Generation Interconnection
Feasibility Study Report
Queue Position V3-036

General

The Interconnection Customer (IC), has proposed a 5.5 MW energy (5.5 MW capacity) natural gas (fuel oil backup) fueled generating facility to be located at the Midtown Thermal Control Center in Atlantic City, New Jersey. The project will consist of a single simple cycle gas turbine with heat recovery steam generator. V3-036 was studied as a 5.5 MW injection into the Atlantic City Electric (ACE) system at the Ontario 23kV substation and evaluated for compliance with reliability criteria for summer peak conditions in 2014. The current in-service date for the project is March 1, 2011.

Point of Interconnection (POI)

V3-036 has the capability to interconnect to three separate ACE 23kV distribution system circuits which feed the Midtown Thermal bus: the Higbee substation #17, the Ontario substation #6, or the Ontario substation #7.

Direct Connection Requirements

Summary of System Enhancements/Changes Needed:

- Replace the existing feeder and reclosing relays on the 23kV feeder terminals at Higbee and Ontario Substation with a multi-function SEL-451 microprocessor relay and a SEL-551 backup relay.

- Install a fiber optic bi-directional transfer trip communication channel (two fibers) between Ontario, Higbee, and the Midtown Thermal site. The transfer trip channel will use SEL Mirrored Bits® protocol. Transfer trip will be sent from Higbee and Ontario to the site to trip the generation. The status of all the generator breaker will be sent from the site to Higbee and Ontario Substations.

The Transmission Owner's (ACE) scope of work includes:

1. Metering

Scope:
Construct a three phase primary metering with metering telemetry and I/Os. Interconnection Customer will be required to provide and maintain a voice quality phone line within approximately 3 feet of the ACE meter to enable ACE to remotely interrogate the meter.

Telemetry
The Interconnection Customer will grant PJM permission to supply ACE telemetry data, including interval and real time data that the Interconnection Customer sends to PJM.

Costs per meter:
Direct (Internal or ACE)
- Labor - $2,000 x 3 = $6,000
- Material – $14,000 = $42,000

Metering Total Cost: $48,000

2. Substation Engineering

Scope:
Relay modifications are needed on the #6 and #7 23kV feeder terminals at Ontario Substation and #17 feeder terminal at Higbee Substation.

Costs per terminal:

Direct (Internal or ACE)
- Labor – $80,000 x 3 = $240,000
- Material – $15,000 x 3 = $45,000

Substation Engineering Total Cost: $285,000

3. Project Management and Special Billing

Scope:
Coordinate all internal groups working on this project as well as with the customer to insure project completion by the agreed upon in-service date and within budget.

Costs:

Direct (Internal or ACE)
- Labor – 5,000
- Material – N/A

Project Management and Special Billing Total Cost: $5,000

4. System Protection

Scope:
System Protection work including relay specifications, relay settings, system modeling, review of customer drawings, review of customer settings, meetings and other support activities would take approximately 80 man-hours.   (This estimate is based on actual hours used for similar landfill generator interconnections.)   Some System Protection expense will be incorporated into the cost estimate for the relay scheme modifications at Corson Substation.

Costs:

Direct (Internal or ACE)
- Labor – $9,000 (80 hrs)
- Material – N/A

System Protection Total Cost: $9,000

5. System Operations

Scope:
This would include EMS display work, database work to accommodate additional monitored points for the new generator, verification of accuracy and scaling constants, meeting participation, inclusion of any new data into our PI system.

Costs:

Direct (Internal or ACE)
- Labor – 1,610 (14 hrs)
- Material – N/A

System Operations Total Cost: $1,610

6. Interconnection Arrangements

Scope:
Perform interconnection technical issue review and resolution. Review installation approach and initial output to insure compliance with agreement.

Costs:

Direct (Internal or ACE)
- Labor - $2,300 (20 hrs)
- Material – N/A

Interconnection Arrangements Total Cost: $2,300

7. System Planning

Scope:
Review initial plans and coordinate the Feasibility/Impact study. Incorporate the capacity resource into overall
to meet the
criteria.

Costs:

Direct (Internal or ACE)
- Labor – $4,600 (40 hrs)
- Material – N/A

System Planning Total Cost: $4,600

Project Total:

Direct (Internal or ACE)
-Labor - $268,510
-Material - $87,000

Total: $355,510

With 18% Overheads (ESAG) and 15% Contingency

Direct (Internal or ACE)
-Labor - $364,368
-Material - $118,059

Indirect (External or Contractor)
-Labor - $0
-Material - $0

ESTIMATED PROJECT TOTAL COSTS: $482,427

Interconnection Customer Scope of Direct Connection Work

The IC is responsible for all construction related activities on their side of the Point of Interconnection. IC will interconnect V3-036 with the ACE system by constructing a customer owned 23kV circuit from their facility to the Midtown Thermal bus. The above cost estimates do not include construction of that line or bus work. Route selection, line design, right-of-way acquisition and construction of such lines will be entirely the responsibility of the Interconnection Customer.

