Generation Interconnection
Feasibility Study Report
Queue Position X2-067

The Interconnection Customer (IC) has proposed a 309 MWE (309 MWC, 309 MW MFO) natural gas fueled 1x1 combined cycle generating facility. The project is to be located in the Garrison Oak Technical Park in Dover, Delaware. PJM studied X2-067 as a 309 MW injection into the Delmarva Power and Light (DPL) system at the Cartanza 230kV substation. The project was evaluated for compliance with reliability criteria for summer peak conditions in 2015. The proposed in-service date, as stated in Attachment N, is June 01, 2016.

Point of Interconnection

X2-067 will interconnect with the Delmarva Power and Light transmission system at the Cartanza 230kV substation via a new bus position.

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:

Attachment Facilities:

Substation Engineering Estimate:
Scope: Construct a 230kV bus position for the IC's direct connect line. The new generation will be in addition to the W3-032A generation. Please note that if both projects go in service then they will likely be supplied by a common 230kV terminal.

Estimate: $5,000,000
Construction Time: 30 – 36 months

Transmission Engineering Estimate:
Scope: Install a self-supporting 230kV steel pole with a concrete foundation, motor operated disconnects and a short span to PHI substation.
Estimate: $375,000
Construction Time: 24 months.

Note: If location of generator is greater than 500 feet from substation an additional Interconnection Customer circuit breaker will be required.

Contribution in Aid of Construction (CIAC) tax will be included upon further study.

Transmission Owner Special Operating Requirements

- PHI will require the capability to remotely trip the generator from its System Operations facility.

- The Interconnection Customer will grant its permission for PJM to send PHI all telemetry that the Interconnection Customer sends to PJM.

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

- 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 between the Interconnection Customer and PHI.

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 (PECO) Nottingham-Nottingham Reactor 230 kV line (from bus 213844 to bus 213846 ckt 1) loads from 99.50% to 100.26% (DC power flow) of its emergency rating (627 MVA) for the single contingency 'PJM17'. This project contributes approximately 33.32 MW to the thermal violation.

2. The (PECO) Nottingham Reactor-Peach Bottom 230 kV line (from bus 213846 to bus 213869 ckt 1) loads from 99.38% to 100.13% (DC power flow) of its emergency rating (627 MVA) for the single contingency 'PJM17'. This project contributes approximately 33.32 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)

1. (BG&E) The North West 2311 & 2310-Granite 2311 & 2312 230 kV line (from bus 220962 to bus 220972 ckt 1) loads from 137.33% to 143.32% (DC power flow) of its emergency rating (621 MVA) for the single contingency 'PP1EB'. This project contributes approximately 22.58 MW to the thermal violation.

2. (PECO) The Richmond-Waneeta 3 230 kV line (from bus 213922 to bus 214012 ckt 1) loads from 125.61% to 126.12% (DC power flow) of its emergency rating (914 MVA) for the single contingency 'CHIC125'. This project contributes approximately 28.57 MW to the thermal violation.

3. (BG&E) The Conastone-EMORY GRV230 230 kV line (from bus 220963 to bus 220400 ckt 2) loads from 108.28% to 108.66% (DC power flow) of its emergency rating (941 MVA) for the single contingency 'PP1EC'. This project contributes approximately 26.60 MW to the thermal violation.

4. (PECO/BG&E) The Cooper-Graceton 230 kV line (from bus 214089 to bus 220964 ckt 1) loads from 130.67% to 131.66% (DC power flow) of its emergency rating (485 MVA) for the single contingency 'PJM17'. This project contributes approximately 33.32 MW to the thermal violation.

5. (PSEG/PECO) The Camden-Richmond 230 kV line (from bus 219125 to bus 213922 ckt 1) loads from 141.02% to 141.5% (DC power flow) of its emergency rating (1037 MVA) for the single contingency 'CHIC125'. This project contributes approximately 30.67 MW to the thermal violation.

6. (PL/METED) The Brunner Island Bus-Yorkana 230 kV line (from bus 207922 to bus 204515 ckt 1) loads from 143.40% to 144.44% (DC power flow) of its emergency rating (617 MVA) for the single contingency 'PJM17'. This project contributes approximately 15.73 MW to the thermal violation.

7. (PL/BG&E) The Otter Creek Switchyard-Conastone 230 kV line (from bus 208048 to bus 220963 ckt 1) loads from 106.97% to 107.63% (DC power flow) of its emergency rating (531 MVA) for the single contingency 'PJM17'. This project contributes approximately 22.06 MW to the thermal violation.

