Generation Interconnection
Feasibility Study Report
Queue Position X3-016

The Interconnection Customer (IC) has proposed a 10 MWE (3.8 MWC; 10 MW MFO) solar powered generating facility to be located in Carneys Point Township, New Jersey. PJM studied X3-016 as a 10 MW injection into the Atlantic City Electric Company (ACE) system at a 50% tap between the Deepwater and Beckett 69kV circuit and evaluated the project for compliance with reliability criteria for summer peak conditions in 2015.

Point(s) of Interconnection

The IC requested the Point of Interconnection (POI) for X3-016 to be a 12.47 kV distribution level interconnection.

X3-013 will interconnect with the Atlantic City Electric Company system at a new 69/12kV substation to be constructed adjacent to the Deepwater-Paulsboro 69kV circuit.

Point(s) of Interconnection Discussion

Description of Atlantic City Electric (ACE) policy

1. Existing 12kV Distribution Circuit
   The aggregate limit of large (250 kW and over) generator injection to a single, existing 12kV distribution circuit is 3 MWs. This project exceeds this limit and the existing feeder will not be used for that reason.

2. Express Feeder
   Intermittent generation installations over 3 MWs on the 12 kV level will require an express feeder to avoid undesired interaction with automatic line equipment and so that other customers on the distribution system may avoid experiencing any voltage and power quality issues that may exist. An express feeder is limited to 10 MW.

   Churchtown Sub. was identified as the closest substation based on the site location supplied in the application and/or Kick-off Call. Churchtown currently has one 42 MVA transformer. The additions of second and third distribution transformers were identified as potential upgrades to this substation as part of previous studies. These proposed transformers would be ACE's standard distribution transformer (37 MVA nameplate rating.)

   The aggregate limit of large (250 kW and over) generator injection to a single distribution transformer is 10 MWs. This applies to transformers 22.5 MVA nameplate and larger, which includes the existing and proposed transformers at Churchtown Sub.

   As of the date of this report, T2, the proposed T3, and the proposed T4 cannot accept any additional generation. On the T2 transformer, 0.4 MW of Net Energy Metering projects have

requested to connect and 9.6 MW of a PJM project is being studied. On the T3 and T4, 10 MW of a PJM project is being studied.

The length of an express feeder is limited to 5 miles, or for the sake of the feasibility study, 3.8 straight line miles. This simplification is used because the feasibility study phase does not allow for the time and resources to examine routes in detail (including existing pole lines, easements, ROW, and environmental issues etc.)

Pennsgrove Sub. (69kV/4kV) is 4.5 miles (straight line distance) from the site. This was eliminated based on distance and availability.

Woodstown Sub. (69kV/12kV) is 5.7 miles (straight line distance) from the site. This was eliminated based on distance and availability.

3. New Substation
   In order to realistically convey the cost to safely and reliably handle additional generation in this area while still receiving service at the distribution level, the cost was supplied for a new 69/12 kV distribution substation. This substation will be supplied by extending existing transmission lines. It is the developer's responsibility to verify eligibility for solar renewable energy certificates with New Jersey's Clean Energy Program if desired.

   All injection limits, given above in MWs, are subject to more detailed study to ensure feasibility.

Direct Connection Requirements

Transmission Owner Scope of Work

The scope of work and estimated costs for the direct connection facilities is as follows:

1. Design and construct a new 69/12 kV substation at the PV site. This substation will be built to the Company's (the "Company" referring to ACE, DPL, or PEPCO) specifications for a distribution substation and be owned and operated by the Company. *Note: There are no plans to serve any load from this substation, however it will be built so that it can serve load in the future. The developer shall supply adequate land for the installation of the substation. The land shall be in close proximity to roads and be on buildable high land.*
2. Create a transmission loop by cutting into the Deepwater - Paulsboro 69 kV line and constructing approximately 0.75 miles of double circuit pole line to the new substation. New transmission lines will include OPGW communication lines.
3. Add OPGW fiber communication line to existing transmission line poles in place of static wire from the new substation to Deepwater (4.9 miles south from the PV site) and Beckett (5.9 miles) to support relaying and communications of transmission lines. This is an approximate total distance of 10.7 miles of new OPGW.
4. Establish one new 12 kV feeder with overhead conductor from the new substation to the PV site.

5. A utility operated recloser equipped with the proper relaying and communications will be installed for each feeder serving the PV generator.
6. Utility grade primary metering will be required for each feeder.
7. Generation telemetry and remote trip capability will be provided to PHI's Energy Management System with future capability to adjust output and power factor if needed.
8. A detailed, time-based study may be performed during later study phases.
9. Protection, Planning, and other engineering departments will perform studies, design work, and prepare engineering estimates.
10. Transfer trip will be required.

