#T107 Essex 230kV

Generation Interconnection

This analysis was completed to assess the reliability impact for the new generation interconnecting to the PJM system as a capacity resource.

Network Impacts

The queue project T107 was studied as a 625MW (capacity) injection onto PSEG's system at the Essex 230kV facility. T107 was evaluated for compliance with reliability criteria for summer peak conditions in 2012. It should be noted that the Q75 MTX project was not modeled in our study because its associate network reinforcements were not available. Potential network impacts are as follows:

Generator Deliverability

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

1. **(PSEG)** The Essex-Kearny 230kV line loads from 96.3% to 148.4% (DC power flow) of its emergency rating (826MVA) for the single line contingency outage (PS72). This project contributes approximately 430.4MW to cause this thermal violation.

2. **(PSEG)** The Kearny-NJT Meadows 230kV line loads from 88.1% to 119.5% (DC power flow) of its normal rating (717MVA) for non-contingency condition. This project contributes approximately 224.9MW to cause this thermal violation.

3. **(PSEG)** The NJT Meadows-Kingsland C 230kV line loads from 86.0% to 117.3% (DC power flow) of its normal rating (717MVA) for non-contingency condition. This project contributes approximately 224.9MW to cause this thermal violation.

4. **(PSEG)** The Bergen-Athenia 230kV line loads from 96.6% to 118.4% (DC power flow) of its emergency rating (750MVA) for the single line contingency outage (PS45B). This project contributes approximately 163.6MW to cause this thermal violation.

5. **(PSEG)** The Cook Road C-Athenia 230kV line loads from 77.0% to 111.4% (DC power flow) of its normal rating (653MVA) for non-contingency condition. This project contributes approximately 224.9MW to cause this thermal violation.

6. **(PSEG)** The Kingsland C-Cook Road C 230kV line loads from 78.6% to 109.2% (DC power flow) of its normal rating (735MVA) for non-contingency condition. This project contributes approximately 224.9MW to cause this thermal violation.

7. **(PSEG)** The Bergen-Leonia T 230kV line loads from 90.2% to 104.7% (DC power flow) of its normal rating (375MVA) for non-contingency condition. This project contributes approximately 54.4MW to cause this thermal violation.

8. **(PSEG)** The Hoboken R-Bergen 230kV line loads from 95.0% to 111.3% (DC power flow) of its normal rating (392MVA) for non-contingency condition. This project contributes approximately 64.2MW to cause this thermal violation.

9. **(PSEG)** The Athenia-Clifton B 230kV line loads from 98.2% to 134.5% (DC power flow) of its emergency rating (865MVA) for the single line contingency outage (PS1). This project contributes approximately 314.3MW to cause this thermal violation.

10. **(PSEG)** The Bergenfield-New Milford 230kV line loads from 99.7% to 117.4% (DC power flow) of its emergency rating (585MVA) for the single line contingency outage (PS45B). This project contributes approximately 103.8MW to cause this thermal violation.

11. **(PSEG)** The Kearny 1-3-Turnpike G 138kV line loads from 94.6% to 109.1% (DC power flow) of its normal rating (249MVA) for non-contingency condition. This project contributes approximately 36.1MW to cause this thermal violation.

12. **(PSEG)** The Clifton B-Cedar Grove B 230kV line loads from 91.5% to 127.5% (DC power flow) of its emergency rating (873MVA) for the single line contingency outage (PS1). This project contributes approximately 314.3MW to cause this thermal violation.

13. **(PSEG)** The Athenia-Clifton K 230kV line loads from 94.1% to 130.3% (DC power flow) of its emergency rating (865MVA) for the single line contingency outage (PS2). This project contributes approximately 313.3MW to cause this thermal violation.

14. **(PSEG)** The Cedar Grove F-Roseland 230kV line loads from 92.1% to 128.3% (DC power flow) of its emergency rating (873MVA) for the single line contingency outage (PS2). This project contributes approximately 316.4MW to cause this thermal violation.

15. **(PSEG)** The Saddle Brook-Athenia 230kV line loads from 93.5% to 113.9% (DC power flow) of its emergency rating (527MVA) for the single line contingency outage (PS12). This project contributes approximately 107.5MW to cause this thermal violation.

16. **(PSEG)** The Cedar Grove B-Roseland 230kV line loads from 84.6% to 120.6% (DC power flow) of its emergency rating (873MVA) for the single line contingency outage (PS1). This project contributes approximately 314.3MW to cause this thermal violation.

17. **(PSEG)** The Clifton K-Cedar Grove F 230kV line loads from 87.4% to 123.3% (DC power flow) of its emergency rating (873MVA) for the single line contingency outage (PS2). This project contributes approximately 313.3MW to cause this thermal violation.

18. **(PSEG)** The Maywood-Saddle Brook 230kV line loads from 89.3% to 108.2% (DC power flow) of its emergency rating (600MVA) for the single line contingency outage (PS25). This project contributes approximately 112.8MW to cause this thermal violation.

19. **(PSEG)** The Turnpike G-Kingsland G 138kV line loads from 96.3% to 118.1% (DC power flow) of its normal rating (249MVA) for non-contingency condition. This project contributes approximately 54.2MW to cause this thermal violation.

