Concho Solar I, LLC, the Interconnection Customer (IC), has proposed a 49.0 MW (18.6 MW Capacity) solar generating facility to be located at Latitude: 38.9995833, Longitude: -76.0044444 in Queen Anne's County, Maryland. PJM studied the AD2-076 project as an injection into the Delmarva Power and Light Company (DPL) transmission system at two locations/transmission voltages and evaluated it for compliance with reliability criteria for summer peak conditions in 2021. The original studies considered injection at the future 138kV Substation that has since been constructed as well as at the existing 69kV Centreville Substation. The project was studied at a commercial probability of 100%. The revised in-service date based on DPL's estimated construction schedule is June 3, 2024.

The proposed 49 MWs of generation will require one (1) new Point of Interconnection (POI). Based on the two options evaluated and construction activities since the original feasibility studies were performed the POI will be at the 138kV Carville Substation.

To accommodate this interconnection the existing 138kV Carville substation will need to be upgraded to a six-position ring bus. Utility grade primary metering, generation telemetry and remote trip capability will also be required as part of this interconnection. The POI will be located between the DPL owned disconnect switch and IC disconnect switch where the IC's circuit breaker is installed.

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

The scope of the project as stated in the Impact Study, submitted in March 2019 has not been changed. Also, the estimates herein were performed in more detail than those provided in the Impact Study.

3 Interconnection Customer's Milestone Schedule

Site Work Complete:	December 4, 2023
Commercial Operation:	June 3, 2024

4 Interconnection Customer's Scope of Work

4.1 IC's General Scope

The IC assumes full responsibility for the design, permitting and construction of all facilities associated with the AD2-076 generating station on their side of the POI. 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 POI. The IC shall conform to Transmission Owner's engineering and construction standards and coordinate all work directly with Transmission Owner to ensure minimal interruption to the electric system. The IC also assumes responsibility for the permitting and construction of the service road(s) to the generating site.

Protective relaying and metering design and installation must comply with Transmission Owner'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. It is critical that the IC also provides 120 VAC power to the primary meter locations installed by Transmission Owner.

This proposed interconnection is required to satisfy the requirements outlined in the latest IEEE 1547 series of standards, including but not limited to over/under voltage, over/under frequency and anti-islanding requirements and the requirements outlined in Transmission Owner's "Technical Considerations Covering Parallel Operations of Customer Owned Generation" document for units greater than 1 MW. Transmission Owner's system protection group will need to receive the proposed settings and associated schemes for review to ensure compliance with these standards.

4.2 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 (138 kV) of the generator's transformer. Potential Transformers (PT's) cannot be installed on the lower voltage bus. This requirement can be avoided by using a grounded-wye/grounded-wye step-up transformer.

4.3 Inverter Requirements and Capabilities

The inverters at the distributed generation (DG/PV site) 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 Transmission Owner. The IC owner/operator shall cooperate with Transmission Owner to implement these capabilities with settings acceptable to Transmission Owner. Transmission Owner reserves the right to request setting changes in the future if needed to maintain electrical system integrity.

It is the responsibility of the IC 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.

4.4 Power Factor Requirements

The generators used for this project shall be capable of operating at a power factor (or schedule) specified by Transmission Owner in the range of 0.95 lead to 0.95 lag. It is the responsibility of the developer/customer to obtain equipment that can operate with these requirements while also meeting all applicable requirements of IEEE and UL standards such as but not limited to IEEE 1547 and UL 1741.

For this project, operate inverters at a unity power factor ("PF") of (1.0) not impacting Volt-ampere reactive ("VARs") continuously. In the future, Transmission Owner reserves the right to issue new fixed power factor setting requirements if necessary.

4.5 Operating Requirements

Transmission Owner will require the capability to remotely disconnect the generator from the grid by communication from its System Operations facility. Such disconnection will be performed by IC circuit breaker and associated disconnect switches. When the trip command is sent to IC equipment the customer shall 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 Transmission Owner 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.

4.6 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.

