S107 Thorofare 230kV
Generation Interconnection

General

The Interconnection Customer (IC), has proposed a 1200 MW (1200 MW of which is capacity) natural gas fueled combined cycle generating facility to be located in West Deptford, Gloucester County, New Jersey. S107 will connect to either the Atlantic City Electric's (ACE) transmission system at the Mickleton 230kV substation (Option 1) or the Public Service Electric and Gas (PSEG) New Freedom 500kV substation (Option 2). The project was evaluated for compliance with reliability criteria for summer peak conditions in 2012.

OPTION 1

Point of Interconnection: S107 will interconnect with the Atlantic City Electric's transmission system at the Mickleton 230kV substation. S107 was studied as a 1200 MW (1200 MW capacity) injection into the Mickleton 230kV substation.

Direct Connection Requirements

Transmission Owner Scope of Direct Connection Work

The Transmission Owner's, (ACE), responsibility includes design and construction of all facilities associated with the Mickleton 230kV substation on the Interconnected Transmission Owner's side of the Point of Interconnection (POI). ACE's direct connection work at the Mickleton substation consists of adding one (1) 230kV circuit breaker and creating a 230kV terminal position for the Interconnection Customer's 230kV line to the S107 site. Revenue metering will be located on the feed to the generator.

The estimated cost to perform this work is **$2,000,000** and can be completed in **24 to 36 months** from the time "Notice to Proceed" is given after the ISA and CSA are executed. Note: the cost does not include the Contribution in Aid of Construction (CIAC) tax.

Interconnection Customer Scope of Direct Connection Work

The IC has assumed full responsibility for design and construction of all facilities associated with the S107 generating station and the 230 kV direct connection line on the Interconnection Customer side of the POI. Site preparation including grading and an access road is assumed to be by the developer.

The Interconnection Customer 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 Atlantic City Electric's Applicable Standards.

Network Impacts

Potential network impacts are as follows:

Generator Deliverability

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

1. The RIDLEY-MACDADE 230kV line loads from 96.2% to 101.3% (DC power flow) of its emergency rating (1432 MVA) for the single line contingency outage (PE23). This project contributes approximately 73.5 MW to cause this thermal violation.

2. The LAUREL L-GOUDY115 115kV line loads from 94.1% to 100.7% (DC power flow) of its emergency rating (129MVA) for the single line contingency outage (PN20). This project contributes approximately 8.6MW to cause this thermal violation.

3. The GLOUCSTR-GLOUCSTR 230/138kV transformer loads from 88.17% (DC power flow) to 116.51% of its emergency rating (341MVA) for the single line contingency outage (PJM89_NF_LOOPB). This project contributes approximately 96.6MW to cause this thermal violation.

4. The GLOUCSTR-CUTHBERT 138kV line loads from 87.9% to 116.3% (DC power flow) of its emergency rating (341MVA) for the single line contingency outage (PJM89_NF_LOOPB). This project contributes approximately 96.6MW to cause this thermal violation.

5. The GLOUCSTR-CUTHBERT 138 kV line loads from 85.1% to 120.2% (DC power flow) of its normal rating (239MVA) for non-contingency condition. This project contributes approximately 83.7 MW to cause this thermal violation.

6. The MCKLTON-THOROFAR 230 kV line loads from 78.1% to 139.0% (DC power flow) of its normal rating (451MVA) for non-contingency condition. This project contributes approximately 275.0MW to cause this thermal violation.

7. The MCKLTON-MONROE 230 kV ckt#2 loads from 72.0% to 134.8% (DC power flow) of its emergency rating (446MVA) for the single line contingency outage (AE2_A19). This project contributes approximately 280.0MW to cause this thermal violation.

8. The MCKLTON-MONROE 230 kV ckt#1 loads from 72.0% to 134.8% (DC power flow) of its emergency rating (446 MVA) for the single line contingency outage (AE12). This project contributes approximately 280.0MW to cause this thermal violation.

9. The GLOUCSTR-GLOUCSTR 230/138kV transformer loads from 77.11% (DC power flow) to 108.70% of its normal rating (265MVA) for non-contingency condition. This project contributes approximately 83.7MW to cause this thermal violation.

10. The MCKLTON-MONROE 230kV line loads from 60.5% to 113.2% (DC power flow) of its normal rating (365MVA) for non-contingency condition. This project contributes approximately 192.6MW to cause this thermal violation.

11. The MCKLTON-MONROE 230kV line loads from 60.5% to 113.2% (DC power flow) of its normal rating (365MVA) for non-contingency condition. This project contributes approximately 192.6MW to cause this thermal violation.

12. The EAGLE PT-GLOUCSTR 230kV line loads from 60.5% to 102.4% (DC power flow) of its normal rating (653MVA) for non-contingency condition. This project contributes approximately 273.6MW to cause this thermal violation.

13. The ROXBURY-ROXBURY 115/138kV transformer loads from 89.76% to 101.14% (DC power flow) of its emergency rating (140MVA) for the single line contingency outage (PJM13B_NNWEST_A). This project contributes approximately 15.9MW to cause this thermal violation.

Multiple Facility Contingency

(Double Circuit Tower Line contingencies only for the full energy output. Stuck breaker and bus fault contingencies will be performed for the System Impact Study)

14. The MCKLTON-THOROFAR 230kV line loads from 94.17% to 171.57% (DC power flow) of its emergency rating (566MVA) for the tower line outage (4AE_A19). This project contributes approximately 438.1MW to cause this thermal violation.