20. **(PSEG)** The Athenia-Clifton B 230kV line loads from 80.1% to 109.0% (DC power flow) of its normal rating (735MVA) for non-contingency condition. This project contributes approximately 212.8MW to cause this thermal violation.

21. **(PSEG)** The New Milford-Maywood 230kV line loads from 86.5% to 101.2% (DC power flow) of its normal rating (400MVA) for non-contingency condition. This project contributes approximately 58.9MW to cause this thermal violation.

22. **(PSEG)** The New Milford-Maywood 230kV line loads from 86.5% to 101.2% (DC power flow) of its normal rating (400MVA) for non-contingency condition. This project contributes approximately 58.9MW to cause this thermal violation.

23. **(PSEG)** The Clifton B-Cedar Grove B 230kV line loads from 75.6% to 104.5% (DC power flow) of its normal rating (735MVA) for non-contingency condition. This project contributes approximately 212.8MW to cause this thermal violation.

24. **(PSEG)** The Cedar Grove F-Roseland 230kV line loads from 74.8% to 104.0% (DC power flow) of its normal rating (735MVA) for non-contingency condition. This project contributes approximately 214.2MW to cause this thermal violation.

25. **(PSEG)** The Athenia-Clifton K 230kV line loads from 72.2% to 101.4% (DC power flow) of its normal rating (735MVA) for non-contingency condition. This project contributes approximately 214.2MW to cause this thermal violation.

26. **(PSEG)** The Roseland-Whippany 230kV line loads from 82.7% to 103.4% (DC power flow) of its normal rating (1303MVA) for non-contingency condition. This project contributes approximately 270.0MW to cause this thermal violation.

27. **(PSEG)** The Kingsland G-West Caldwell G 138kV line loads from 81.1% to 102.9% (DC power flow) of its normal rating (249MVA) for non-contingency condition. This project contributes approximately 54.2MW to cause this thermal violation.

Multiple Facility Contingency

(Double Circuit Tower Line, Line with Failed Breaker and Bus Fault contingencies for the full energy output)

28. **(PSEG)** The Foundry-Newark 2 138kV line loads from 98.51% to 134.93% (DC power flow) of its emergency rating (367MVA) for the tower line outage (27PS). This project contributes approximately 133.7MW to cause this thermal violation.

29. **(PSEG)** The Essex-Newark 138kV line loads from 92.53% to 127.66% (DC power flow) of its emergency rating (388MVA) for the tower line outage (27PS). This project contributes approximately 136.3MW to cause this thermal violation.

30. **(PSEG)** The Essex-ECRR 138kV line loads from 91.64% to 126.60% (DC power flow) of its emergency rating (383MVA) for the tower line outage (27PS). This project contributes approximately 133.9MW to cause this thermal violation.

31. **(PSEG)** The Newark-Federal Square 138kV line loads from 86.56% to 142.34% (DC power flow) of its emergency rating (268MVA) for the tower line outage (27PS). This project contributes approximately 149.5MW to cause this thermal violation.

32. **(PSEG)** The Federal Square-Bayway 138kV line loads from 65.98% to 118.06% (DC power flow) of its emergency rating (287MVA) for the tower line outage (27PS). This project contributes approximately 149.5MW to cause this thermal violation.

33. **(PSEG)** The Essex 230/138kV transformer loads from 63.48% (DC power flow) to 104.50% of its emergency rating (573MVA) for the tower line outage (26PS). This project contributes approximately 235.1MW to cause this thermal violation.

34. **(PSEG)** The Essex-Essex PAR 230kV line loads from 67.73% to 109.42% (DC power flow) of its emergency rating (843MVA) for the tower line outage (27PS). This project contributes approximately 351.4MW to cause this thermal violation.

35. **(PSEG)** The Marion 3-Homestead F 138kV line loads from 92.78% to 113.09% (DC power flow) of its emergency rating (309MVA) for the tower line outage (27PS). This project contributes approximately 62.8MW to cause this thermal violation.

36. **(PSEG)** The Kearny 1-3-Turnpike G 138kV line loads from 98.27% to 120.97% (DC power flow) of its emergency rating (308MVA) for the tower line outage (22PS). This project contributes approximately 69.9MW to cause this thermal violation.

37. **(PSEG)** The Turnpike G-Kingsland G 138kV line loads from 90.39% to 112.80% (DC power flow) of its emergency rating (312MVA) for the tower line outage (22PS). This project contributes approximately 69.9MW to cause this thermal violation.

38. **(PSEG)** The Kingsland G-West Caldwell G 138kV line loads from 83.75% to 109.57% (DC power flow) of its emergency rating (312MVA) for the tower line outage (22PS). This project contributes approximately 80.6MW to cause this thermal violation.

39. **(PSEG)** The Hudson1-6-Cook Road D 230kV line loads from 82.83% to 111.37% (DC power flow) of its emergency rating (1000MVA) for the tower line outage (22PS). This project contributes approximately 285.4MW to cause this thermal violation.

40. **(PSEG)** The Leonia T-Bergenfield 230kV line loads from 84.64% to 100.62% (DC power flow) of its emergency rating (585MVA) for the tower line outage (31PS). This project contributes approximately 93.5MW to cause this thermal violation.

41. **(PSEG)** The Cook Road D-West Caldwell D 230kV line loads from 75.28% to 103.81% (DC power flow) of its emergency rating (1000MVA) for the tower line outage (22PS). This project contributes approximately 285.4MW to cause this thermal violation.

