

#U2-099 Martins Creek 700 MW
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 U2-099 was studied as a 700 MW Capacity injection into the Martins Creek - Quarry and Martins Creek - Northwood 230 kV lines. Project U2-099 was evaluated for compliance with reliability criteria for summer peak conditions in 2012. Potential network impacts were as follows:

NETWORK IMPACTS

Generator Deliverability

(Normal System, Single or N-1 contingencies for the Capacity portion only of the interconnection. This project is the first to cause these reliability criteria violations.)

1. The Queue U2-099 - Martins Creek 230 kV line (bus #93105-3076) loads from **52.40% to 124.37%** of its emergency rating (573 MVA) for the single line contingency outage of the Hosensack – Steel City 500 kV line (Contingency designation = ‘PJM28A’). This project contributes approximately **412.4 MW** to cause the thermal violation.
2. The Morris Park – Gilbert 230kV line (bus #2556-2528) loads from **96.10% to 109.28%** of its emergency rating (1386 MVA) for the single line contingency outage of the following: Portland - Kittatiny 230kV line, Portland - Greystone 230kV line, and the Kittatiny 34.5/230 kV transformer (Contingency designation = ‘14JC’). This project contributes approximately **182.7 MW** to cause the thermal violation.
3. The Queue U2-099 – Northwood 230 kV line (bus #93105-1160) loads from **68.9% to 102.7%** of its emergency rating (573 MVA) for the single line contingency outage of the Queue U2-099 - Quarry 230 kV line, with the Quarry 230/69 kV transformer (Contingency designation = ‘PL37_U2-099-A’). This project contributes approximately **193.6 MW** to cause the thermal violation.

Multiple Facility Contingencies

(Double Circuit Tower Line contingencies only for the full energy output. Stuck Breaker and Bus Fault contingencies will be performed for the Impact Study. This project is the first to cause these reliability criteria violations.)

4. The Portland - Kittatiny 230 kV line (bus #1162-2535) loads from **99.11% to 107.98%** of its emergency rating (1068 MVA) for the double circuit tower line

outage of the following lines: Gilbert – Morristown 230 kV, Portland – Greystone 230 kV, along with the Morristown 230/34.5 kV transformer (Contingency designation = ‘15JC’). This project contributes approximately **94.7 MW** to cause this thermal violation.

Contribution to Previously Identified Overloads

(This project contributes greater than the PJM cost allocation threshold loading to the following contingency overloads, i.e. “Network Impacts”, identified for earlier generation or transmission interconnection projects in the PJM Queue)

5. The Lackawanna - Oxbow 230 kV line (bus #3070-417) loads from **146.48% to 157.02%** of its emergency rating (617 MVA) for the single line contingency outage of the Jefferson – Lackawanna 500 kV line (Contingency designation = ‘PJM JEFF-LACK 500’). This project contributes approximately **33.5 MW** to the thermal violation.
6. The Oxbow – N. Meshoppen 230 kV line (bus #417-414) loads from **141.30% to 146.63%** of its emergency rating (617 MVA) for the single line contingency outage of the Jefferson – Lackawanna 500 kV line (Contingency designation = ‘PJM JEFF-LACK 500’). This project contributes approximately **32.9 MW** to the thermal violation.
7. The Martins Creek – Portland 230kV line (bus #3076-1162) loads from **106.7% to 119.5%** of its emergency rating (1386 MVA) for the single line contingency outage of the following lines: Morris Park – Gilbert 230 kV, Morris Park – Martins Creek 230 kV, and the Morris Park 34.5/230 kV transformer (Contingency designation = ‘JC44’). This project contributes approximately **179.1 MW** to the thermal violation.
8. The Martins Creek – Morris Park 230 kV line (bus #3076-2556) loads from **104.86% to 118.23%** of its emergency rating (1394 MVA) for the single line contingency outage of the following: Portland - Kittatiny 230 kV line, Portland - Greystone 230 kV line, and the Kittatiny 34.5/230 kV transformer (Contingency designation = ‘14JC’). This project contributes approximately **186.3 MW** to the thermal violation.
9. The Kittatiny - Newton 230 kV line (bus #2535-2553) loads from **100.18% to 104.55%** of its emergency rating (925 MVA) for the double circuit tower line outage of the following lines: Portland - Greystone 230 kV, Kittatiny - Pohatcong 230 kV, and the Pohatcong 230/34.5 kV transformer (Contingency designation = ‘5JC’). This project contributes approximately **40.4 MW** to the thermal violation.
10. The Gilbert – Springf 230 kV line (bus #2528-3447) loads from **100.67% to 116.08%** of its emergency rating (783 MVA) for the double circuit tower outage of the following lines: Queue U2-099 – Northwood 230 kV, Northwood 230/34.5