15. The EAGLE PT-GLOUCSTR 230kV line loads from 76.57% to 134.64% (DC power flow) of its emergency rating (752MVA) for the tower line outage (4AE_A19). This project contributes approximately 436.7MW to cause this thermal violation.

16. The THOROFAR-DEPTFORD 230kV line loads from 70.37% to 135.17% (DC power flow) of its emergency rating (676MVA) for the tower line outage (4AE_A19). This project contributes approximately 438.1MW to cause this thermal violation.

17. The DEPTFORD-EAGLE PT 230kV line loads from 51.53% to 109.78% (DC power flow) of its emergency rating (752MVA) for the tower line outage (4AE_A19). This project contributes approximately 438.1MW to cause this thermal violation.

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)

18. The PRINTZ-RIDLEY 230kV line loads from 107.31% to 113.87% (DC power flow) of its emergency rating (1432MVA) for the single line contingency outage (PE23). This project contributes approximately 94.1MW to the thermal violation.

19. The EDDYSTN3-ISLANDR6 230kV line loads from 101.84% to 107.27% (DC power flow) of its emergency rating (1410MVA) for the single line contingency outage (PE46). This project contributes approximately 76.7MW to the thermal violation.

20. The LACKAWNA-OXBOW 230kV line loads from 150.54% to 157.46% (DC power flow) of its emergency rating (504MVA) for the single line contingency outage (PJM JEFF-LACK 500). This project contributes approximately 34.8MW to the thermal violation.

21. The N.MESHPN-MESH2REA 230/115kV transformer loads from 130.39% to 137.89% (DC power flow) of its emergency rating (201MVA) for the single line contingency outage (PN47B). This project contributes approximately 15.1MW to the thermal violation.

22. The MESH2REA-NO MESHO 115 kV line loads from 130.33% to 137.83% (DC power flow) of its emergency rating (201 MVA) for the single line contingency outage (PN47B). This project contributes approximately 15.1 MW to the thermal violation.

23. The LACKAWNA-OXBOW 230kV line loads from 151.62% to 159.62% (DC power flow) of its normal rating (499MVA) for non-contingency condition. This project contributes approximately 40.0MW to the thermal violation.

24. The OXBOW-N.MESHPN 230kV line loads from 151.47% to 159.47% (DC power flow) of its normal rating (499MVA) for non-contingency condition. This project contributes approximately 40.0 MW to the thermal violation.

25. The OXBOW-N.MESHPN 230kV line loads from 128.35% to 134.46% (DC power flow) of its emergency rating (617MVA) for the single line contingency outage (PJM66_WITH_R24A). This project contributes approximately 37.7MW to the thermal violation.

26. The PEACHBTM-CNASTONE 500kV ckt#1 loads from 138.57% to 153.27% (DC power flow) of its emergency rating (2598MVA) for the single line contingency outage (PJM17_2). This project contributes approximately 381.8MW to the thermal violation.

27. The PEACHBTM-CNASTONE 500kV ckt#2 loads from 138.57% to 153.27% (DC power flow) of its emergency rating (2598 MVA) for the single line contingency outage (PJM17). This project contributes approximately 381.8MW to the thermal violation.

28. The CNASTONE-N-NWEST 500kV line loads from 143.56% to 156.37% (DC power flow) of its normal rating (2078MVA) for non-contingency condition. This project contributes approximately 266.3MW to the thermal violation.

29. The NWEST311-GRANITE1 230kV line loads from 149.91% to 161.63% (DC power flow) of its emergency rating (641MVA) for the single line contingency outage

(PJM13B_NNWEST_B). This project contributes approximately 75.1MW to the thermal violation.

30. The RAPHAEL-NEAST339 230kV line loads from 113.87% to 121.18% (DC power flow) of its emergency rating (758MVA) for the single line contingency outage (BG8). This project contributes approximately 55.4MW to the thermal violation.

31. The RAPHAEL-NEAST317 230kV line loads from 112.27% to 119.48% (DC power flow) of its emergency rating (758MVA) for the single line contingency outage (BG18). This project contributes approximately 54.7MW to the thermal violation.

32. The CONASTON-MT CAR22 230kV line loads from 126.49% to 136.03% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage (PJM13B_NNWEST_A). This project contributes approximately 88.0MW to the thermal violation.

33. The CONASTON-MT CAR10 230kV line loads from 126.49% to 136.03% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage (PJM13B_NNWEST_A). This project contributes approximately 88.0MW to the thermal violation.

34. The MT CAR10-N-NWEST 230kV line loads from 124.20% to 133.74% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage (PJM13B_NNWEST_A). This project contributes approximately 88.0MW to the thermal violation.

35. The MT CAR22-N-NWEST 230kV line loads from 124.20% to 133.74% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage (PJM13B_NNWEST_A). This project contributes approximately 88.0MW to the thermal violation.

36. The NEAST317-N.EAST 230/115kV transformer loads from 112.66% to 119.32% (DC power flow) of its emergency rating (378 MVA) for the tower line outage (NORTHEAST_RIVERSIDE). This project contributes approximately 25.2 MW to the thermal violation.

