Generation Interconnection
Feasibility Study Report
Queue Position X1-074

The Interconnection Customer (IC) has proposed a 291 MWE (291 MWC; 291 MW MFO) natural gas fueled combined cycle generating facility consisting of one (1) combustion turbine and one steam turbine. The project is to be located in Wilmington, Delaware. PJM studied X1-074 as a 291 MW injection into the Delmarva Power and Light system at the Hay Road 230kV substation and evaluated the project for compliance with reliability criteria for summer peak conditions in 2015. The proposed in-service date, as stated in Attachment N, is June 1, 2015.

Point of Interconnection

X1-074 will interconnect with the Delmarva Power and Light transmission system at the Hay Road 230kV substation.

Direct Connection Requirements

Transmission Owner Scope of Direct Connection Work

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

There is no Delmarva Power and Light direct connect work associated with X1-074.

Special Operating Requirements

1. The Company 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 of the Company.

2. The Interconnection Customer will grant its permission to PJM for PJM to send the Company the following telemetry data that the Interconnection Customer sends to PJM: real time megawatts, megavars, volts, amperes and status, and interval megawatt-hours, and megavar-hours. For generation larger than 10 MW, a direct telemetry connection to PHI System Operations will be required via a radial connection to PHI's telecommunications system or a rented data circuit, at the Interconnection Customer's cost.

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 Direct Connection Work

The Interconnection Customer (IC) is responsible for all design and construction related 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 Interconnection Customer will be responsible for contributing to future O & M costs associated with the direct connect facilities.

Protective relaying and metering design and installation must comply with PHI'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.

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)*

1. The (PL/BG&E) Otter Creek Switchyard-Conastone 230 kV line (from bus 208048 to bus 220963 ckt 1) loads from 97.83% to 98.45% (DC power flow) of its emergency rating (531 MVA) for the single contingency 'PJM17'. This project contributes approximately 20.62 MW to the thermal violation.

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)

2. The (PECO) Linwood-Chichester 2 230 kV line (from bus 213750 to bus 213490 ckt 1) loads from 113.67% to 114.39% (DC power flow) of its emergency rating (983 MVA) for the single contingency '220-39'. This project contributes approximately 46.42 MW to the thermal violation.

3. The (PJM) Peach Bottom-Conastone 500 kV line (from bus 200013 to bus 200004 ckt 1) loads from 129.95% to 133.77% (DC power flow) of its emergency rating (2815 MVA) for the single contingency 'PJM67'. This project contributes approximately 111.29 MW to the thermal violation.

4. The (PJM) Peach Bottom-Conastone 500 kV line (from bus 200013 to bus 200004 ckt 1) loads from 129.42% to 134.12% (DC power flow) of its normal rating (2490 MVA) for non contingency condition. This project contributes approximately 120.04 MW to the thermal violation.

5. The (DP&L) Darley-Citisteel Tap 69 kV line (from bus 231205 to bus 231213 ckt 1) loads from 100.12% to 101.31% (DC power flow) of its emergency rating (137 MVA) for the tower contingency 'DBL_5NC'. This project contributes approximately 10.07 MW to the thermal violation.

6. The (PECO) Linwood-Chichester 2 230 kV line (from bus 213750 to bus 213490 ckt 2) loads from 114.07% to 114.79% (DC power flow) of its emergency rating (983 MVA) for the single contingency '220-43'. This project contributes approximately 46.58 MW to the thermal violation.

7. The (PECO) Richmond-Waneeta 3 230 kV line (from bus 213922 to bus 214012 ckt 1) loads from 136.47% to 136.95% (DC power flow) of its emergency rating (914 MVA) for the single contingency 'CHIC125'. This project contributes approximately 27.03 MW to the thermal violation.

8. The (BG&E) Conastone-EMORY GRV230 230 kV line (from bus 220963 to bus 220400 ckt 2) loads from 103.61% to 104.0% (DC power flow) of its emergency rating (941 MVA) for the single contingency 'PP1EC'. This project contributes approximately 24.87 MW to the thermal violation.

9. The (PECO/BG&E) Cooper-Graceton 230 kV line (from bus 214089 to bus 220964 ckt 1) loads from 115.36% to 116.38% (DC power flow) of its emergency rating (485 MVA) for the single contingency 'PJM17'. This project contributes approximately 30.44 MW to the thermal violation.

