

Generator Interconnection

This analysis was completed to assess the reliability impact for a new generator interconnecting to the PJM System as a Capacity Resource.

Network Impacts

Queue T115 was studied as a 32.5 MW Capacity increase at Croydon 230 kV bus. Project T115 was evaluated for compliance with reliability criteria for summer peak conditions in 2012. Network impacts were as follows:

NETWORK IMPACTS

Generator Deliverability

(Normal System with all facilities in-service and Single, or N-1, contingencies for the Capacity portion only of the interconnection)

No new problems were identified.

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 Impact Study)

No new problems were identified.

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. The Emilie - Neshaminy 138kV line loads from **163.45% to 164.89%** (before and after T115) of its normal rating (550MVA) for non-contingency condition. This project contributes approximately **7.9MW** to the thermal violation.
2. The Emilie - Neshaminy 138kV line loads from **163.02% to 164.55%** (before and after T115) of its emergency rating (791MVA) for the outage of Croydon – Eddington Tap 230 kV line and Emilie 230/34.5 kV transformer (PE55). This project contributes approximately **12.0MW** to the thermal violation.
3. The Croydon – Burlington section of the Croydon – Mt Laurel 230 kV line loads from **218.48% to 221.80%** (before and after T115) of its emergency rating (558 MVA) for the outage of Croydon – Eddington Tap 230 kV line and Emilie 230/34.5 kV transformer (PE55). This project contributes approximately **18.5MW** to the thermal violation.

4. The Richmond Reactor - Richmond line section of the Richmond to Holmsburg Tap 230 kV line loads from **264.75% to 268.93%** (before and after T115) of its emergency rating (374MVA) for the outage of Croydon - Burlington - Mt Laurel – Coxs Corner 230 kV line (PS59). This project contributes approximately **15.6MW** to the thermal violation.
5. The Holmsburg Tap – Richmond Reactor line section of Richmond to Holmsburg 230kV line loads from **264.75% to 268.93%** (before and after T115) of its emergency rating (374MVA) for the outage of Croydon - Burlington - Mt Laurel – Cox’s Corner 230 kV line (PS59).
6. The Neshaminy – Byberry 138kV line loads from **166.67% to 168.35%** (before and after T115) of its emergency rating (719MVA) for the outage of Croydon – Eddington Tap 230 kV line and Emilie 230/34.5 kV transformer (PE55). This project contributes approximately **12.0MW** to the thermal violation.
7. The Emilie 230/138kV transformer #8 loads from **144.97% to 146.26%** (before and after T115) of its emergency rating (525MVA) for the outage of Emilie 230/138 kV transformer #7 (PE206). This project contributes approximately **6.8MW** to the thermal violation.
8. The Eddington Tap to Eddington section of the Croydon - Eddington - Emilie 230 kV line loads from **165.19% to 167.07%** (before and after T115) of its emergency rating (856MVA) for the outage of Emilie – Neshaminy 138 kV line and Neshaminy 138/13.8 kV transformer (PE90). This project contributes approximately **16.1MW** to the thermal violation.
9. The Burlington to Mt Laurel section of the Croydon to Mt Laurel 230 kV line loads from **165.44% to 167.62%** (before and after T115) of its emergency rating (844 MVA) for the outage of Croydon – Eddington Tap 230 kV line and Emilie 230/34.5 kV transformer (PE55). This project contributes approximately **18.5MW** to the thermal violation.
10. The Emilie 230/138kV transformer #7 loads from **132.70% to 133.91%** (before and after T115) of its emergency rating (525MVA) for the outage of Emilie Transformer #8 (PE207). This project contributes approximately **6.3MW** to the thermal violation.
11. The Mt Laurel – Cox’s Corner 230 kV line loads from **154.56% to 156.67%** (before and after T115) of its emergency rating (873 MVA) for the outage of Croydon – Eddington Tap 230 kV line and Emilie 230/34.5 kV transformer (PE55).
12. The Neshaminy – Byberry 138kV line loads from **138.33% to 139.69%** (before and after T115) of its normal rating (584MVA) for non-contingency, normal (all

- facilities in-service) condition. This project contributes approximately **7.9MW** to the thermal violation.
13. The Eddington – Holmsburg Tap 230kV line loads from **152.33% to 154.14%** (before and after T115) of its emergency rating (887MVA) for the outage of Emilie – Neshaminy 138 kV line and Neshaminy 138/13.8 kV transformer (PE90).
 14. The Croydon – Burlington section of the Croydon – Mt Laurel 230kV line loads from **155.92% to 158.38%** (before and after T115) of its normal rating (466MVA) for non-contingency condition. This project contributes approximately **11.5MW** to the thermal violation.
 15. The Richmond Reactor – Richmond section of the Richmond – Holmsburg Tap 230kV line loads from **171.94% to 174.67%** of its normal rating (374MVA) for non-contingency condition. This project contributes approximately **10.2MW** to the thermal violation.
 16. The Holmsburg Tap – Richmond Reactor section of the Holmsburg Tap – Richmond 230 kV line loads from **171.94% to 174.67%** (before and after T115) of its normal rating (374 MVA) for non-contingency, normal system (all facilities in-service) condition. This project contributes approximately **10.2MW** to the thermal violation.
 17. The Eddington – Eddington Transformer #6 230 kV line section loads from **135.95% to 137.64%** (before and after T115) of its normal rating (737 MVA) for non-contingency, normal system (all facilities in-service) condition. This project contributes approximately **12.4MW** to the thermal violation.
 18. The Burlington – Mt Laurel section of the Croydon – Mt Laurel 230kV line loads from **122.82% to 124.37%** (before and after T115) of its normal rating (734MVA) for non-contingency, normal system (all facilities in-service) condition. This project contributes approximately **11.4MW** to the thermal violation.
 19. The Eddington – Holmsburg Tap 230kV line loads from **128.29% to 129.99%** (before and after T115) of its normal rating (732MVA) for non-contingency, normal system (all facilities in-service) condition. This project contributes approximately **12.4MW** to the thermal violation.
 20. The Mt Laurel to Cox’s Corner 230 kV line loads from **116.42% to 117.97%** (before and after T115) of its normal rating (734MVA) for non-contingency, normal system (all facilities in-service) condition. This project contributes approximately **11.4MW** to the thermal violation.