37. The 3 MILE I-TMI 500/230kV transformer loads from 130.88% to 141.86% (DC power flow) of its emergency rating (1077MVA) for the tower line outage (Conas_PB). This project contributes approximately 118.3MW to the thermal violation.

38. The BRUNNER-YORKANA 230kV line loads from 105.54% to 113.44% (DC power flow) of its emergency rating (617MVA) for the tower line outage (Conas_PB). This project contributes approximately 48.8MW to the thermal violation.

39. The NOTTNGHM-NOTTREAC 230kV line loads from 143.87% to 159.84% (DC power flow) of its emergency rating (627MVA) for the tower line outage (Conas_PB). This project contributes approximately 100.1MW to the thermal violation.

40. The NOTTREAC-PCHBTMTP 230kV line loads from 143.81% to 159.78% (DC power flow) of its emergency rating (627MVA) for the tower line outage (Conas_PB). This project contributes approximately 100.1MW to the thermal violation.

41. The PCHBTMTP-GRACETON 230kV line loads from 143.81% to 159.78% (DC power flow) of its emergency rating (627MVA) for the tower line outage (Conas_PB). This project contributes approximately 100.1 MW to the thermal violation.

42. The CNASTONE-N-NWEST 500 kV line loads from 132.43% to 142.92% (DC power flow) of its emergency rating (2901MVA) for the tower line outage (CNSTN_NWEST_NNWEST_A). This project contributes approximately 304.4 MW to the thermal violation.

43. The N.MESHPN-E.TWANDA 230kV line loads from 111% to 119% (DC power flow) of its normal rating (499MVA) under non-contingency conditions. This project contributes approximately 40 MW to the thermal violation.

Short Circuit

The following breakers were found to be overstressed:

Deepwater 69 kV CB 6603 (103.6%)
Mickleton 230 kV CB U (118.8%)
Mickleton 230 kV CB V (118.8%)

Stability and Reactive Power Requirements

Will be performed during the Queue S107 System Impact Study.

Steady State Voltage Requirements

Will be performed during the Queue S107 System Impact Study.

New System Reinforcements

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

1. To mitigate the RIDLEY-MACDADE 230kV (PECO) overload would require the replacement of terminal equipment. The estimated cost to perform this work is **$3,000,000** and will take **30 months** to complete.

2. To mitigate the LAUREL L-GOUDY115 115kV (PENELEC) line overload the Tiffany-Goudey 115kV line should be operated open, consistent with existing FirstEnergy procedures to control thermal limits that occur on the PENELEC/NY-ISO tie lines.

3 and 9. To mitigate the GLOUCSTR-GLOUCSTR 230/138kV (PSEG) transformer overloads would require the replacement of the transformer. The estimated cost to perform this work is **$3,975,000**.

4 and 5. To mitigate the GLOUCSTR-CUTHBERT 138kV (PSEG) line overloads would require reconductoring approximately 5 miles of line and upgrading terminal equipment. The estimated cost to perform this work is **$20,800,000.**

6 and 14. To mitigate the MCKLTON-THOROFAR 230 kV (AE/PSEG) line overloads would require reconductoring the line with an ACSS/TW conductor and upgrading terminal equipment. The estimated cost to perform this work is **$1,500,000** and will take **30 months** to complete from the time "Notice to Proceed is given after the ISA and CSA are executed.

7, 8, 10 and 11. To mitigate the MCKLTON-MONROE 230 kV circuits #1 and #2 (AE) overloads would require reconductoring the line with an ACSS/TW conductor. The estimated cost to perform this work is **$9,000,000** and will take **30 months** to complete from the time "Notice to Proceed is given after the ISA and CSA are executed.

12 and 15. To mitigate the EAGLE PT-GLOUCSTR 230kV (PSEG) line overload would require the reconductoring of approximately 5 miles of line and upgrading of terminal equipment. The estimated cost to perform this work is **$3,800,000.**

13. To mitigate the ROXBURY-ROXBURY 115/138kV (PENELEC) transformer overload would require the transformer to be operated open, consistent with existing FirstEnergy procedures to control thermal contingencies that occur on the PENELEC /AP tie lines.

16. To mitigate the THOROFAR-DEPTFORD 230kV (PSEG) line overload would require the reconductoring of approximately 3.5 miles of line and upgrading of terminal equipment. The estimated cost to perform this work is **$4,700,000.**

17. To mitigate the DEPTFORD-EAGLE PT 230kV (PSEG) line overload would require the reconductoring of approximately 1 mile of line and upgrading of terminal equipment. The estimated cost to perform this work is **$1,200,000.**

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the System Impact Study)

18. To mitigate the PRINTZ-RIDLEY 230kV (PECO) line overload would require the replacement of terminal equipment. The estimated cost to perform this work is **$5,000,000** and will take **30 months** to complete.

19. To mitigate the EDDYSTN3-ISLANDR6 230kV (PECO) line overload would require the replacement of terminal equipment. The estimated cost to perform this work is **$5,000,000** and will take **30 months** to complete.