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 the Atlantic City Electric Applicable Standards.

Cost and Timing Summary

While the information in this transmittal is reasonable for the scope of work defined, it should be noted however, that the cost figures are conceptual in nature at this stage, and that an engineering team has not yet been assigned to the project. Any change to the scope of work will require that the estimates be revisited. The costs are a best estimate, but the developer will be charged for actual costs. Any under-runs or over-runs will be reconciled at the conclusion of the project.

The estimated time to provide for the interconnection of this project is **6-12 months** after the receipt of a fully executed Interconnection Service Agreement and Interconnection Construction Service Agreement.

Abnormal ACE System Conditions

The Midtown Thermal site has the capability to be served from three separate feeders. If it is desired for the generator to run under all conditions, transfer trip and relay upgrades will need to be provided for all three terminals. To avoid tripping the generation for a problem on a non-connected source, logic could be used to only accept transfer trip from the currently connected source. Alternately, the generation could be restricted to running only on the normal source.

Load limitations

Midtown Thermal will have the following load limitations with the generator:

1. No two ACE feeders can be tied together at the generator site, i.e the generator can only be connected to one of the three feeders at a time.

2. The Midtown Thermal plant load cannot exceed 9 MVA without the generator, or 3.3 MVA with the generator on when connected to Ontario Sub Feeder NJ9245 (#6) so that under a generator trip, the load will not exceed 9 MVA.

3. The Midtown Thermal plant load cannot exceed 14.3 MVA without the generator, or 8.6 MVA with the generator on when connected to Ontario Sub Feeder NJ9246 (#7) so that under a generator trip the load will not exceed 14.3 MVA.

4. The Midtown Thermal plant load cannot exceed 11 MVA without the generator, or 5.3 MVA with the generator on when connected to Higbee Sub Feeder NJ9257 (#17) so that under a generator trip the load will not exceed 11 MVA.

Short Circuit

The System Protection ASPEN Short Circuit Program was used to calculate short circuit values. A comparison of existing fault values and the resulting fault values with the new 5.7 MW generators in service is provided in the tables below.

3-Phase Faults at Selected Locations with & Without Interconnected Generators

Fault Location	No Gen	With Gen	% Change
Ontario 69kV Bus (#6)	26774 A.	26934 A.	+0.6 %
Ontario 23kV Bus (#6)	26140 A	26838 A	+2.6 %
Midtown 23kV Bus (#6)	13796 A	14508 A	+ 4.91 %
Ontario 69kV Bus (#7)	26774 A	26934 A	+0.6 %
Ontario 23kV Bus (#7)	26140 A	26824 A	+2.6 %
Midtown 23kV Bus (#7)	14174 A	14885 A	+ 5.02 %
Higbee 69kV Bus (#17)	27064 A	27284 A	+0.81 %
Higbee 23kV Bus (#17)	11998 A	12697 A	+5.83 %
Midtown 23kV Bus (#17)	8753 A	9465 A	+8.13 %

1L-G Faults at Selected Locations with & Without Interconnected Generators

Fault Location	No Gen	With Gen	% Change
Ontario 69kV Bus (#6)	23807 A	23891 A	+0.35%
Ontario 23kV Bus (#6)	27747 A	28268 A	+1.88%
Midtown 23kV Bus (#6)	14250 A	14740 A	+3.44%
Ontario 69kV Bus (#7)	23807 A	23891 A	+0.35%
Ontario 23kV Bus (#7)	27747 A	28257 A	+1.84%
Midtown 23kV Bus (#7)	14421 A	14896 A	+3.29%
Higbee 69kV Bus (#17)	25138 A	25265 A	+0.51%
Higbee 23kV Bus (#17)	12674 A	13187 A	+4.05%
Midtown 23kV Bus (#17)	9228 A	9744 A	+5.59%

The impedance of the 23kV distribution circuit and the generation location tend to limit the increase in overall feeder fault current. There is minimal impact to 69kV and 23kV faults at Ontario or Higbee Substation. The largest fault current increases are in the area nearer the generation site and even these appear to be well within equipment ratings. Any possible feeder re-conductoring done to support this additional generation interconnection will have some impact on the above short circuit values. However, the feeder circuit reactance should remain about the same which will limit any significant increase in fault current values. The generator owner will have to design their 23kV and 480V equipment to handle the expected short circuit currents at their site.