8. (BG&E) The North West 2326 & 2322-Granite 2326 & 2332 230 kV line (from bus 220961 to bus 220973 ckt 1) loads from 113.72% to 118.62% (DC power flow) of its emergency rating (728 MVA) for the single contingency 'PP1EB'. This project contributes approximately 21.83 MW to the thermal violation.

9. (PJM) The Peach Bottom-Conastone 500 kV line (from bus 200013 to bus 200004 ckt 1) loads from 152.06% to 158.17% (DC power flow) of its emergency rating (2815 MVA) for the single contingency 'PJM67'. This project contributes approximately 118.57 MW to the thermal violation.

10. (PJM) The Peach Bottom-Conastone 500 kV line (from bus 200013 to bus 200004 ckt 1) loads from 155.76% to 163.04% (DC power flow) of its normal rating (2490 MVA) for non contingency condition. This project contributes approximately 128.23 MW to the thermal violation.

11. (DP&L) The New Meredith-Church 69 kV line (from bus 232812 to bus 232203 ckt 1) loads from 100.82% to 104.61% (DC power flow) of its emergency rating (93 MVA) for the tower contingency 'DBL_4NC'. This project contributes approximately 21.82 MW to the thermal violation.

12. (BG&E) The EMORY GRV230-North West 2326 & 2322 230 kV line (from bus 220400 to bus 220961 ckt 1) loads from 103.99% to 105.0% (DC power flow) of its emergency rating (1800 MVA) for the single contingency 'BG_CKT2322A'. This project contributes approximately 19.13 MW to the thermal violation.

13. (PJM) The Conastone-EMORY GR500 500 kV line (from bus 200004 to bus 200101 ckt 1) loads from 125.94% to 126.48% (DC power flow) of its emergency rating (2901 MVA) for the tower contingency 'CNSTN_NWESTA'. This project contributes approximately 96.56 MW to the thermal violation.

14. (PJM) The Conastone-EMORY GR500 500 kV line (from bus 200004 to bus 200101 ckt 1) loads from 103.90% to 109.73% (DC power flow) of its emergency rating (2901 MVA) for the single contingency 'CNSTN__230-4'. This project contributes approximately 88.73 MW to the thermal violation.

15. (PJM) The Conastone-EMORY GR500 500 kV line (from bus 200004 to bus 200101 ckt 1) loads from 118.73% to 125.7% (DC power flow) of its normal rating (2338 MVA) for non contingency condition. This project contributes approximately 85.54 MW to the thermal violation.

16. (PECO) The Linwood-Chichester 2 230 kV line (from bus 213750 to bus 213490 ckt 1) loads from 114.06% to 114.86% (DC power flow) of its emergency rating (983 MVA) for the single contingency '220-39'. This project contributes approximately 52.88 MW to the thermal violation.

17. (PECO) The Linwood-Chichester 2 230 kV line (from bus 213750 to bus 213490 ckt 2) loads from 114.46% to 115.26% (DC power flow) of its emergency rating (983 MVA) for the single contingency '220-43'. This project contributes approximately 53.06 MW to the thermal violation.

18. (DP&L) The Kent-New Meredith 69 kV line (from bus 232215 to bus 232812 ckt 1) loads from 125.66% to 129.45% (DC power flow) of its emergency rating (93 MVA) for the tower contingency 'DBL_4NC'. This project contributes approximately 21.82 MW to the thermal violation.

19. (PJM/AP) The EMORY GR500-Kemptown 500 kV line (from bus 200101 to bus 235632 ckt 1) loads from 107.95% to 108.16% (DC power flow) of its emergency rating (2901 MVA) for the tower contingency 'CNSTN_NWESTB'. This project contributes approximately 94.67 MW to the thermal violation.

20. (BG&E) The Conastone-EMORY GRV230 230 kV line (from bus 220963 to bus 220400 ckt 1) loads from 124.08% to 124.31% (DC power flow) of its emergency rating (819 MVA) for the single contingency 'PP1EC'. This project contributes approximately 26.28 MW to the thermal violation.

21. (PL/BG&E) The Safe Harbor Units 3-4 Tap-Graceton 230 kV line (from bus 208071 to bus 220964 ckt 1) loads from 108.36% to 108.89% (DC power flow) of its emergency rating (485 MVA) for the single contingency 'PJM17'. This project contributes approximately 16.03 MW to the thermal violation.