20 and 23. To mitigate the LACKAWNA-OXBOW 230kV (PENELEC/PPL) line overload would require the following: for PENELEC, the rebuild of approximately 16.33 miles of transmission line to support bundled conductor. The Oxbow substation would require replacement of substation conductor and replacement of a disconnect switch. The estimated cost to perform this work is **$19,771,000** and will take **48 to 60 months** to complete after an ISA and CSA are executed. For PPL; the rebuild of 0.18 miles of transmission line and the upgrade of the Lackawanna substation terminal equipment. The estimated cost to perform this work is **$550,000.**

21 and 22. To mitigate the N.MESHPN-MESH2REA 230/115kV (PENELEC) transformer overload would require the addition of two (2) 230 kV circuit breakers at the North Meshoppen substation. The North Meshoppen 230 kV bus would also need to be reconfigured into a ring bus. The estimated cost to perform this work is **$4,000,000** and will take **24 months** to complete after an ISA and CSA is executed.

24 and 25. To mitigate the OXBOW-N.MESHPN 230kV (PENELEC) line overloads would require the rebuild of approximately 10.16 mile of transmission line to support bundled conductor. Oxbow substation would require the replacement of a disconnect switch and substation conductor. North Meshoppen substation would require the upgrade/replacement of two (2) CT circuits, replacement of substation conductor, and the replacement/upgrade of a line/wave trap. The estimated cost to perform this work is **$12,939,000** and will take **48 to 60 months** to complete after an ISA and CSA is executed.

26 and 27. To mitigate the PEACHBTM-CNASTONE 500kV (BGE/PECO) overload would require a second 500kV circuit to be built.

If right of way <u>CAN</u> be acquired, following is the reinforcement and cost estimates:

<u>PECO portion of the Conastone – Peach Bottom line:</u>

Substation work at Peach Bottom	$ 2,500,000
Construct 6.25 miles of 500kV line	<u>$10,000,000</u>
	$12,500,000

This estimate does not include the cost of new right of way.

Construction of the new line will take approximately **30 months** after the right of way is acquired.

Note: It should be noted that PJM Queue P04 project also requires widening of about two miles of this right of way for their direct connection line and would use the last remaining terminal position that exists at Peach Bottom substation. If Queue P04 proceeds with their project it may complicate right of way acquisition and double the substation costs at Peach Bottom.

BGE portion of the Conastone – Peach Bottom line:
Build new 500 kV line adjacent to existing circuit 5012 from Conastone to Pennsylvania State Line at an estimated cost of **$48,000,000** and a construction time of approximately **84 months.**

Assumptions:

- Acquire 150 ft. wide R/W adjacent to existing R/W, mostly rural land at $100,000 per acre
- 2 to 3 year CPCN process prior to land acquisition
- Length of line 9.6 miles

Install one 500kV breaker at Conastone **$1,500,000**. Breaker installation can be completed concurrently with the line construction.

If right of way CANNOT be acquired, following is the reinforcement and cost estimates:

The line from Graceton to Peach Bottom is about 7.5 miles long and has a normal rating of 528MVA. Assuming that we could maintain this rating with a single 230 kV pipe type cable, the new underground installation would cost about **$30,000,000** plus another **$1,000,000** for terminal modifications. The assumption is made that the underground line will not have to cross any rivers or large creeks. If a cable rating of 450 MVA is insufficient, it will cost an additional **$30,000,000**.

Removal of the existing 230 kV tower line is approximately **$1,500,000.**

Construction of a double circuit 500kV line from Conastone to Peach Bottom would be approximately $3,500,000 per mile. The line is 16.5 miles long. Total cost is estimated to be **$58,000,000.**

Substation additions and modifications at Peach Bottom would are estimated to cost approximately **$10,000,000.**

Note: Future work is being done by the BGE and PECO to come up with reinforcements to further mitigate the overload.

28 and 42. To mitigate the CNASTONE-N-NWEST 500kV (BG&E) overload would require:

1 new single circuit line with the following assumptions:

A new 200 ft. wide ROW paralleling the existing Conastone to Northwest ROW
Total ROW length = 19.6 miles
3 - bundle 1,590 kcm conductor
North Northwest substation is located 4 miles north of Northwest substation

The estimated cost to perform this work, which includes breakers and terminations, is **$110,000,000** and will take **10 years** to complete.

Additional substation work to include:
At the Conastone 500kV substation – install a 1 breaker bay
At the NNW 500kV substation – install a 3 breaker bay.

The estimated cost to perform this work is **$9,200,000** with a **10 year** lead time to complete.

29. To mitigate the NWEST311-GRANITE1 230kV (BGE) line overload would require the replacement of the 230 kV circuit breaker at Northwest. The estimated cost to perform this work is **$383,000.**

30 and 31. To mitigate the RAPHAEL-NEAST339 and 317 230kV (BGE) line overloads would require the replacement of the 230kV circuit breaker in each line. The total estimated cost to perform this work is **$766,000.**

32, 33, 34 and 35. To mitigate the CONASTON- MT CARMEL - NORTHWEST 230kV (BGE) line overloads would require the installation of the North Northwest substation including; two (2) 500/230kV transformers, four (4) 500 kV circuit breakers, seven (7) 230 kV circuit breakers and related substation equipment and land. The estimated cost to perform this work is **$70,000,000**. It also requires to reconductor Conastone to Northwest #2322 with 1,272kcmil ACSR 1,590kcmil ACSR. The estimated cost to perform this work is **$8,210,000**. This work would take **36 to 48 months** to build the substation and **18 to 24 months** for the line work.

36. To mitigate the NEAST317-N.EAST 230/115kV transformer (BGE) overload would require the replacement of the transformer with a 500kV unit. The estimated cost to perform this work is **$10,200,000.**

37. To mitigate the 3 MILE I-TMI 500/230kV (METED) transformer would require the installation of a second 500/230kV transformer. The estimated cost to perform this work is **$11,800,000** and will take **20 months** to complete after an ISA and CSA are executed.