In summary, there is limited impact on area short circuit currents and no ACE breakers or other equipment appears to be over stressed as a result of the proposed generator interconnection.

Islanding Protection

Background

In the event of source circuit loss, the generators must not continue to operate in an island condition with other Atlantic City Electric load. In addition, the generators must be disconnected before any auto reclose on the ACE source circuit. Local protection at the generator site must detect islanding and disconnect the generators. Frequency and voltage sensing is generally used to detect islanding in addition to being used for fault detection and to prevent abnormal generator operation outside allowable ranges. Trip values and operating times for voltage and frequency protection are outlined in IEEE Standard 1547, 2005, *IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems*. The generator protection must sense these quantities at the 23kV Point of Interconnection (POI) and disconnect the generators within the values and operating times defined in IEEE 1547.

To utilize frequency and voltage protection to detect islanding, the voltage and/or frequency must decline to the required setting range and within the necessary clearing time. For this to occur, a certain amount of generation to load mismatch is required. The IEEE 1547 Standard (Section 4.4, "Islanding" & "Footnote 12") require that the generator capacity be less than one third of the minimum load in the local electric power system. This criteria was used to evaluate the generator isolation cases detailed below.

<u>Trip of the 23kV Source Feeder</u>
The initial tripping of any of the three possible source lines will result in the proposed generator being isolated with the total loads of that feeder. Distribution planning for the Atlantic Region provides the following load data for these feeders.

Feeder	Peak Load
#6	10.3 MVA
#7	14.2 MVA
#17	5.5 MVA

<u>#6</u>
0.9(10.3) = 9.27 MW @ 0.9 PF
9.27/5.7 = 1.62/1 Load to Generation Ratio at Peak Load

System Operations normally considers minimum load to be approximately 40% of peak load.
0.4(9.27) = 3.71 MW
3.71/5.7 = 0.65/1 Load to Generation Ratio at Estimated Minimum Load

<u>#7</u>
0.9(14.2) = 12.78 MW @ 0.9 PF
12.78/5.7 = 2.24/1 Load to Generation Ratio at Peak Load

System Operations normally considers minimum load to be approximately 40% of peak load.
0.4(12.78) = 5.11 MW
5.11/5.7 = 0.897/1 Load to Generation Ratio at Estimated Minimum Load

<u>#17</u>
0.9(5.5) = 4.95 MW @ 0.9 PF
4.95/5.7 = 0.86/1 Load to Generation Ratio at Peak Load

System Operations normally considers minimum load to be approximately 40% of peak load.
0.4(4.95) = 1.98 MW
1.98/5.7 = 0.34/1 Load to Generation Ratio at Estimated Minimum Load

Based on the preceding minimum loading, it appears that operation of the local voltage and frequency relaying at the generator site is inadequate at minimum load and cannot insure detection of all islanding cases. Therefore, transfer trip is required between Higbee and Ontario Substations and the generators. The existing over current relays on the supply feeders will need to be replaced with a SEL-451 multi-function microprocessor relays that will interface with the transfer trip channel.

Trip of the Higbee #2 69/23kV Transformer

A trip of the Higbee #2 transformer will island the generator with the #17 load. In the event of a breaker failure operation of Higbee CB C6 transfer trip should be sent to the generator.

Trip of the Ontario #1 or #2 23kV Bus

A trip of either the Ontario #1 or #2 transformer will island the generator with either the #6 or #7 load. In the event of a breaker failure operation of Ontario CB S or U transfer trip should be sent to the generator.

Feeder Circuit Fault Detection

The generator must automatically and immediately disconnect in the event of fault conditions on the ACE source circuit. The IEEE 1547 document (Section 4.1.2, "Integration with Area EPS Grounding" and Section 4.2.1 "Area EPS Faults") requires that interconnected generators disconnect for utility source circuit faults and not cause over voltages.

Generator Impact on Feeder Terminal Protection

The relay sensitivity on the 23kV Feeder Terminals at Higbee and Ontario Substations will still be adequate with the proposed new generation at the Midtown Thermal facility.

Generator Feeder Circuit Fault Detection Sensitivity

The available fault current from the Midtown Thermal generator will be somewhat limited due to their size and the impedance of the generator step-up transformer. Specific information on the protection set points is not yet available. However, the generator protection should be capable of detecting faults on the 23kV system and disconnecting the generator.

Transmission Network Impacts

Potential 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

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

Stability Analysis

Not Required.