The estimated cost to perform this work is:

Estimated Costs			
New Substation			
New Substation			$4,404,000
Express Feeder (Including recloser)			$70,000
Transmission Feed 69 kV	1.5	Miles	$975,000
Fiber Installation			$1,177,000
Utility Grade Metering		1	$20,000
SCADA Integration into EMS		1	$10,000
Detailed Time Based Study			$30,000
Various Departments Work			$20,000
Subtotal Cost			$6,706,000
Subtotal Cost with 18% Overheads			$7,913,080
Approximate Total Cost with 15% Contingency			$9,100,042

The estimated time to complete the work is **24-36 months**.

Additional Operating Requirements

1. PHI will require the capability to remotely trip the generator from its System Operations facility. Such tripping may be facilitated by either a generator breaker, inverter (if so equipped), or a line recloser, depending upon the specific circumstances and the evaluation by PHI.

2. It is the Interconnection Customer's responsibility to send the data that PJM and the Company requires directly to PJM. The Interconnection Customer will grant permission for PJM to send the Company the following telemetry that the Interconnection Customer sends to PJM: real time MW, MVAR, volts, amperes, generator/status, and interval MWH and MVARH.

3. The Interconnection Customer will be required to make provisions for a voice quality phone line within approximately 3 feet of each Company metering position to facilitate remote interrogation and data collection.

4. 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 PHI Engineering.

Interconnection Customer 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. Site preparation, including grading and an access road, as necessary, is assumed to be by the IC. Route selection, line design, and right-of-way acquisition of the direct connect facilities is not included in this report, and is the responsibility of the IC.

The IC will be required to install metering and telemetry equipment to provide revenue metering and real-time telemetry data to PJM. The requirements for this equipment are listed in Appendix 2, Section 8 of Attachment O to the PJM Tariff, as well as PJM Manuals 01 and 14D. Protective relaying and metering design and installation must comply with PHI's Applicable Standards.

The Interconnection Customer will purchase and install all metering instrument transformers as well as construct a metering structure per PHI's specifications. The secondary wiring connections at the instrument transformers will be completed by the Interconnection Customer's contractors and inspected by PHI, while the secondary wiring work at the metering enclosure will be completed by PHI's meter technicians. The metering control cable and meter cabinets will be supplied by PHI and installed by the Interconnection Customer's contractors. PHI's meter technicians will program and install two solid state multi function meters (Primary & Backup) for the new metering position. Each meter will be equipped with load profile, telemetry, and form-c pulse outputs.

Inverter Requirements and Capabilities

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

1. Voltage flicker reduction through dynamic VAR response
2. Ramp rate control
3. SCADA communications
4. Curtailment or other mitigation ability if high voltage were to occur
5. Low voltage and system disturbance ride through
6. Ability to receive and respond to a transfer trip or SCADA signal including real power curtailment and power factor changes

The inverter shall operate in accordance with the IEEE 1547 series of standards that have been approved. While inverters should be capable of voltage stabilization thru dynamic VAR response and capable of low voltage and system disturbance ride through, neither of these capabilities shall be implemented until such time that the IEEE 1547 series of standards are revised and approved to include standards for these capabilities. At such time as these revised standards become available, the PV owner/operator shall cooperate with PHI (ACE, DPL, or PEPCO) to implement these

capabilities with settings acceptable to PHI. Until such time, the inverters shall operate with a fixed power factor schedule as supplied by PHI.

Transmission Network Impacts

Potential transmission network impacts are as follows:

Generator Deliverability

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

None

Multiple Facility Contingency

*(Double Circuit Tower Line, Line with Failed 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

Short Circuit

No issues identified.

Stability Analysis

Not required due to project size.

Dynamic Analysis

ACE will commence a time-based dynamic study during the System Impact Study phase to evaluate the project's impact on the ACE distribution system. Once complete, the results of the study will be reviewed and the proposed project will be evaluated for protection and coordination issues. Other required upgrades may be identified at that time.

System Protection

Protective relaying and metering design and installation must comply with PHI's applicable standards. Any other costs determined by system protection as a result of the short circuit studies will be supplied in the near future.

Other Charges

PHI reserves the right to charge the Interconnection Customer Operation and Maintenance expenses to maintain the Interconnection Customer's Attachment Facilities, including metering and telecommunications facilities which are owned by PHI.

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. "Network Impacts," initially caused by the addition of this project's generation)

None

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project.

None

Potential Congestion due to Local Energy Deliverability

(PJM also studied the delivery of the energy portion of the surrounding generation. Any potential 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 Transmission Interconnection Request. Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full deliverability for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which analyzes all overload conditions associated with the identified overloaded element(s). As a result of the aggregate energy resources in the area, the following violations were identified:

These are ***not*** required reliability upgrades.

1. The (AE) X3-016 TAP-Beckett 69 kV line (from bus 910640 to bus 228321 ckt 1) loads from 106.59% to 109.72% (DC power flow) of its emergency rating (97 MVA) for the operational contingency 'MICK-BRIDG'. This project contributes approximately 3.03 MW to the thermal violation.