38. To mitigate the BRUNNER-YORKANA 230kV (METED/PPL) line overload would require the re-conductor of 0.64 miles of the existing single circuit 1033 Kcmil conductor which is

limiting the line capacity of the Brunner Island – Yorkana 230kV line. The new line will be 1590 Kcmil equivalent ACCC (composite core) conductor. The 230 kV lines will be rated for summer normal/emergency of 653/793 MVA respectively or higher. This rebuild may require reinforcing the existing structures to accommodate the larger size of the new conductor. The rebuild will be 0.64 miles long and will travel the existing right of way. The estimated cost to perform this work including substation terminal equipment cost is **$600,000**.

39. To mitigate the NOTTNGHM-NOTTREAC 230kV (PECO) line overload would require the replacement of the line reactor. The estimated cost to perform this work is **$200,000** and will take **18 months** to complete after an ISA and CSA are executed.

40 and 41. To mitigate the NOTTREAC-PCHBTMTP-GRACETON 230kV (PECO/BGE) line overloads would require the following: A portion of this line must be relocated to underground to facilitate the construction of additional 500 kV lines between Peach Bottom and Conastone. The estimated cost to perform this work is **$61,000,000** and will take **36 months** to complete. The Peach Bottom to Nottingham portion (13.6 miles) must be rebuilt as a high capacity 230 kV line, (1243MVAn/1411MVAe) which includes a Susquehanna River crossing. The estimated cost to perform this work is **$42,500,000** and will take **48 months** to complete.

43. To mitigate the N.MESHPN-E.TWANDA 230kV (PENELEC) line overload would require the rebuilding of 21.66 miles of transmission line to support bundled conductors. East Towanda substation would require replacement of a line/wave trap, a disconnect switch, and a CT circuit. The North Meshoppen substation would require the upgrade/replacement of two CT circuits, and replacement of the substation conductor. The estimated cost to perform this work is **$26,754,000** and will take **48 to 60 months** to complete after an ISA and CSA are executed.

Potential Overloads

(Circuits with overloads nearing their rating)

1. The GLASGOW-CECIL138 138kV line loads from 95.2 % to 99.74% (DC power flow) of its emergency rating (79 MVA) for the tower line outage (PE500). This project contributes approximately 4 MW to the thermal violation.

2. The MACDADE – ELMWOOD 230 kV line loads from 94% to 99.49% (DC power flow) of its emergency rating (1432 MVA) for the single line contingency outage (PE23). This project contributes approximately 73.5 MW to cause this thermal violation.

OPTION 2

Point of Interconnection: S107 will interconnect with the Public Service Electric and Gas (PSEG) transmission system at the New Freedom 500kV substation. S107 was studied as a 1200 MW (1200 MW capacity) injection into the New Freedom 500kV substation.

Direct Connection Requirements

Transmission Owner Scope of Direct Connection Work

The Transmission Owner's, (PSEG), responsibility includes design and construction of all facilities associated with the New Freedom 500kV substation on the Interconnected Transmission Owner's side of the Point of Interconnection (POI). PSEG's direct connection work at the New Freedom substation would consist of reconfiguring the substation to create a terminal position for the Interconnection Customer's 500kV line to the S107 site. Revenue metering will be located on the feed to the generator.

The estimated cost to perform this work along with a single line diagram depicting the POI is currently under development and is expected to be available during the System Impact Study should this Option be selected.

Interconnection Customer Scope of Direct Connection Work

The IC has assumed full responsibility for design and construction of all facilities associated with the S107 generating station and the 500 kV direct connection line on the Interconnection Customer side of the POI. Site preparation including grading and an access road if required is assumed to be by the developer. Right of Way acquisition is the responsibility of the IC.

The Interconnection Customer 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 Public Service Electric and Gas's Applicable Standards.

Network Impacts

Potential network impacts are as follows:

Generator Deliverability

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

1. The LAUREL L-GOUDY115 115kV line loads from 94.1% to 100.8% (DC power flow) of its emergency rating (129MVA) for the single line contingency outage (PN20). This project contributes approximately 8.6MW to cause this thermal violation.

2. The GLOUCSTR-GLOUCSTR 230/138kV transformer loads from 90.15% (DC power flow) to 104.88% of its emergency rating (341 MVA) for the single line contingency outage (PJM89_NF_LOOPB). This project contributes approximately 50.2MW to cause this thermal violation.

3. The GLOUCSTR-CUTHBERT 138 kV line loads from 89.9% to 104.6% (DC power flow) of its emergency rating (341 MVA) for the single line contingency outage (PJM89_NF_LOOPB). This project contributes approximately 50.2MW to cause this thermal violation.

4. The ROXBURY-ROXBURY 138/115 kV transformer loads from 89.76% (DC power flow) to 101.16% of its emergency rating (140MVA) for the single line contingency outage (PJM13B_NNWEST_A). This project contributes approximately 16.0 MW to cause this thermal violation.

Multiple Facility Contingency

(Double Circuit Tower Line contingencies only for the full energy output. Stuck breaker and bus fault contingencies will be performed for the System Impact Study)

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)

5. The LACKAWNA-OXBOW 230kV line loads from 157.74% to 164.61% (DC power flow) of its emergency rating (504MVA) for the single line contingency outage (PJM JEFF-LACK 500). This project contributes approximately 34.6MW to the thermal violation.