10. The (PSEG/PECO) Camden-Richmond 230 kV line (from bus 219125 to bus 213922 ckt 1) loads from 140.96% to 141.41% (DC power flow) of its emergency rating (1037 MVA) for the single contingency 'CHIC125'. This project contributes approximately 29.01 MW to the thermal violation.

11. The (PL/METED) Brunner Island Bus-Yorkana 230 kV line (from bus 207922 to bus 204515 ckt 1) loads from 130.17% to 130.56% (DC power flow) of its emergency rating (617 MVA) for the single contingency 'PJM17'. This project contributes approximately 14.74 MW to the thermal violation.

12. The (PECO) Peach Bottom-Cooper 230 kV line (from bus 213869 to bus 214089 ckt 1) loads from 116.85% to 117.86% (DC power flow) of its emergency rating (485 MVA) for the single contingency 'PJM17'. This project contributes approximately 30.44 MW to the thermal violation.

13. The (PJM) Conastone-EMORY GR500 500 kV line (from bus 200004 to bus 200101 ckt 1) loads from 109.37% to 109.87% (DC power flow) of its emergency rating (2901 MVA) for the tower contingency 'CNSTN_NWESTA'. This project contributes approximately 90.38 MW to the thermal violation.

14. The (PJM) Conastone-EMORY GR500 500 kV line (from bus 200004 to bus 200101 ckt 1) loads from 105.31% to 108.74% (DC power flow) of its normal rating (2338 MVA) for non contingency condition. This project contributes approximately 80.11 MW to the thermal violation.

15. The (BG&E) Conastone-EMORY GRV230 230 kV line (from bus 220963 to bus 220400 ckt 1) loads from 117.21% to 117.64% (DC power flow) of its emergency rating (819 MVA) for the single contingency 'PP1EC'. This project contributes approximately 24.58 MW to the thermal violation.

16. The (DP&L) Silverside Road-Darley 69 kV line (from bus 231215 to bus 231205 ckt 1) loads from 106.27% to 107.2% (DC power flow) of its emergency rating (175 MVA) for the tower contingency 'DBL_5NC'. This project contributes approximately 10.07 MW to the thermal violation.

17. The (PECO/AE) Delco Tap-Mickleton 230 kV line (from bus 213559 to bus 228401 ckt 1) loads from 109.12% to 109.59% (DC power flow) of its emergency rating (725 MVA) for the single contingency 'CHIC125'. This project contributes approximately 22.08 MW to the thermal violation.

18. The (PJM/METED) Three Mile Island-Three Mile Island 500/230 kV transformer (from bus 200016 to bus 204514 ckt 2) loads from 107.84% to 111.16% (DC power flow) of its emergency rating (1072 MVA) for the single contingency 'PJM17'. This project contributes approximately 37.24 MW to the thermal violation.

19. The (BG&E) North West 2311 & 2310-Granite 2311 & 2312 230 kV line (from bus 220962 to bus 220972 ckt 1) loads from 115.87% to 119.1% (DC power flow) of its emergency rating (621 MVA) for the single contingency 'PP1EB'. This project contributes approximately 21.15 MW to the thermal violation.

20. The (DP&L) Citisteel Tap-Naamans 69 kV line (from bus 231213 to bus 231211 ckt 1) loads from 113.78% to 115.15% (DC power flow) of its emergency rating (119 MVA) for the tower contingency 'DBL_5NC'. This project contributes approximately 10.07 MW to the thermal violation.

Short Circuit

No overstressed breakers were identified.

Stability Analysis

Will be performed during System Impact Study phase of the project.

New System Reinforcements

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

1. To mitigate the (PPL/BG&E) Otter Creek Switchyard-Conastone 230 kV line (from bus 208048 to bus 220963 ckt 1) overload will require the following:

   The BG&E portion of the Conastone to Otter Creek line can be upgraded by reconductoring the circuit from Gorsuch Mills to the Pennsylvania state line (change of ownership to PPL). The existing circuit 2302 conductor is 1,590 kcmil 45/7 ACSR from Conastone to Gorsuch Mills and 795 kcm 30/19 ACSR from Gorsuch Mills to the PA State Line.