42. **(PSEG)** The Essex-Hudson 1-6 230kV line loads from 92.24% to 142.05% (DC power flow) of its emergency rating (826MVA) for the tower line outage (27PS). This project contributes approximately 411.5MW to cause this thermal violation.

43. **(PSEG)** The West Caldwell G-Roseland 5-7 138kV line loads from 71.46% to 101.19% (DC power flow) of its emergency rating (271MVA) for the tower line outage (22PS). This project contributes approximately 80.6MW to cause this thermal violation.

Short Circuit

The Short Circuit analysis for this project will be done in the Impact Study due to the large number of network reinforcements that are required.

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)

44. **(PSEG)** The Essex-Hudson 1-6 230kV line loads from 136.27% to 199.06% (DC power flow) of its emergency rating (826MVA) for the single line contingency outage (PS20). This project contributes approximately 518.6MW to the thermal violation.

45. **(PENELEC/NYISO)** The Laurel L-Goudy 115kV line loads from 103.97% to 109.01% (DC power flow) of its emergency rating (129MVA) for the single line contingency outage (PN20). This project contributes approximately 6.5MW to the thermal violation.

46. **(PSEG)** The Essex-Hudson 1-6 230kV line loads from 103.60% to 153.39% (DC power flow) of its normal rating (716MVA) for non-contingency condition. This project contributes approximately 356.6MW to the thermal violation.

47. **(PSEG)** The Kearny-NJT Meadows 230kV line loads from 117.01% to 169.03% (DC power flow) of its emergency rating (826MVA) for the single line contingency outage (PS72). This project contributes approximately 429.7MW to the thermal violation.

48. **(PSEG)** The Hudson 1-6-South Waterfront P 230kV line loads from 140.74% to 154.50% (DC power flow) of its normal rating (404MVA) for non-contingency condition. This project contributes approximately 55.6MW to the thermal violation.

49. **(PSEG)** The NJT Meadows-Kingsland C 230kV line loads from 115.11% to 167.13% (DC power flow) of its emergency rating (826MVA) for the single line contingency outage (PS72). This project contributes approximately 429.7MW to the thermal violation.

50. **(PSEG)** The Cook Road C-Athenia 230kV line loads from 111.32% to 168.46% (DC power flow) of its emergency rating (752MVA) for the single line contingency outage (PS72). This project contributes approximately 429.7MW to the thermal violation.

51. **(PSEG)** The Kingsland C-Cook Road C 230kV line loads from 107.99% to 158.84% (DC power flow) of its emergency rating (845MVA) for the single line contingency outage (PS72). This project contributes approximately 429.7MW to the thermal violation.

52. **(PSEG)** The South Waterfront-Newport R 230kV line loads from 136.87% to 157.24% (DC power flow) of its normal rating (315MVA) for non-contingency condition. This project contributes approximately 64.2MW to the thermal violation.

53. **(JCPL)** The Werner-Raritan River 115kV line loads from 106.79% to 112.34% (DC power flow) of its emergency rating (140MVA) for the single line contingency outage (JCPL101). This project contributes approximately 7.8MW to the thermal violation.

54. **(PSEG)** The Bergen-Leonia T 230kV line loads from 142.65% to 162.80% (DC power flow) of its emergency rating (557MVA) for the single line contingency outage (PS45). This project contributes approximately 112.2MW to the thermal violation.

55. **(PSEG)** The Newport R-Hoboken R 230kV line loads from 109.58% to 127.11% (DC power flow) of its normal rating (366MVA) for non-contingency condition. This project contributes approximately 64.2MW to the thermal violation.

56. **(PSEG)** The Bergen-Leonia T 230kV line loads from 136.16% to 154.79% (DC power flow) of its emergency rating (557MVA) for the single line contingency outage (PS45B). This project contributes approximately 103.8MW to the thermal violation.

57. **(JCPL)** The Parlin-Williams 230kV line loads from 106.70% to 110.51% (DC power flow) of its emergency rating (805MVA) for the single line contingency outage (JC17). This project contributes approximately 30.7MW to the thermal violation.

58. **(PPL/PENELEC)** The Lackawanna-Oxbow 230kV line loads from 168.16% to 173.81% (DC power flow) of its emergency rating (504MVA) for the single line contingency outage (APS-SB-658A). This project contributes approximately 28.5MW to the thermal violation.

59. **(JCPL)** The Williams-Freneau 230kV line loads from 106.07% to 109.88% (DC power flow) of its emergency rating (805MVA) for the single line contingency outage (JC17). This project contributes approximately 30.7MW to the thermal violation.

60. **(PSEG)** The Bergen-Leonia T 230kV line loads from 133.87% to 150.79% (DC power flow) of its normal rating (375MVA) for non-contingency condition. This project contributes approximately 63.4MW to the thermal violation.

61. **(PSEG)** The New Milford-Maywood 230kV line loads from 108.32% to 127.03% (DC power flow) of its emergency rating (585MVA) for the single line contingency outage (PS9). This project contributes approximately 109.5MW to the thermal violation.

62. **(PENELEC)** The North Meshoppen-Meshoppen Reactor 230/115kV transformer loads from 139.86% to 145.72% (DC power flow) of its emergency rating (201MVA) for the single line contingency outage (PN47B). This project contributes approximately 11.8MW to the thermal violation.

