Generation Interconnection Feasibility Study Report Queue Position X3-027

The Interconnection Customer (IC) has proposed a 10 MW energy only (0 MWC; 10 MW MFO) solar powered generating facility to be located at the South Ocean Landfill in Ocean Township, New Jersey. PJM studied X3-027 as a 10 MW injection into the Atlantic City Electric Company (ACE) system at the Barnegat 12kV substation and evaluated the project for compliance with reliability criteria for summer peak conditions in 2015. The planned in-service date, as stated in the Attachment N, is December 31, 2012.

Point(s) of Interconnection

The IC requested a Point of Interconnection (POI) for X3-027 at the 12.47 kV distribution level. As a result, the X3-027 project will interconnect with the Atlantic City Electric system at the Barnegat 69/12V substation T1 transformer via a 12kv express feeder.

Direct Connection Requirements and Point(s) of Interconnection Conclusions

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 circuit will not be used for this 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.

   The Barnegat substation was identified as the closest substation based on the site location supplied in the application and/or Kick-off Call. Barnegat currently has one transformer.

   The aggregate limit of large (250 kW and over) generator injection to a single distribution transformer with a rating of 22.5 MVA or larger is 10 MWs. The Barnegat substation T1 transformer is available.

   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 following scope of work is dependent on approval from various local, county, state, and federal regulatory agencies. If approval is not granted, ACE will be unable to provide interconnection at Barnegat Substation.

Environmental Analysis and Scope of Work:

ACE will seek to secure environmental permits to construct a 12 kV feeder approximately 4.5 miles in length from the PV facility to the Barnegat Substation. The developer is to provide easements into the PV facility for ACE facilities at no expense to ACE prior to construction. This estimate assumes the following: 1) all applicable permitting will be obtained for the PV facility by the developer; and 2) distribution pole replacement (not in-kind but in the same immediate area) is required, wherever existing, along the length of the 12 kV feeder route.

Prepare and submit consultation letters to various local, county, State, and Federal regulatory agencies. Prepare and submit a development application to the Pinelands Commission. Attend field/office meetings with the Pinelands Commission for the development application. Perform a delineation of freshwater wetlands. Perform a habitat assessment for any T&E species with the potential to occur in the vicinity of the project. Conduct necessary T&E surveys, including preparation and submittal of protocol(s) and final report(s). Perform a Phase I Cultural Resource Site Survey for historic and/or archeological resources for the underground segment (does not include Phase 2B studies and/or artifact recovery and cataloging). Collect and deliver relevant GIS and survey data for preparation of required mapping. Preparation of mapping for permit applications. Preparation of permit applications. Submittal of permit applications. Preparation of a Soil Erosion Plan and the associated application, and submittal of such to the appropriate Soil Conservation District. Provide regulatory agency coordination and support. Provide public relations plan support and material for public meetings as required. Wetlands restoration plan preparation. Perform soil testing and remediation as required. Preparation of an Environmental Construction Monitoring Manual. Perform environmental construction monitoring during construction (including post construction review for restoration as needed). Preparation of a Health and Safety Plan.

ACE Scope of Work after Environmental Permitting:

1. One new 12 kV feeder will be constructed from Barnegat Substation to the PV site – a distance of approximately 4.5 miles. Due to physical space limitations on the transmission poles in the ROW the section of the feeder directly outside of the substation (approximately 2500 ft.) will be underground. All other sections of the feeder will be 954 kcmil AAC.
2. One new 12 kV feeder terminal position will be constructed.
3. A utility operated recloser equipped with the proper relaying and communications will be installed for each feeder serving the PV generator.
4. Utility grade primary metering will be required for each feeder.
5. 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.
6. A detailed, time-based study may be performed during later study phases.

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7. Protection, Planning, and other engineering departments will perform studies, design work, and prepare engineering estimates.
8. Transfer trip will be required.

The estimated cost to perform this work is:

Estimated Costs			
Barnegat Substation T1			
954 AAC Express Feeder		Miles	$6,567,000
Fiber Installation	4.5	Miles	$225,000
New Feeder Terminal			$407,000
Recloser w/ Relaying and Communications			$50,000
Utility Grade Metering			$20,000
SCADA Integration into EMS			$10,000
Detailed Time Based Study			$30,000
Environmental Engineering			$131,500
Various Departments Work			$20,000
Subtotal Cost			$7,460,500
Subtotal Cost with 18% Overheads			$8,803,390
Approximate Total Cost with 15% Contingency			$10,123,899

The estimated time to complete this work is **21-28 months (9-16 months for permitting, 12 months for construction)** after receipt of a fully executed interconnection agreement.

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.

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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.

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:

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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)

1. The (AE/JCPL) Cedar-Oyster Creek 230 kV line (from bus 227955 to bus 206302 ckt 1) loads from 147.55% to 148.63% (DC power flow) of its emergency rating (800 MVA) for the tower contingency 'AE3TOWER'. This project contributes approximately 8.64 MW to the thermal violation.

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.

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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.

1. To mitigate the (AE/JCPL) Cedar-Oyster Creek 230 kV line (from bus 227955 to bus 206302 ckt 1) overload will require the following:

   ACE
   Substation – Upgrade the Oyster Creek 230kV terminal at Cedar Substation to 3000A emergency rating. The estimated cost to perform this work is **$400,000** and will take **18-24 months** to complete.