   Assumptions:

   - Reconductor with 1,590 kcm ACSR from Gorsuch Mills to PA line to match capability of remainder of line.
   - Length of this line section is 1.7 miles.
   - Towers can be reinforced instead of replaced.
   - Based on previous estimate by R.W.M. for PJM (B48) study on circuit 22008

   The estimated cost of this upgrade is **$700,000**. Estimated construction time is **36 months**.

   PPL has recently submitted plans to PJM to rebuild the Otter Creek - Conastone 230kV line as part of a modernization project (submitted to PJM as supplemental project S0233). This project is tentatively scheduled to be complete by May 2013 (prior to the X1-074 project's 2015 requested in-service date).

   The S0233 upgrade will consist of rebuilding approximately 12 miles of 795 kcmil 30/19 ACSR (current ratings 425/531MVA Summer Normal/Summer Emergency based on conductor temp @ 125 Deg C) with new 1590 kcmil 45/7 ACSR or equivalent (new ratings 653/793MVA Summer Normal/Summer Emergency based on conductor temp @ 125 Deg C). The new circuit will be designed for double circuit but built single circuit initially. Existing structures will need to be removed and rebuilt as part of this upgrade.

   This does not include rebuilding of the remaining ~5 miles of the BG&E portion of the line or the upgrade of any substation terminal equipment required at Conastone 230 kV substation. BG&E will need to provide comments on the proposed upgrade and the associated cost estimate.

Contribution to Previously Identified System Reinforcements

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

2,6. To mitigate the Linwood-Chichester 230 kV circuits #1 and #2 overloads will require the installation of a 3rd Linwood-Chichester 230kV line underground with a minimum summer normal and emergency rating of 831/983 MVA. This line is approximately 1.6 miles long. A new 230kV bus position and breaker at Chichester and Linwood Substations will be required for this new line.

The estimated cost to perform this work is **$25,000,000** and will take **4 years** to complete. This cost does not include any right-of-way costs which may be required.

3,4. To mitigate the Peach Bottom-Conastone 500 kV line overloads will require the installation of a new 2nd PB-Conastone 500 kV line with a minimum normal and emergency rating of 2,920 / 3,707 MVA, respectively. The line is approximately 6 miles long. The estimated cost to perform this work is **$25M and** will require **60 months** to complete. The cost does not include right-of-way costs for the new line.

PECO segment additional work:
Replace the 5012 terminal equipment at Peach Bottom substation to achieve the conductor normal and emergency rating of 2,920 / 3,707 MVA, respectively. The estimated cost to perform this work is **$5M** and will require **3 years** to complete. (Network upgrade n2139)

BGE segment additional work:
Rebuild bay with breakers A, B, C to a new 4000A rating. The estimated cost to perform this work is **$6.6M** and will require **2-3 years** to complete.

5. To mitigate the (DP&L) Darley-Citisteel Tap 69 kV line overload will require rebuilding the 0.23 mile section of single circuit steel poles, the 0.52 mile section of single circuit wood poles, the 0.11 mile section of wood pole H-Frames, and the 0.04 mile tap section with new steel poles and 954 ACSR"Rail". The estimated cost to perform this work is **$710,000** and will take **24-30 months** to complete.

7. To mitigate the (PECO) Richmond-Waneeta 3 230 kV line overload will require upgrading 24 of the 61 components including underground and aerial conductors. The estimated cost to perform this work is **$20M** and will take **3 years** to complete.

The two largest components of this work include:

1) Remove the existing two UG cables (2-3-1x3000 KCMIL CU HPOFP) and replace with three dielectric (XLPE - cross link polyethelene) cables. Plus the additional terminal equipment (underground Line conductor)

2) Reconductor the aerial portion of the line using the Pecos conductor which has an emergency rating of 3131A , which meets the minimum rating requirement of 3121A. This will result in a 10A = 4 MVA margin when compared to the new aerial conductor rating.

8,13,14,15. To mitigate the (BG&E) Conastone-EMORY GRV230 230 kV line overloads will require the two breaker bay at Conastone for the Brighton line to be upgraded due to it being over its continuous rating. Upgrade the Conastone bay with two (2) 4000A breakers, four (4) 4000A breaker disconnects and a 4000 A line switch. The estimated cost to perform this work is **$3M** and will take **24-36 months** to complete.