63. **(PENELEC)** The Meshoppen Reactor-North Meshoppen 115kV line loads from 139.80% to 145.66% (DC power flow) of its emergency rating (201MVA) for the single line contingency outage (PN47B). This project contributes approximately 11.8MW to the thermal violation

64. **(PSEG)** The Leonia T-Bergenfield 230kV line loads from 101.01% to 118.75% (DC power flow) of its emergency rating (585MVA) for the single line contingency outage (PS45B). This project contributes approximately 103.8MW to the thermal violation.

65. **(JCPL)** The South River-Atlantic 230kV line loads from 102.22% to 106.36% (DC power flow) of its emergency rating (805MVA) for the single line contingency outage (JC11). This project contributes approximately 33.3MW to the thermal violation.

66. **(PPL/PENELEC)** The Lackawanna-Oxbow 230kV line loads from 168.91% to 175.20% (DC power flow) of its normal rating (499MVA) for non-contingency condition. This project contributes approximately 31.4MW to the thermal violation.

67. **(PENELEC)** The Oxbow-North Meshoppen 230kV line loads from 168.75% to 175.04% (DC power flow) of its normal rating (499MVA) for non-contingency condition. This project contributes approximately 31.4MW to the thermal violation.

68. **(BGE)** The Raphael-Northeast 339 230kV line loads from 147.35% to 150.94% (DC power flow) of its emergency rating (758MVA) for the single line contingency outage (BG8). This project contributes approximately 27.1MW to the thermal violation.

69. **(BGE)** The Raphael-Northeast 317 230kV line loads from 144.50% to 148.03% (DC power flow) of its emergency rating (758MVA) for the single line contingency outage (BG18). This project contributes approximately 26.8MW to the thermal violation.

70. **(BGE)** The Conastone-North Northwest 500kV line loads from 182.22% to 188.04% (DC power flow) of its normal rating (2078MVA) for non-contingency condition. This project contributes approximately 121.1MW to the thermal violation.

71. **(BGE)** The Northwest 311-Granite 311 230kV line loads from 183.80% to 189.21% (DC power flow) of its emergency rating (641MVA) for the single line contingency outage (PJM13B_NNWEST_B). This project contributes approximately 34.7MW to the thermal violation.

72. **(PECO/BGE)** The Peach Bottom-Conastone 500kV line loads from 178.26% to 184.33% (DC power flow) of its emergency rating (2598MVA) for the single line contingency outage (PJM17_2). This project contributes approximately 157.6MW to the thermal violation.

73. **(PECO/BGE)** The Peach Bottom-Conastone 500kV line loads from 178.26% to 184.33% (DC power flow) of its emergency rating (2598MVA) for the single line contingency outage (PJM17). This project contributes approximately 157.6MW to the thermal violation.

74. **(PENELEC)** The Roxbury 115/138kV transformer loads from 122.53% to 128.99% (DC power flow) of its emergency rating (140MVA) for the single line contingency outage (PJM13B_NNWEST_A). This project contributes approximately 9.1MW to the thermal violation.

75. **(PENELEC/AP)** The Roxbury-Greene 138kV line loads from 120.80% to 127.18% (DC power flow) of its emergency rating (142MVA) for the single line contingency outage (PJM13B_NNWEST_A). This project contributes approximately 9.1MW to the thermal violation.

76. **(BGE)** The Conastone-Mt. Carmel 22 230kV line loads from 155.26% to 159.74% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage (PJM13B_NNWEST_A). This project contributes approximately 41.4MW to the thermal violation.

77. **(BGE)** The Conastone-Mt. Carmel 10 230kV line loads from 155.26% to 159.74% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage (PJM13B_NNWEST_A). This project contributes approximately 41.4MW to the thermal violation.

78. **(BGE)** The Mt. Carmel 22-North Northwest 230kV line loads from 152.96% to 157.45% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage (PJM13B_NNWEST_A). This project contributes approximately 41.4MW to the thermal violation.

79. **(BGE)** The Mt. Carmel 10-North Northwest 230kV line loads from 152.96% to 157.45% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage (PJM13B_NNWEST_A). This project contributes approximately 41.4MW to the thermal violation.

80. **(METED/PENELEC)** The Gardners-Carlisle 115kV line loads from 101.12% to 106.22% (DC power flow) of its emergency rating (109MVA) for the single line contingency outage

(PJM13B_NNWEST_A). This project contributes approximately 5.6MW to the thermal violation.

81. **(BGE)** The Northwest 326-Granite 6 230kV line loads from 130.36% to 134.11% (DC power flow) of its emergency rating (923MVA) for the single line contingency outage (PJM13B_NNWEST_B). This project contributes approximately 34.6MW to the thermal violation.

82. **(PSEG)** The Linden 1-North Avenue 138kV line loads from 156.82% to 219.34% (DC power flow) of its emergency rating (308MVA) for the tower line outage (27PS). This project contributes approximately 192.6MW to the thermal violation.

83. **(PSEG)** The ECRR-Foundry 138kV line loads from 118.51% to 156.70% (DC power flow) of its emergency rating (350MVA) for the tower line outage (27PS). This project contributes approximately 133.7MW to the thermal violation.