22. (DP&L) The Milford-Steele 230 kV line (from bus 232004 to bus 232000 ckt 1) loads from 116.17% to 152.87% (DC power flow) of its emergency rating (551 MVA) for the tower contingency 'DBL_4NC'. This project contributes approximately 202.19 MW to the thermal violation.

23. (METED) The Three Mile Island-Jackson 1 230 kV line (from bus 204514 to bus 204502 ckt 1) loads from 108.62% to 109.04% (DC power flow) of its emergency rating (591 MVA) for the single contingency 'PJM17'. This project contributes approximately 15.51 MW to the thermal violation.

24. (PECO) The Peach Bottom-Cooper 230 kV line (from bus 213869 to bus 214089 ckt 1) loads from 132.15% to 133.13% (DC power flow) of its emergency rating (485 MVA) for the single contingency 'PJM17'. This project contributes approximately 33.32 MW to the thermal violation.

25. (PECO/AE) The Delco Tap-Mickleton 230 kV line (from bus 213559 to bus 228401 ckt 1) loads from 101.28% to 101.85% (DC power flow) of its emergency rating (725 MVA) for the single contingency 'CHIC125'. This project contributes approximately 25.63 MW to the thermal violation.

26. (BG&E) The EMORY GRV230-North West 2311 & 2310 230 kV line (from bus 220400 to bus 220962 ckt 1) loads from 104.03% to 105.05% (DC power flow) of its emergency rating (1800 MVA) for the single contingency 'BG_CKT2310A'. This project contributes approximately 19.20 MW to the thermal violation.

27. (PJM/METED) The Three Mile Island-Three Mile Island 500/230 kV transformer (from bus 200016 to bus 204514 ckt 2) loads from 121.65% to 125.28% (DC power flow) of its emergency rating (1072 MVA) for the single contingency 'PJM17'. This project contributes approximately 39.58 MW to the thermal violation.

28. (DP&L) The Citisteel Tap-Naamans 69 kV line (from bus 231213 to bus 231211 ckt 1) loads from 110.55% to 112.1% (DC power flow) of its emergency rating (119 MVA) for the tower contingency 'DBL_5NC'. This project contributes approximately 11.38 MW to the thermal violation.

Short Circuit

No overstressed breakers were identified.

Stability Analysis

The Stability Analysis will commence 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 (PECO) Nottingham-Nottingham Reactor 230 kV line (from bus 213844 to bus 213846 ckt 1) overload will require replacing the Line 220-08 reactor and by-pass circuit switcher at Nottingham substation to get a minimum summer emergency rating of 741 MVA. The estimated cost to perform this work is **$1.7M** and will take **24 months** to complete.

2. To mitigate the (PECO) Nottingham Reactor-Peach Bottom 230 kV line (from bus 213846 to bus 213869 ckt 1) overload will require reconductoring Line 220-08 from Nottingham Reactor to PB Tap to get a minimum summer emergency rating of 741 MVA. The line is approximately 14 miles long. The estimated cost to perform this work is **$10M** and will take **48 months** to complete.

Contribution to Previously Identified System Reinforcements

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

1&8. To mitigate the (BG&E) North West 2311 & 2310-Granite 2311 & 2312 230 kV line (from bus 220962 to bus 220972 ckt 1) and the (BG&E) North West 2326 & 2322-Granite 2326 & 2332 230 kV line (from bus 220961 to bus 220973 ckt 1) overloads will require reconductoring the circuit with 2167 ACSR and upgrading substation terminal equipment. The estimated cost to perform this work is **$23,600,000** and will take **6 years** to complete.

2. To mitigate the (PECO) Richmond-Waneeta 3 230 kV line (from bus 213922 to bus 214012 ckt 1) overload will require reconductoring the aerial portion of the line which meets the minimum rating requirement of 2882A. This will result in a 249A = 99 MVA margin when compared to the new aerial conductor rating. Using the Pecos conductor avoids the need to rebuild the line. The total aerial mileage per the PECO 230 kV line length spreadsheet is 2.23 miles. Replace with 2-2000 kcmil AAC 127 Str (Cowslip) with emergency rating of 4130. Remove the existing two UG cables (2-3-1x3000 KCMIL CU HPOFP) and replace with two dielectric (XLPE - cross link polyethelene) cables. The estimated cost to perform this work is **$15,000,000** and will take **3 years** to complete.