9. To mitigate the (PECO/BG&E) Cooper-Graceton 230 kV line overload will require the following:

PECO portion: Reconductor the line 220-93 from Cooper Substation to Graceton Substation to get a minimum summer emergency rating of 725 MVA. The line is approximately 4 miles long. The estimated cost to perform this work is **$2.8M** and will take **24 months** to complete. This cost is for the PECO portion only.

BGE portion: Construct a double circuit line with 1033.5kcmil ACSR creating one circuit by connecting the two lines into one. Rating for 2 – 1033.5kcmil 45/7 ACSR (Ortolan) at 125°C = 968/1227MVA SN/SE. BGE owns 1.85 miles of the circuit and the rebuild of 11 structures. It would be built as a double circuit line with the conductors jumpered across at the terminal ends. The estimated cost to construct the line is at **$3,000,000**. Two (2) breakers ($400,000/breaker) would need to be replaced at Graceton for a cost of **$800,000**. An additional cost of **$200,000** would also be incurred for four (4) breaker disconnects and line connections. The project is estimated to take **30 months** to complete: 12 months for the CPCN process & design and an additional 18 months for construction. The total cost of the project is estimated at **$4.0M**.

10. To mitigate the (PSEG/PECO) Camden-Richmond 230 kV line overload will require accelerating a previously identified 2016 RTEP project which constructs an express circuit from Camden to Richmond. The need to accelerate is based on the X1-074 project's current requested in-service date of June 1, 2015. Costs associated with accelerating this project will be determined during a later study phase. The total cost for the RTEP project is **$40M** with a lead time of **36-48 months**. (baseline upgrade b1590)

11. To mitigate the (PPL/METED) Brunner Island Bus-Yorkana 230 kV line overload will require the following:

PPL segment:
To mitigate the Brunner – Yorkana 230kV line overload will require the rebuild and upgrade of approximately 0.6 miles of PPL EU owned Brunner Island – Yorkana 230kV line and the substation line terminal equipment. The existing 1033 kcmil ACSR conductor will be replaced with new 1590 kcmil ACSR conductor or equivalent with and operating temperature of 140deg C to achieve the summer normal and emergency ratings of 712 MVA and 865 MVA respectively. The Yorkana 230kV bay conductors at Brunner Island 230kV switchyard will also be upgraded to conform with the higher line ratings. The estimated cost to perform this work is **$1,700,000** and will take **24 months** to complete.

METED segment:
This portion of the reinforcement remains under development and will be provided as part of the System impact Study report.

12. To mitigate the (PECO) Peach Bottom-Cooper 230 kV line overload will require reconductoring line 220-08 from PB Tap to Cooper Substation to get a minimum summer emergency rating of 741 MVA. The line is approximately 1.4 miles long. The estimated cost to perform this work is **$1.0M** and will take **24 months** to complete.

16. Construction is already planned within DPL to start in September 2011 to reconductor the Darley - Silverside Road 69kV line. The rating for this line should increase to 191 MVA as a result of the work which would eliminate the 107.2% overload we are seeing.

17. To mitigate the MCKLTON-DELCOTAP 230kV (AE/PECO) overload would require upgrading the 2-954 AL 230kV strand bus at Mickleton to 2-1590 AL. The estimated cost to perform this work is **$74,000** and will take **6-12 months** to complete.

18. To mitigate the 3 MILE I-TMI 500/230kV (METED) transformer overload would require the addition of a second 500/230kV transformer at TMI as well as transmission line upgrades between the 230kV and 500kV substations. The estimated cost to perform this work is **$15M** and will take **36 months** to complete.

19. To mitigate the Northwest-Granite 2311 230kV line overload will require reconductoring the line with 2,167 ACSR which will increase the rating to 1105MVA. There will also be substation terminal upgrade costs associated with the reinforcement. The estimated cost to perform this work is **$23.6M** and will take **6 years** to complete.

20. To mitigate the (DP&L) Citisteel Tap-Naamans 69 kV line overload will require rebuilding the 0.23 mile section of single circuit steel poles, the 0.52 mile section of single circuit wood poles, the 0.11 mile section of wood pole H-Frames, and the 0.04 mile tap section with new steel poles and 954 ACSR“Rail”. The estimated cost to perform this work is **$240,000** and will take **24-30 months** to complete.