84. **(PSEG)** The Passaic Valley SC-Bayonne 138kV line loads from 135.18% to 199.58% (DC power flow) of its emergency rating (299MVA) for the tower line outage (27PS). This project contributes approximately 192.6MW to the thermal violation.

85. **(PSEG)** The Bayonne-B-M Reactor 1/AC 1kV transformer loads from 139.62% to 192.10% (DC power flow) of its emergency rating (311MVA) for the tower line outage (27PS). This project contributes approximately 163.2MW to the thermal violation.

86. **(PSEG)** The B-M Reactor-Marion AC 1/4 1kV transformer loads from 139.60% to 192.07% (DC power flow) of its emergency rating (311MVA) for the tower line outage (27PS). This project contributes approximately 163.2MW to the thermal violation.

87. **(PSEG)** The North Avenue-Passaic Valley SC 138kV line loads from 116.21% to 167.97% (DC power flow) of its emergency rating (372MVA) for the tower line outage (27PS). This project contributes approximately 192.6MW to the thermal violation.

88. **(PSEG)** The Essex PAR-Stanley Terrace 230kV line loads from 103.80% to 167.69% (DC power flow) of its emergency rating (550MVA) for the tower line outage (27PS). This project contributes approximately 351.4MW to the thermal violation.

89. **(PSEG)** The Stanley Terrace-Aldene 230kV line loads from 101.09% to 164.98% (DC power flow) of its emergency rating (550MVA) for the tower line outage (27PS). This project contributes approximately 351.4MW to the thermal violation.

90. **(PSEG)** The Marion 3-Hudson 7-12 138/230kV transformer loads from 103.11% to 123.94% (DC power flow) of its emergency rating (441MVA) for the tower line outage (27PS). This project contributes approximately 91.9MW to the thermal violation.

91. **(PSEG)** The Hudson1-6-South Waterfront P 230kV line loads from 128.31% to 144.21% (DC power flow) of its emergency rating (622MVA) for the tower line outage (30PS). This project contributes approximately 98.9MW to the thermal violation.

92. **(PSEG)** The South Waterfront P-Newport R 230kV line loads from 140.18% to 163.50% (DC power flow) of its emergency rating (490MVA) for the tower line outage (30PS). This project contributes approximately 114.2MW to the thermal violation.

93. **(PSEG)** The Newport R-Hoboken R 230kV line loads from 126.07% to 147.99% (DC power flow) of its emergency rating (521MVA) for the tower line outage (30PS). This project contributes approximately 114.2MW to the thermal violation.

94. **(PSEG)** The Hoboken R-Bergen 230kV line loads from 119.84% to 141.64% (DC power flow) of its emergency rating (524MVA) for the tower line outage (30PS). This project contributes approximately 114.2MW to the thermal violation.

95. **(PPL/METED)** The Brunner Island-Yorkana 230kV line loads from 131.06% to 135.34% (DC power flow) of its emergency rating (617MVA) for the tower line outage (CONAS_PB). This project contributes approximately 26.4MW to the thermal violation.

96. **(PENELEC)** The Oxbow-North Meshoppen 230kV line loads from 185.39% to 191.36% (DC power flow) of its emergency rating (617MVA) for the tower line outage (CONAS_PB). This project contributes approximately 36.8MW to the thermal violation.

97. **(PECO)** The Three Mile Island 500/230kV transformer loads from 153.90% to 158.39% (DC power flow) of its emergency rating (1077MVA) for the tower line outage (CONAS_PB). This project contributes approximately 48.4MW to the thermal violation.

98. **(PECO)** The Nottingham-Nottingham Reactor 230kV line loads from 203.20% to 209.17% (DC power flow) of its emergency rating (627MVA) for the tower line outage (CONAS_PB). This project contributes approximately 37.5MW to the thermal violation.

99. **(PECO/BGE)** The Peach Bottom Tap-Graceton 230kV line loads from 203.17% to 209.14% (DC power flow) of its emergency rating (627MVA) for the tower line outage (CONAS_PB). This project contributes approximately 37.5MW to the thermal violation.

100. **(PECO)** The Nottingham Reactor-Peach Bottom Tap 230kV line loads from 203.17% to 209.14% (DC power flow) of its emergency rating (627MVA) for the tower line outage (CONAS_PB). This project contributes approximately 37.5MW to the thermal violation.

101. **(BGE)** The Conastone-North Northwest 500kV line loads from 173.43% to 178.25% (DC power flow) of its emergency rating (2901MVA) for the tower line outage (CNSTN_NWEST_NNWEST_A). This project contributes approximately 139.9MW to the thermal violation.

102. **(PPL/BGE)** The Manor-Graceton 230kV line loads from 192.52% to 198.85% (DC power flow) of its emergency rating (531MVA) for the tower line outage (CONAS_PB). This project contributes approximately 33.6MW to the thermal violation.

103. **(PENELEC)** The North Meshoppen-East Towanda 230kV line loads from 121.35% to 126.59% (DC power flow) of its emergency rating (554MVA) for the tower line outage (CONAS_PB). This project contributes approximately 29.0MW to the thermal violation.

104. **(PPL/METED)** The Hosensack-North Boyertown 230kV line loads from 108.20% to 113.83% (DC power flow) of its emergency rating (525MVA) for the tower line outage (CONAS_PB). This project contributes approximately 29.5MW to the thermal violation.