   Transmission – Rebuild the 14 mile Cedar-Oyster Creek 230kV circuit to 3000A emergency rating. The estimated cost to perform this work is **$24.5 million** and will take **36-48 months** to complete.

   JCPL
   Replace with 3000A Disconnect Switch (Motor Operated and SCADA Controlled). The estimated cost to perform this work is $187,300.

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.

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1. The (AE) Cedar-Cardiff 230 kV line (from bus 227955 to bus 227900 ckt 1) loads from 135.97% to 137.01% (DC power flow) of its emergency rating (805 MVA) for the operational contingency 'B_CNJ2-SX-#34'. This project contributes approximately 8.39 MW to the thermal violation.

2. The (AE/JCPL) Cedar-Oyster Creek 230 kV line (from bus 227955 to bus 206302 ckt 1) loads from 147.19% to 148.26% (DC power flow) of its emergency rating (800 MVA) for the operational contingency 'CARD-CEDAR'. This project contributes approximately 8.63 MW to the thermal violation.

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Generation Interconnection
Feasibility Study Report
Queue Position X3-027

The Interconnection Customer (IC) has proposed a10 MW energy only (0 MWC; 10 MW MFO) solar powered generating facility to be located in Ocean Township, New Jersey.
PJM studied X3-027 as a 10 MW injection into the Atlantic City Electric Company (ACE) system at the Barnegat 12kV substation and evaluated the project for compliance with reliability criteria for summer peak conditions in 2015. The planned in-service date, as stated in the Attachment N, is December 31, 2012.

Point(s) of Interconnection

The IC requested the Point of Interconnection (POI) for X3-027 to be a 12.47 kV distribution level interconnection.

X3-027 will interconnect with the Atlantic City Electric Company system at a new 69/12kV substation to be constructed adjacent to the Barnegat-Cedar 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 circuit will not be used for this 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.

   The Barnegat substation was identified as the closest substation based on the site location supplied in the application and/or Kick-off Call. Barnegat currently has one transformer.

   The length of an express feeder is limited to 5 miles. Also, for the sake of the feasibility study, 3.8 straight line miles is used as an initial screen. 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.) In the case of this study, it was immediately apparent that no direct route exists between the substation and the solar site. For this reason, the area was examined in some detail and a reasonable path for the feeder was found to be approximately 7 miles in length. The annual energy loss (4.5%) anticipated over the 12kV express feeder is significantly higher than ACE would consider to

be good practice (3% maximum.) The 12kV express feeder will not be used in this report because it exceeds ACE's maximum allowable length.

There are no other substations within 3.8 straight line miles of the solar site or where a feeder of less than 5 miles in length could be established.

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 or near 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 Barnegat – Cedar 0777 69 kV line with an approximate total distance of 7 miles of double circuit transmission line to the new substation. New transmission lines will include OPGW communication lines.
3. Add OPGW fiber line to existing transmission line poles in place of static wire from Barnegat to Cedar to support relaying and communications of transmission lines. This is an approximate total distance of 6.5 miles of new OPGW.
4. Establish a 12 kV connection and 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)	1		$70,000
Transmission Feed 69 kV	14	Miles	$9,100,000
Fiber Installation			$715,000
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			$14,369,000
Subtotal Cost with 18% Overheads			$16,955,420
Approximate Total Cost with 15% Contingency			$19,498,733

The estimated time to complete the work is **24 – 36 months** after receipt of a fully executed interconnection agreement.

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)

1. The (AE/JCPL) Cedar-Oyster Creek 230 kV line (from bus 227955 to bus 206302 ckt 1) loads from 147.55% to 148.63% (DC power flow) of its emergency rating (800 MVA) for the tower contingency 'AE3TOWER'. This project contributes approximately 8.64 MW to the thermal violation.

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.

1. To mitigate the (AE/JCPL) Cedar-Oyster Creek 230 kV line (from bus 227955 to bus 206302 ckt 1) overload will require the following:

   ACE
   Substation – Upgrade the Oyster Creek 230kV terminal at Cedar Substation to 3000A emergency rating. The estimated cost to perform this work is **$400,000** and will take **18-24 months** to complete.

   Transmission – Rebuild the 14 mile Cedar-Oyster Creek 230kV circuit to 3000A emergency rating. The estimated cost to perform this work is **$24.5 million** and will take **36-48 months** to complete.

   JCPL
   Replace with 3000A Disconnect Switch (Motor Operated and SCADA Controlled). The estimated cost to perform this work is $187,300.

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) Cedar-Cardiff 230 kV line (from bus 227955 to bus 227900 ckt 1) loads from 135.97% to 137.01% (DC power flow) of its emergency rating (805 MVA) for the operational contingency 'B_CNJ2-SX-#34'. This project contributes approximately 8.39 MW to the thermal violation.

2. The (AE/JCPL) Cedar-Oyster Creek 230 kV line (from bus 227955 to bus 206302 ckt 1) loads from 147.19% to 148.26% (DC power flow) of its emergency rating (800 MVA) for the operational contingency 'CARD-CEDAR'. This project contributes approximately 8.63 MW to the thermal violation.