Short Circuit

Not applicable, there are no changes to generator and transformer impedances.

Stability Analysis

Not required, there are no changes to generator characteristics

Power Factor Analysis

Preliminary evaluation indicates that T115 Interconnection Customer intends to add inlet cooling to operate at a lower summer inlet temperature to enable the generation to meet PJM's Power Factor requirements.

Queue T115 generator interconnection design must be capable of either;

- A power factor of 0.95 lead to 0.90 lag (at the generator terminals) at the new MW value, or
- A MVAR capability equal to the original MVAR capability (grandfathered lead and lag MVAR capability before the MW increase, or 0.95 lead to 0.90 lag for the original MWs whichever is less) plus a power factor of 1.0 to 0.90 lag for T115 MW increase, all measured at the generator terminals.

T115 design capability ("D" curves or other documentation) information was not provided by the Interconnection Customer in sufficient time to include a Power Factor analysis in this Feasibility Study. **T115 Power Factor requirements will be further evaluated for the Impact Study.**

NETWORK UPGRADE REQUIREMENTS

New System Reinforcements

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

None

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)

1. Neshaminy to Emilie 138 kV line - Rebuild line to 230 kV double circuit, high capacity standards and operate both sides of the tower line at 138 kV to achieve rating of 1490MVA_n/1690MVA_e. 4.4 miles at \$2.5M per mile plus modifications at both substations, total estimated cost is **\$21,000,000** and estimated construction

- time is **48 months** to complete. This upgrade also satisfies Network Upgrade requirement #3 below for Network Impact #3.
2. Network Upgrade #1 above also satisfies Network Impact and Upgrade #2.
 3. Croydon to Burlington 230 kV interconnection line to Public Service - Rebuild as high capacity 230 kV line, 1243 MVA (Normal) / 1411 MVA (Emergency). 1.4 miles at \$1.5M per mile plus construct a new Delaware river crossing line span, approx **\$22,000,000** and **36 months** to complete. PECO portion only.
 4. Eddington Tap to Eddington to Holmesburg Tap/Holmesburg to Richmond 230 kV line - Construct second 230 kV line along railroad rights of way. 15.7 miles @ \$2.5M per mile, **\$39,000,000** and **36 months** to complete. Modify Eddington, Holmesburg, and Richmond substations to accommodate new line, **\$10,000,000** and **three years** to complete. This upgrade also satisfies Network Upgrade requirements #6, 9, 14, 16, 17, 18 and 20 below for Network Impacts of #6, 9, 14, 16, 17, 18 and 20.
 5. Network Upgrade #4 above also satisfies Network Impact #5.
 6. Byberry to Neshaminy 138kV line - Rebuild line to 230 kV double circuit, high capacity standards and operate both sides of the tower line at 138 kV to achieve rating of 1490MVA_n/1690MVA_e. 4.4 miles at \$2.5M per mile plus modifications at both substations, **\$21,000,000** and **48 months** to complete.
 7. Emilie #7 and #8 230/138 kV transformers - Parallel existing transformers with new transformers of additional capacity, **\$8,000,000 plus \$5,000,000** for substation modifications.
 8. Network Upgrade #4 above also satisfies Network Impact and Upgrade #8.
 9. Reinforcement information will be provided for the Impact Study if applicable.
 10. Network Upgrade #7 above also satisfies Network Impact and Upgrade #10.
 11. Reinforcement information will be provided for the Impact Study if applicable.
 12. Network Upgrade #6 above also satisfies Network Impact and Upgrade #12.
 13. Network Upgrade #1 above also satisfies Network Impact and Upgrade #13.
 14. Croydon – Burlington 230 kV line upgrade:
 - a) Croydon to Burlington 230 kV interconnection line to Public Service – Rebuild as high capacity 230 kV line, 1243MVA_n/1411MVA_e. 1.4 miles at

\$1.5M per mile plus new Delaware river crossing, approx **\$22,000,000** and **36 months** to complete. **PECO portion only.**

- b)** Reinforcement information for the PSEG portion of the Croydon – Burlington 230 kV line will be provided for the Impact Study if applicable.
- 15. Network Upgrade #1 above also satisfies Network Impact and Upgrade #15.
- 16. Network Upgrade #1 above also satisfies Network Impact and Upgrade #16.
- 17. Network Upgrade #1 above also satisfies Network Impact and Upgrade #17.
- 18. Reinforcement information will be provided for the Impact Study if applicable.
- 19. Network Upgrade #1 above also satisfies Network Impact and Upgrade #19.
- 20. Reinforcement information will be provided for the Impact Study if applicable.