105. **(BGE)** The North Northwest-Kempton 500kV line loads from 153.73% to 158.60% (DC power flow) of its emergency rating (2901MVA) for the tower line outage (CNSTN_NWEST_NNWEST_B). This project contributes approximately 141.3MW to the thermal violation.

106. **(PPL/BGE)** The Otter Creek-Conastone 230kV line loads from 167.83% to 173.62% (DC power flow) of its emergency rating (627MVA) for the tower line outage (CONAS_PB). This project contributes approximately 36.3MW to the thermal violation

New System Reinforcements

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

1. The Essex-Kearny 230kV line overload can be alleviated by constructing a new 230kV line from Hudson to Essex (1590 ACSS). This upgrade will cost approximately **$10M** and take **2-3 years** to complete. **This upgrade also mitigates Network Impact number 2, 3, 5, 6, 29, 30, 33, 34, 39, 41, 42, 44, 46, 47, 49, 50, 51, 53, 85, 86, 87, 88, and 89**.

4. The Bergen – Athenia 230kV line overload can be alleviated by constructing a new 230kV line from Athenia directly to Bergen. The cost of constructing this new line is approximately **$95M**. **This upgrade also mitigates Network Impact number 10, 15, 18, 21, 22, and 61**.

7. The Bergen-Leonia "T" ckt #1 and ckt#2 230kV line overloads can be alleviated by adding oil circulation to increase the emergency rating by 15%. The estimated cost is **$5M**. The overload will also warrant a cost allocation for a new 230kV pipe-type cable from Bergen – Leonia at a cost of **$60M**. **This upgrade also mitigates Network Impact number 54, 56, and 60**.

8. The Hoboken R – Bergen 230kV overload can be alleviated by installing a 4 breaker ring bus at 49th street which taps Hoboken – Bergen. The line from 49th street to Bergen will also need to be reconductored with 1590 ACSS wire. The upgrade will cost approximately **$21.3M**. **This upgrade also mitigates Network Impact number 31, 32, 55, 93, and 94**.

9. The Athenia – Clifton B 230kV line overload can be alleviated by reconductoring the existing line with 1590 ACSR (779N/1156E MVA) at a cost of **$0.5M**. **This upgrade also mitigates Network Impact number 20**.

11. The Kearny – Turnpike G 138kV line overload can be alleviated by constructing a new 230kV circuit along the path Bergen – Homestead – Hudson. The estimated cost of this upgrade is **$33.7M**. The overload will also require the Kearny – Turnpike G line to be reconductored with 1059 ACSS cable at a cost of **$2.91M**.**This upgrade also mitigates Network Impact number 35, and 36**.

12. The Clifton B – Cedar Grove B 230kV line overload can be alleviated by reconductoring the existing line with 1590 ACSR at a cost of **$2.87M**. **This upgrade also mitigates Network Impact number 23**.

13. The Athenia – Clifton K 230kV line overload can be alleviated by reconductoring the existing line with 1590 ACSS at a cost of **$0.5M**. **This upgrade also mitigates Network Impact number 25**.

14. The Cedar Grove F – Roseland 230kV line overload can be alleviated by reconductoring the existing line with 1590 ACSS at a cost of **$5.86M**. **This upgrade also mitigates Network Impact number 24**.

16. The Cedar Grove B – Roseland 230kV line overload can be alleviated by reconductoring the existing line with 1590 ACSS at a cost of **$5.86M**.

17. The Clifton K – Cedar Grove F 230kV line overload can be alleviated by reconductoring the existing line with 1590 ACSS at a cost of **$2.87M**.

19. The Turnpike G – Kingland G 230kV line overload can be alleviated by reconductoring the existing line with 1059 ACSS at a cost of **$2.99M**. **This upgrade also mitigates Network Impact number 37**.

26. Whippany – Roseland 230 kV (A941) Upgrade: This overload requires rebuilding existing Whippany to Roseland line from 1033.5 Kcmil 54/7 ACSR (2) (2.7 mile) to 1590 Kcmil 54/19 ACSS/AW (2) (2.7 mile) for 1303/1601 MVA (JC) summer normal/emergency ratings and addition of a line trap (4000 amp) (1) and bundled drop loop conductors at Whippany substation at an estimated cost of **$5,580,400**.

27. The Kingland – West Caldwell G 230kV line overload can be alleviated by reconductoring the existing line with 1059 ACSS at a cost of **$11.09M**. **This upgrade also mitigates Network Impact number 38**.

28. The Foundry – Newark line violation can be alleviated by adjusting the angle of the Linden PAR to 270MW out of Bayway.

40. The Bergenfield – Leonia "T" circuit overload can be alleviated by adding oil circulation to increase the emergency rating. The estimated cost of providing oil circulation to this line is approximately **$2.5M**. **This upgrade also mitigates Network Impact number 64**.

43. The West Caldwell – Roseland 138kV line overload can be alleviated by reconductoring the existing line with 1059 ACSS at a cost of **$3.78M**.

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)

45. The Laurel L – Goudey 115kV line overload will be alleviated by a PJM operating procedure which will open the Tiffany-Goudey 115kV line to control thermal limits that occur on the Penelec/NY ISO tie lines.

48. The Hudson-South Waterfront 230kV line overloads can be alleviated by reconductoring the circuit to increase its normal rating to a minimum of 475MVA and the emergency rating to a minimum of 575MVA. The estimated cost is **$6M**. **This upgrade also mitigates Network Impact number 91**.