Transmission Owner Facilities Study Results

5 New Attachment Facilities: Transmission Owner Scope of Work

This section describes the attachment facilities necessary to support the interconnection to the IC's generating site. This section describes facilities identified to be installed, replaced, and/or upgraded by Transmission Owner to accommodate the project. During detailed design and analysis other components may be identified for installation or replacement due to this interconnection.

The scope of work for the installation of IC's interconnection and generation facilities are not included in this study nor are the responsibility of the Transmission Owner.

5.1 Attachment Facilities – Transmission Lines

Install a new short transmission line (no longer than 500 ft) from new bus position at Carville sub to the IC's POI station.

5.2 Attachment Facilities – Substation

No new substation facilities are necessary for the planned interconnection of AD2-076 given the planned generating capacity and system configuration.

5.3 Attachment Facilities – Distribution

No new distribution facilities are necessary for the planned interconnection of AD2-076 given the planned generating capacity and system configuration.

6 Upgrade Facilities: Transmission Owner Scope of Work

This section describes upgrades to existing facilities required to accommodate the interconnection of AD2-076. During detailed design and analysis other components may be identified for installation or replacement due to this interconnection.

6.1 Upgrade Facilities-Transmission Lines

No upgrades to existing transmission facilities are necessary for the planned interconnection of AD2-076 given the planned generating capacity and system configuration.

6.2 Upgrade Facilities-Substations

The interconnection of AD2-076 will require modifications to the existing Carville ring bus. This includes installing an additional 138kV circuit breaker (CB 135), 138kV line disconnect switch, 138kV CCVTs (P7), and new protection & control relaying. The new relaying will consist of two (2) SEL-487B's and one (1) SEL-451. The SEL-487B relays will protect the bus connection between Carville and the POI. The SEL-451 relay will perform control and provide breaker failure protection for the new CB135. Lockout relays will be utilized to directly trip the IC breaker under fault conditions. Additionally, relay outputs will be wired to remotely control IC breaker for operational switching. CT/PT wiring will be added and modified to accommodate the new equipment. Existing Ethernet switches and GPS clock have the capability to support the additional relaying. A ground grid study will be required to ensure the original station design is adequate with the new source. Impacts for the ground grid study are assumed to be minimal but need to be confirmed during detailed design.

Major Substation Equipment to be Installed

Material/Equipment	Quantity
▪ 138kV Circuit Breaker, 2000A, 40kA, 3 cycle	1
▪ 138kV Line Disconnect Switch, 2000A, Manual, Quick Break Whips	1
▪ 138kV CB Disconnect Switch, 2000A, Manual, with Arcing Horns	1
▪ 138kV CCVT, 1-Phase	3
▪ 138kV Surge Arresters, 1-Phase (hung on take-off structure)	3
▪ 138kV Line Disconnect Switch Stand	1
▪ 138kV 3-Phase CCVT Stand	1
▪ 138kV Dead-end/Take-off Structure	1
▪ 138kV Breaker Foundation (slab)	1
▪ 138kV Line Disconnect Switch Stand Foundation (group of piers)	1

▪ 138kV 3-Phase CCVT Stand Foundation (group of piers)	1
▪ 138kV Dead-end/Take-off Structure Foundation (group of piers)	1
▪ Control Cable 4C#10AWG	3,500 ft
▪ Control Cable 4C#12AWG	2,000 ft
▪ Serial/Fiber Optic Transceiver (SEL-2830)	1
▪ Multimode (62.5um) Fiber-Optic Cable	100 ft
▪ Single-Mode (1300nm) Fiber-Optic Patch Cable	500 ft
▪ Control panel with SEL-451/LOR (10" wide)	1
▪ Protection panel with two (2) SEL-487B & two (2) LORs (20" wide)	1