3,12,20,26. To mitigate the (BG&E) Conastone-EMORY GRV230 230 kV line and the EMORY GRV230-North West 2326 & 2322 230 kV line overloads will require construction of a new double circuit 230kV line from Conastone-NW using 1590 MCM conductor. The estimated cost to perform this work is **$54.7 M** and will take **72-84 months** to complete. It is anticipated that a CPCN will be required. This estimate is based on a cursory review of BGE land for transmission lines. A detailed study will be conducted during the Facilities Study phase.

4. To mitigate the (PECO/BG&E) Cooper-Graceton 230 kV line (from bus 214089 to bus 220964 ckt 1) 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**.

5. To mitigate the (PSEG/PECO) Camden-Richmond 230 kV line overload will require constructing an express circuit from Camden to Richmond. This work has been previously identified as a 2016 RTEP project (b1590). If X2-066 in-service date precedes the RTEP project's in service date the Interconnection Customer may elect to accelerate the project. 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**.

6. To mitigate the (PPL/MET-ED) 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 an 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 **$1,300,000** and will take **24 months** to complete.

MET-ED segment:
Reconductor 12.5 mile section of the Brunner -Yorkana (1055) 230 kV line with 1590 ACSS conductor. Based on the Feasibility Study review performed, the total cost of this Network Upgrade is **$9,270,900** excluding tax. Should tax need to be added, the total cost will be **$12,382,200**. It is estimated that it will take **3 years** from the full execution of a Construction Service Agreement to complete the work needed to implement this project. Note that a revised estimate will be required if this project proceeds to an Impact Study.

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

BG&E portion
Reconductor the circuit from Gorsuch Mills to the Pennsylvania State Line (change of ownership to PPL) with 1,590 kcm ACSR to match capability of remainder of line. A distance of approximately 1.7 miles. It is anticipated that the towers can be reinforced instead of replaced. The estimated cost to perform this work is **$700,000** and will take **36 months** to complete.

PPL Portion
A project to re-conductor Manor-Conastone with 1590 ACSR is underway. This project will equip the line to handle 653/793 MVA (Summer Normal/Emergency). The estimated cost to perform this work is **$17,000,000** and the expected in service date is **October 2013**.

9&10. To mitigate the (PJM) Peach Bottom-Conastone 500 kV line (from bus 200013 to bus 200004 ckt 1) overloads will require the construction of a second 500kV circuit. The estimated cost to perform this work is **$56.7M** and will take 7 years to complete.

11. To mitigate the (DP&L) New Meredith-Church 69 kV line (from bus 232812 to bus 232203 ckt 1) overload will require the following:

a. Reconductoring the 69kV circuit. The estimated cost to perform this work is **$8,250,000** and will take **24-30 months** to complete.

b. Replace the line tap switch. The estimated cost to perform this work is **$300,000** and will take **18 months** to complete.

13,14,15,19. To mitigate the Conastone-Emory GR 500kV and Emory GR500-Kemptown 500kV overloads will require upgrading the Conastone bay with two (2) 4000A breakers, four (4) 4000A breaker disconnects and one (1) 4000 A line switch. The estimated cost to perform this work is **$3M** and will **take 24-36 months** to complete.

16&17. 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.

18. To mitigate the (DP&L) Kent-New Meredith 69 kV line (from bus 232215 to bus 232812 ckt 1) overload will require the following:

    c. Replace a disconnect switch. The estimated cost to perform this work is **$20,000** and will take **12 months** to complete.

    d. Reconductor the 69kV circuit. The estimated cost to perform this work is **$4,900,000** and will take **24-30 months** to complete.

21. The (PL/BG&E) Safe Harbor Units 3-4 Tap-Graceton 230 kV line (from bus 208071 to bus 220964 ckt 1) overload will be mitigated by baseline upgrade b0497 which will remove limitations at the Graceton substation.

22. To mitigate the (DP&L) Milford-Steele 230 kV line (from bus 232004 to bus 232000 ckt 1) overload will require reconductoring the 230kV circuit. The estimated cost to perform this work is **$23,000,000** and will take **24-30 months** to complete.

23. To mitigate the (METED) Three Mile Island-Jackson 1 230 kV line (from bus 204514 to bus 204502 ckt 1) overload will require upgrading 18.5 miles of circuit. The estimated cost to perform this work is **$10,910,000**.

24. 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.

25. To mitigate the DELCOTAP-MCKLTON 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.

27. 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.

28. 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.

Other Charges

DPL reserves the right to charge the Interconnection Customer Operation and Maintenance (O&M) expenses to maintain the Interconnection Customer’s Attachment Facilities, including metering and telecommunications facilities that are owned by DPL.