52. The South Waterfront-Newport "R" 230kV line overloads can be alleviated by providing oil circulation to increase the rating. The estimated cost is **$5M**. This upgrade, in conjunction with the 4-breaker ring bus at 49th street (upgrade for Network Impact 10) will alleviate the overload. **This upgrade also mitigates Network Impact number 92**.

57. Parlin - Williams (K1025) Upgrade: This overload requires reconductoring of Parlin - Williams line from 1590 Kcmil 45/7 ACSR (2.9 mile DCT) to 1590 Kcmil 54/19 ACSS/AW - Bundled (1.7 mile DCT) for 1642/1850 MVA summer normal/emergency ratings. It also requires replacement of disconnect switch (4000 amp) (1), bundled conductor at Williams substation and at Parlin substation. Total estimated cost is **$3.86M**.

58. The Lackawanna – Oxbow 230kV line: The Penelec portion of the upgrade involves the rebuild of 16.33 miles of transmission line as well as substation work at the Oxbow facility. The estimated cost of the Penelec upgrade is **$19.771M** and it would take **4-5 years** to complete. PPL owns the Lackawanna substation. PPL is assuming that terminal upgrade work would be required at the Lackawanna substation. The estimated cost for the terminal upgrade is **$500,000**. **This upgrade also mitigates Network Impact number 66**.

59. Williams - Freneau 230 kV (K1025) Upgrade: This overload requires reconductoring of Freneau to Williams line from 1590 Kcmil 45/7 ACSR (7.7 mile) to 1590 Kcmil 54/19 ACSS/AW (7.7 mile) for 869/1068 MVA summer normal/emergency ratings at an estimated cost of **$3.85M**. It requires addition of a disconnect switch (3000 amp) (1) at Freneau substation at an estimated cost of **$75,000** and a disconnect switch (3000 amp) (1) at Williams substation at an

estimated cost of **$75,000**. It also requires bundled conductor at Freneau substation at an estimated cost of **$20,000** and at Williams substation at an estimated cost of **$20,000**.

62. The N. Meshoppen 230/115 kV ckt#3 transformer overload would require the upgrade of the transmission transformer and associated equipment (circuit breaker, substation conductor, CT circuits), which is estimated to cost approximately **$4M** and requires a lead time of at least **24 months**. **This upgrade also mitigates Network Impact number 63**.

65. The South River-Atlantic 230kV line overload can be alleviated by reconductoring the line from 1590 Kcmil 45/7 ACSR (18.7 mile DCT) to 1590 Kcmil 54/19 ACSS/AW-Bundled (10.03 mile DCT) for 1642/1850 MVA summer normal/emergency ratings. It also requires replacement of disconnect switch (4000 amp) (1), line trap (4000 amp) (1), bundled drop loop conductor at Atlantic substation and replacement of line trap (4000 amp) (1) and bundled drop loop conductor at South River substation. Total estimated cost is **$20,660,800**.

67. The Oxbow-North Meshoppen 230kV line overload can be alleviated by reconductoring approximately 10.16 miles of transmission line (estimated to cost approximately $5.08 million), a CT circuit (estimated to cost approximately $140,000), and substation conductor (estimated to cost approximately $125,000) at North Meshoppen substation. The total estimated cost is **$5.345M**. **This upgrade also mitigates Network Impact number 96**.

68. The Raphael – Northeast339 230kV line overload would increasing the rated conductor temp to 160°C, which attains 1153 MVA. The existing conductor is 2,167 ACSR @ 125°C. The transmission line is 3.9 miles long. Approximately 7 spans have ground clearance of less than 35 feet. Assume replacement of 5 double circuit steel poles to increase ground clearance. The estimated cost to perform the line and substation work is **$6M** and will require **5 years** to complete. **This upgrade also mitigates Network Impact number 69**.

70. The Conastone-North North West overloads can be alleviated by adding a single circuit 500kV line at an estimated cost of **$109M** and estimated time of 10 yrs.

Assumptions:
New 200 ft. wide R/W parallels existing Conastone to Northwest R/W
Total R/W length = 19.6 miles
3 - bundle 1,590 kcm conductor
North Northwest located 4 miles north of Northwest
This upgrade also mitigates Network Impact number 101.

71. The Northwest 311 – Granite1 230kV overload can be alleviated by reconductoring the line with 2,167 ACSR. There will also be substation terminal cost upgrades associated with the reinforcement. The estimated cost to perform the substation and transmission line work is **$23.6M** and will require **6 years** to complete. **This upgrade also mitigates Network Impact number 81**.

72. Conastone – Peach Bottom 500 kV Line - To mitigate the overload of the Conastone – Peach Bottom 500 kV circuit a second circuit will need to be built.

If RIGHT OF WAY can be acquired following is the Reinforcement and Cost Estimates:

PECO portion of the Conastone – Peach Bottom line:

Substation work at Peach Bottom	$ 2,500,000
Construct 6.25 miles of 500kV line	$10,000,000
	$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 **$48M** 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 **$1.5M**. 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 (and we may not be able to do this), the new underground installation would cost about **$30M** plus another **$1M** for terminal modifications. I assume 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 $30M.

Removal of the existing 230 kV tower line is about **$1.5M**.