6. The N.MESHPN-MESH2REA 230/115 kV transformer loads from 130.39% to 137.92% (DC power flow) of its emergency rating (201 MVA) for the single line contingency outage (PN47B). This project contributes approximately 15.1MW to the thermal violation.

7. The MESH2REA-NO MESHO 115 kV line loads from 130.33% to 137.86% (DC power flow) of its emergency rating (201 MVA) for the single line contingency outage (PN47B). This project contributes approximately 15.1 MW to the thermal violation.

8. The LACKAWNA-OXBOW 230 kV line loads from 160.99% to 169.03% (DC power flow) of its normal rating (499 MVA) for non-contingency condition. This project contributes approximately 40.1MW to the thermal violation.

9. The OXBOW-N.MESHPN 230 kV line loads from 160.84% to 168.88% (DC power flow) of its normal rating (499 MVA) for non-contingency condition. This project contributes approximately 40.1MW to the thermal violation.

10. The OXBOW-N.MESHPN 230 kV line loads from 132.94% to 139.10% (DC power flow) of its emergency rating (617 MVA) for the single line contingency outage (PJM66_WITH_R24A). This project contributes approximately 38.0MW to the thermal violation.

11. The PEACHBOTTOM – CONASTONE 500 kV CKT#2 loads from 142.54% to 160.30% (DC power flow) of its emergency rating (2598 MVA) for the single line contingency outage (PJM17). This project contributes approximately 461.2 MW to the thermal violation.

12. The PEACHBOTTOM – CONASTONE 500 kV CKT#1 loads from 142.54% to 160.30% (DC power flow) of its emergency rating (2598MVA) for the single line contingency outage (PJM17_2). This project contributes approximately 461.2 MW to the thermal violation.

13. The CNASTONE-N-NWEST 500kV line loads from 146.19% to 159.17% (DC power flow) of its normal rating (2078MVA) for non-contingency condition. This project contributes approximately 269.7MW to the thermal violation.

14. The NWEST311-GRANITE1 230kV line loads from 153.71% to 167.58% (DC power flow) of its emergency rating (641MVA) for the single line contingency outage (PJM13B_NNWEST_B). This project contributes approximately 88.9MW to the thermal violation.

15. The RAPHAEL-NEAST339 230kV line loads from 114.37% to 121.47% (DC power flow) of its emergency rating (758MVA) for the single line contingency outage (BG8). This project contributes approximately 53.8MW to the thermal violation.

16. The RAPHAEL-NEAST317 230kV line loads from 112.76% to 119.77% (DC power flow) of its emergency rating (758MVA) for the single line contingency outage (BG18). This project contributes approximately 53.1MW to the thermal violation.

17. The CONASTON-MT CAR22 230kV line loads from 129.27% to 138.82% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage (PJM13B_NNWEST_A). This project contributes approximately 88.2MW to the thermal violation.

18. The CONASTON-MT CAR10 230kV line loads from 129.27% to 138.82% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage (PJM13B_NNWEST_A). This project contributes approximately 88.2MW to the thermal violation.

19. The MT CAR10-N-NWEST 230kV line loads from 126.98% to 136.53% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage (PJM13B_NNWEST_A). This project contributes approximately 88.2MW to the thermal violation.

20. The MT CAR22-N-NWEST 230kV line loads from 126.98% to 136.53% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage (PJM13B_NNWEST_A). This project contributes approximately 88.2MW to the thermal violation.

21. The GLASGOW-CECIL138 138kV line loads from 142.40% to 151.01% (DC power flow) of its emergency rating (79MVA) for the tower line outage (10APECO_A57). This project contributes approximately 6.8MW to the thermal violation.

22. The NEAST317-N.EAST 230/115kV transformer loads from 112.66% to 119.12% (DC power flow) of its emergency rating (378MVA) for the tower line outage (NORTHEAST_RIVERSIDE). This project contributes approximately 24.4MW to the thermal violation.

23. The 3 MILE I-TMI 500/230 kV transformer loads from 130.88% to 142.21% (DC power flow) of its emergency rating (1077 MVA) for the tower line outage (Conas_PB). This project contributes approximately 122.0MW to the thermal violation.

24. The BRUNNER-YORKANA 230 kV line loads from 104.72% to 112.79% (DC power flow) of its emergency rating (617 MVA) for the tower line outage (Conas_PB). This project contributes approximately 49.8MW to the thermal violation.

25. The NOTTNGHM-NOTTREAC 230 kV line loads from 143.83% to 158.43% (DC power flow) of its emergency rating (627 MVA) for the tower line outage (Conas_PB). This project contributes approximately 91.6MW to the thermal violation.

26. The PCHBTMTP-GRACETON 230 kV line loads from 143.77% to 158.37% (DC power flow) of its emergency rating (627 MVA) for the tower line outage (Conas_PB). This project contributes approximately 91.6MW to the thermal violation.

27. The NOTTREAC-PCHBTMTP 230 kV line loads from 143.77% to 158.37% (DC power flow) of its emergency rating (627 MVA) for the tower line outage (Conas_PB). This project contributes approximately 91.6MW to the thermal violation.