Major Labor Activities

- Disassemble the existing 138kV bus affected by this scope (approx. 90 linear ft).
- Install 138kV breaker.
- Install Dead-end structure.
- Install 138kV Line & CB Switches.
- Install 138kV CCVTs.
- Install surge arresters.
- Install two 3-inch conduits from new breaker to existing trench.
- Install one 3-inch conduit from new CCVT to existing trench.
- Install three 3-inch conduits from existing trench to IC yard.
- Install four 4C#10 cables between POI breaker and control house termination cabinet, and panels.
- Install two 12C#12 cables between POI breaker and control house termination cabinet, and panels.
- Install four 4C#10 cables between new 138kV breaker and control house termination cabinet, and panels.
- Install two 4C#12 cables between new PT and control house termination cabinet, and panels.
- Rewire CT/PT connections for existing equipment in the termination cabinet to reflect new breaker installment.
- Install one Single-Mode Fiber-Optic Patch cable between panels inside the control house.
- Install one SEL-2830 transceiver on new CB 135-SEL451 relay.
- Install new 20" panel for two (2) SEL-487B
- Install new 10" panel for SEL-451.
- Install wireless modem/communication package for telemetry including copper ethernet connection to existing ethernet switch.
- Relay settings for new CB 135-SEL451, 138kVBUSF-SEL487B, 138kVBUSB-SEL487B.
- Review/update settings for existing adjacent relays.
- RTU points list updates and configurations for existing Orion RTU & ethernet switch.
- Testing and commissioning.

Assumptions

- Existing conduits/trench are adequate for newly installed cables.

6.3 Upgrade Facilities-Distribution

No upgrades to other distribution facilities beside those noted in Section 5 and 6.2 are necessary for the planned interconnection of AD2-076 given the planned generating capacity and system configuration.

6.4 Upgrade Facilities-Telecommunications

No upgrades to other communication systems beside those noted in Section 5 are necessary for the planned interconnection of AD2-076.

7 Metering

A three-phase 138kV 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 specifications. The secondary wiring connections at the instrument transformers will be completed by the IC's contractors and inspected by DPL, while the secondary wiring work at the metering enclosure will be completed by DPL meter technicians. The metering control cable and meter cabinets will be supplied and installed by DPL at a mutually agreed upon location (determined during the detailed design phase) accessible to DPL. The IC will provide 120 VAC to the cabinet location. 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. The IC will be provided with the Primary meters DNP output via RS485.

Transmission Owner 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.

8 Telemetry

It is the IC's responsibility to send the data that PJM and Transmission Owner requires directly to PJM. The IC will grant permission for PJM to send Transmission Owner the following telemetry that the IC sends to PJM: real time MW, MVAR, volts, amperes, generator status, and generator breaker position.

9 Environmental, Real Estate and Permitting

9.1 Permitting and Real Estate

All work to accommodate the interconnection of AD2-076 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 Transmission Owner. Any setbacks in obtaining the necessary real property rights, acquisitions and permits required for this interconnection may delay the construction schedule.

9.2 Environmental

Environmental permits may need to be secured. Additional tree trimming/clearing may be needed. This estimate assumes that all the applicable permitting will be obtained by the IC for the generating facility and the service road(s).

10 Proposed Schedule for Completion of Work

The Transmission Owner project schedule is based on an 24-36-month lead-time from receipt of a fully executed interconnection agreement; this timeline is subject to storm damage and restoration efforts that may impact the resources and/or the geographic area of this project, 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 Transmission Owner 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 planned in-service date.

Attachment/Upgrade Facilities	*Timeframe*
Network Upgrades AD2-076 Construction	24-36 months

11 Total Cost of Transmission Owner Facilities

Item	*Total Cost*
Network Upgrades	$1,094,153

12 Transmission Owner Scope of Work Cost Breakdown

Network Upgrades for AD2-076	*Costs ($)*		*Total Cost ($)*
	Material/Equip.	Labor/Fees	
Planning/Engineering & Design	$500	$128,315	$128,815
Execution/Construction	$574,458	$307,323	$881,781
Project Oversight and Overhead Cost		$83,557	$83,557
Total Cost	$574,958	$519,195	$1,094,153

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. Transmission Owner 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.

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