Construction of a double circuit 500kV line from Conastone to Peach Bottom would be about $3.5M per mile. The line is 16.5 miles long. Total cost **$58M**.

Substation additions and modifications at Peach Bottom would cost about **$10M**.

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

This upgrade also mitigates Network Impact numbers 73.

74. The Roxbury 138/115 kV transformer overload would require the upgrade of the transmission transformer and associated equipment (circuit breaker, substation conductor, CT circuits), which is estimated to cost approximately **$2.25M** and requires a lead time of at least **2 years**. **This upgrade also mitigates Network Impact numbers 75**.

76. Northwest - Mt Carmel - Conastone upgrade –

This overload requires to install NNW station 2-500/230kV xfmrs 4-500 kV bkrs, 7-230 kV Bkrs and related substation equipment and land at a cost of **$70M**. It also requires to reconductor Conastone to Northwest #2322 with 1,272kcmil ACSR 1,590kcmil ACSR with an estimated cost of **$8.21M**. This work would take 3-4 years to build substation and 18-24 months for the line work. **This upgrade also mitigates Network Impact numbers 77, 78, and 79**.

80. The Gardners – Carlisle 115kV line overload will be alleviated by a PJM operating procedure which will open this line pre-contingency if the contingency scenario mentioned (PJM13B_NNWEST_A) occurs.

82. The Linden – North Ave 138kV line violation can be alleviated by adjusting the angle of the Linden PAR to 270MW out of Bayway. The overload will also constitute a cost allocation to the 49th street rack upgrade identified by Network Impact number 8. The cost of this upgrade was determined to be **$21.3M**. **This upgrade also mitigates Network Impact numbers 83 and 84**.

90. The Marion – Hudson 138/230kV transformer overload can be alleviated by replacing the existing transformer with a new transformer. The upgrade will cost approximately **$10M**.

95. The Brunner Island – Yorkana 230kV line: Meted owns 12.6 miles of the transmission line and the Yorkana substation. PPL owns .64 miles of the transmission line and the Brunner Island substation. The PPL portion of the line will be rebuilt with 1590 ACSR cable. The cost of the rebuilt and the terminal work at Brunner Island is **$2M**.

97. 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 **$11.8M** and will take **20 months** to complete.

98. The Nottingham – Peach Bottom line reactor overload can be alleviated by replacing the line reactor. The upgrade will cost about **$0.2M** and will take about **18 months** to complete.

99. The Peach Bottom – Graceton 230kV line (PECO and BGE portions) overload can be alleviated by replacing the existing 230kV line with a double circuit 230kV underground cable capable of handling about 1226MVA during emergency conditions. The upgrade will cost about **$61M** and will take about **48 months** to complete.

100. The Nottingham – Peach Bottom 230kV line overload can be alleviated by tearing down and rebuilding the existing 230kV line. This will increase the line rating to 1243N/1410E MVA. This portion of the upgrade will cost **$40M** and take **4 years** to complete. A second 230kV line will also need to be constructed on new right of way at a cost of **$40M** and a time estimate of **10 years**. Finally, a new substation will need to be built at Peach Bottom at a cost of **$10M and** an estimated **4 years** to complete.

102. The Manor – Graceton 230kV line: PPL owns 14.5 miles of the transmission line and the Manor substation. BGE owns 1.4 miles of the transmission line and the Graceton substation. The PPL portion of the line will be rebuilt with 1590 ACSR cable. The cost of the rebuilt and the terminal work at Manor is **$36M**.

103. North Meshoppen - East Towanda 230 kV Line - This overload would require the reconductor of approximately 21.66 miles of 230 kV transmission line between North Meshoppen and East Towanda substations. The East Towanda substation would require the replacement of a line/wave trap, disconnect switch, and CT circuit. The North Meshoppen substation would require the upgrade or replacement of two CT circuits as well as the replacement of substation conductor. The estimated cost of this upgrade is **$16.245M**, and it would take **4-5 years** to complete.

104. Hosensak – North Boyertown 230kV Line – This overload would require the reconductoring of approximately 8 miles of 230kV transmission line with 1590 ACRS wire. The existing structures between Hosensak and North Boyertown are insufficient to support a large size wire, so they will also need to be upgraded. For the worst case scenario where all support structures need to be replaced, the estimated cost of the reinforcement is **$11.75M**. The upgrade will take approximately **3 years** to complete.

105. Kemptown to North Northwest 500 kV line **-** 2 single circuit lines at an estimated cost of **$279M** and estimated time of **10 yrs**.

Assumptions:
New 350 ft. wide R/W parallels existing Northwest to Mt Airy Tap R/W
Total R/W length = 28.3 miles
3 - bundle 1,590 kcm conductor
Kemptown located 1/4 mile west of Mt Airy Tap
North Northwest located 4 miles north of Northwest

Substation Terminations (all in 2012 dollars):
NNW - Install a 3 breaker bay $7.7M
Kemptown - Install a 3 breaker bay $7.7M

106. The Otter Creek - Conastone 230kV line: PPL owns 12 miles of the transmission line and the Otter Creek substation. BGE owns 4.7 miles of the transmission line and the Conastone substation. The PPL portion of the line will be reconductored with 795 ACSS cable. The cost of the reconductoring and the terminal work at Otter Creek is **$6M**.