28. The CNASTONE-N-NWEST 500 kV line loads from 132.43% to 143.02% (DC power flow) of its emergency rating (2901 MVA) for the tower line outage (CNSTN_NWEST_NNWEST_A). This project contributes approximately 307.2MW to the thermal violation.

Short Circuit

The following breakers were found to be overstressed.

The analysis found 22 new breakers to be over-duty in the PSEG transmission area. All new over duty breakers were found using Option 2 and are listed below:

NEW FREEDOM 500.kV	21X
NEW FREEDOM 500.kV	22X
NEW FREEDOM 500.kV	31X
NEW FREEDOM 500.kV	32X
NEW FREEDOM 500.kV	42X
NEW FREEDOM 500.kV	30X
NEW FREEDOM 500.kV	20X
SALEM 500.kV	12X

SALEM 500.kV	20X
SALEM 500.kV	32X
SALEM 500.kV	11X
SALEM 500.kV	21X
SALEM 500.kV	31X
SALEM 500.kV	10X
NEW FREEDOM 230.kV	101 H
NEW FREEDOM 230.kV	41H
NEW FREEDOM 230.kV	51H
NEW FREEDOM 230.kV	50H
NEW FREEDOM 230.kV	10H
NEW FREEDOM 230.kV	21H
NEW FREEDOM 230.kV	31H
NEW FREEDOM 230.kV	12H

In addition, the analysis also showed a significant fault contribution to 7 breakers, which were already identified as over-duty. The breakers are listed below:

NEW FREEDOM 230.kV	20H (opt 1 and opt 2)
NEW FREEDOM 230.kV	22H
NEW FREEDOM 230.kV	32H
NEW FREEDOM 230.kV	30H
NEW FREEDOM 230.kV	42H
NEW FREEDOM 230.kV	40H

S107 had a significant enough fault contribution at all of these breakers to receive a cost allocation for their upgrade or replacement.

Stability and Reactive Power Requirements

Will be performed during the Queue S107 System Impact Study.

Steady State Voltage Requirements

Will be performed during the Queue S107 System Impact Study.

New System Reinforcements

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

1. To mitigate the LAUREL L-GOUDY115 115kV (PENELEC) line overload the Tiffany-Goudey 115kV line should be operated open, consistent with existing FirstEnergy procedures to control thermal limits that occur on the PENELEC/NY-ISO tie lines.

2 To mitigate the GLOUCSTR-GLOUCSTR 230/138kV (PSEG) transformer overload would require the replacement of the transformer. The estimated cost to perform this work is **$3,975,000**.

3. To mitigate the GLOUCSTR-CUTHBERT 138kV (PSEG) line overload would require reconductoring approximately 5 miles of line and upgrading terminal equipment. The estimated cost to perform this work is **$20,800,000.**

4. To mitigate the ROXBURY-ROXBURY 115/138kV (PENELEC) transformer overload would require the transformer to be operated open, consistent with existing FirstEnergy procedures to control thermal contingencies that occur on the PENELEC /AP tie lines.

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study. Summary form of Cost allocation for transmission lines and transformers will be inserted here if any).

5 and 8. To mitigate the LACKAWNA-OXBOW 230kV (PENELEC/PPL) line overloads would require the following: for PENELEC, the rebuild of approximately 16.33 miles of transmission line to support bundled conductor. The Oxbow substation would require replacement of substation conductor and replacement of a disconnect switch. The estimated cost to perform this work is **$19,771,000** and will take **48 to 60 months** to complete after an ISA and CSA are executed. For PPL; the rebuild of 0.18 miles of transmission line and the upgrade of the Lackawanna substation terminal equipment. The estimated cost to perform this work is **$550,000.**

6 and 7. To mitigate the N.MESHPN-MESH2REA 230/115kV (PENELEC) transformer overloads would require the addition of two (2) 230 kV circuit breakers at the North Meshoppen substation. The North Meshoppen 230 kV bus would also need to be reconfigured into a ring bus. The estimated cost to perform this work is **$4,000,000** and will take **24 months** to complete after an ISA and CSA is executed.

9 and 10. To mitigate the OXBOW-N.MESHPN 230kV (PENELEC) line overloads would require the rebuild of approximately 10.16 mile of transmission line to support bundled conductor. Oxbow substation would require the replacement of a disconnect switch and substation conductor. North Meshoppen substation would require the upgrade/replacement of two (2) CT circuits, replacement of substation conductor, and the replacement/upgrade of a line/wave trap. The estimated cost to perform this work is **$12,939,000** and will take **48 to 60 months** to complete after an ISA and CSA is executed.

11 and 12. To mitigate the PEACHBTM-CNASTONE 500kV (BGE/PECO) overloads would require a second 500kV circuit to be built.

If right of way <u>CAN</u> be acquired, following is the reinforcement and cost estimates:

<u>PECO portion of the Conastone – Peach Bottom line:</u>

Substation work at Peach Bottom	$ 2,500,000
Construct 6.25 miles of 500kV line	<u>$10,000,000</u>
	$12,500,000

This estimate does not include the cost of new right of way.

Construction of the new line will take approximately **30 months** after the right of way is acquired.

<u>Note</u>: It should be noted that PJM Queue P04 project also requires widening of about two miles of this right of way for their direct connection line and would use the last remaining terminal position that exists at Peach Bottom substation. If Queue P04 proceeds with their project it may complicate right of way acquisition and double the substation costs at Peach Bottom.

<u>BGE portion of the Conastone – Peach Bottom line:</u>
Build new 500 kV line adjacent to existing circuit 5012 from Conastone to Pennsylvania State Line at an estimated cost of **$48,000,000** and a construction time of approximately **84 months.**

Assumptions:

- Acquire 150 ft. wide R/W adjacent to existing R/W, mostly rural land at $100,000 per acre
- 2 to 3 year CPCN process prior to land acquisition
- Length of line 9.6 miles

Install one 500kV breaker at Conastone **$1,500,000**. Breaker installation can be completed concurrently with the line construction.

If right of way <u>CANNOT</u> be acquired, following is the reinforcement and cost estimates:

The line from Graceton to Peach Bottom is about 7.5 miles long and has a normal rating of 528MVA. Assuming that we could maintain this rating with a single 230 kV pipe type cable, the new underground installation would cost about **$30,000,000** plus another **$1,000,000** for terminal modifications. The assumption is made that the underground line will not have to cross any rivers or large creeks. If a cable rating of 450 MVA is insufficient, it will cost an additional **$30,000,000**.

Removal of the existing 230 kV tower line is approximately **$1,500,000.**

Construction of a double circuit 500kV line from Conastone to Peach Bottom would be approximately $3,500,000 per mile. The line is 16.5 miles long. Total cost is estimated to be **$58,000,000.**

Substation additions and modifications at Peach Bottom would are estimated to cost approximately **$10,000,000.**

Note: Future work is being done by the BGE and PECO to come up with reinforcements to further mitigate the overload.

13 and 28. To mitigate the CNASTONE-N-NWEST 500kV (BG&E) overloads would require:

1 new single circuit line with the following assumptions:

A new 200 ft. wide ROW paralleling the existing Conastone to Northwest ROW
Total ROW length = 19.6 miles
3 - bundle 1,590 kcm conductor
North Northwest substation is located 4 miles north of Northwest substation

The estimated cost to perform this work, which includes breakers and terminations, is **$110,000,000** and will take **10 years** to complete.

Additional substation work to include:
At the Conastone 500kV substation – install a 1 breaker bay
At the NNW 500kV substation – install a 3 breaker bay.

The estimated cost to perform this work is **$9,200,000** with a **10 year** lead time to complete.

14. To mitigate the NWEST311-GRANITE1 230kV (BGE) line overload would require the replacement of the 230 kV circuit breaker at Northwest. The estimated cost to perform this work is **$383,000.**

15 and 16. To mitigate the RAPHAEL-NEAST339 and 317 230kV (BGE) line overloads would require the replacement of the 230kV circuit breaker in each line. The total estimated cost to perform this work is **$766,000.**

17, 18, 19 and 20. To mitigate the CONASTON- MT CARMEL - NORTHWEST 230kV (BGE) line overloads would require the installation of the North Northwest substation including; two (2) 500/230kV transformers, four (4) 500 kV circuit breakers, seven (7) 230 kV circuit breakers and related substation equipment and land. The estimated cost to perform this work is **$70,000,000**. It also requires to reconductor Conastone to Northwest #2322 with 1,272kcmil ACSR 1,590kcmil ACSR. The estimated cost to perform this work is **$8,210,000**. This work would take **36 to 48 months** to build the substation and **18 to 24 months** for the line work.

21. The reinforcement for this overload is under development and is expected to be available during the S107 System Impact Study phase.

22. To mitigate the NEAST317-N.EAST 230/115kV transformer (BGE) overload would require the replacement of the transformer with a 500kV unit. The estimated cost to perform this work is **$10,200,000.**

23. To mitigate the 3 MILE I-TMI 500/230kV (METED) transformer overload would require the installation of a second 500/230kV transformer. The estimated cost to perform this work is **$11,800,000** and will take **20 months** to complete after an ISA and CSA are executed.

24. To mitigate the BRUNNER-YORKANA 230kV (METED/PPL) line overload would require the re-conductor of 0.64 miles of the existing single circuit 1033 Kcmil conductor which is limiting the line capacity of the Brunner Island – Yorkana 230kV line. The new line will be 1590 Kcmil equivalent ACCC (composite core) conductor. The 230 kV lines will be rated for summer normal/emergency of 653/793 MVA respectively or higher. This rebuild may require reinforcing the existing structures to accommodate the larger size of the new conductor. The rebuild will be 0.64 miles long and will travel the existing right of way. The estimated cost to perform this work including substation terminal equipment cost is **$600,000**.

25. To mitigate the NOTTNGHM-NOTTREAC 230kV (PECO) line overload would require the replacement of the line reactor. The estimated cost to perform this work is **$200,000** and will take **18 months** to complete after an ISA and CSA are executed.

26 and 27. To mitigate the NOTTREAC-PCHBTMTP-GRACETON 230kV (PECO/BGE) line overloads would require the following: A portion of this line must be relocated to underground to facilitate the construction of additional 500 kV lines between Peach Bottom and Conastone. The estimated cost to perform this work is **$61,000,000** and will take **36 months** to complete. The Peach Bottom to Nottingham portion (13.6 miles) must be rebuilt as a high capacity 230 kV line, (1243MVAn/1411MVAe) which includes a Susquehanna River crossing. The estimated cost to perform this work is **$42,500,000** and will take **48 months** to complete.