kV transformer, Quarry – Queue U2-099 Tap 230 kV, and Quarry 230/69 kV transformer (Contingency designation = ‘9PPL_A_U2-099_B’). This project contributes approximately **120.6 MW** to the thermal violation.

11. The Lenox – Tiffany 115 kV line (bus #385-386) loads from **106.39% to 110.85%** of its emergency rating (151 MVA) for the single line contingency outage of the East Towanda – Hillside 230 kV line and the East Sayreville – North Waverly 115 kV line (Contingency designation = ‘PN20’). This project contributes approximately **6.7 MW** to the thermal violation.

12. The Tiffany – Laurel Lake 115 kV line (bus #386-387) loads from **100.33% to 104.99%** of its emergency rating (151 MVA) for the single line contingency outage of the East Towanda - Hillside 230 kV line and the East Sayreville – North Waverly 115 kV line (Contingency designation = ‘PN20’). This project contributes approximately **7.0 MW** to the thermal violation.

Short Circuit

13. Queue U2-099 generation contributes to the overduty of the following 230 kV circuit breakers at Martins Creek substation initially caused by Queue U2-053:

- a) G2-Northwood
- b) Gen 2
- c) LMBE-Portland

Stability Analysis

Will be performed for the Impact Study.

NETWORK UPGRADE REQUIREMENTS

(Note: Network Upgrade numbering corresponds to Network Impact numbering on pages 8-10)

(Queue U2-099 cost allocation for these upgrades will be determined for the 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. (PPL)** The Queue U2-099 to Martins Creek 230 kV line overload requires that the existing line be re-conducted utilizing HS 285 1192 kcmil ACSS (Oxbird) conductor for 150 deg C operation for 4 miles from Queue U2-099 to Martins Creek (along the Martins Creek-Northwood path). This will achieve an increase in load carrying capability to approximately 692 MVA (SN) and 840 MVA (SE) at 150 deg C. Terminal equipment at Martins Creek 230kV substation would also be replaced with higher ratings. Please note that the description of work and the cost estimates are preliminary without any field checks and extensive engineering review. The total estimated cost of the upgrade is **\$3,500,000**. The estimated time to complete is **36 months**.
- 2. (PPL / FE) This reinforcement also mitigates Network Impact numbers 3, 4, 7, 8, 9, and 10.** Build a new 22 mile 230 kV line from PPL's Martins Creek 230 kV Switchyard to a new 500/230 kV yard at a location near the intersection of the proposed Branchburg - Jefferson 500 kV line with the Pequest River - Flanders 115 kV line. For PPL's portion, build a new 230 kV single circuit line in a new 200 ft ROW for approximately 0.5 mi from Martins Creek east across the river to a point near FE's 115 kV line to Pequest River. The line will be built using bundled 2493 ACAR for ratings of 1382 (SN) and 1717 (SE). FE will be responsible for the remainder of the line to the new substation. Install a new 230 kV breaker and a half line bay at Martins Creek with two breakers initially. The total estimated cost for the PPL portion of the upgrade is \$3,000,000 million. The estimated time to complete PPL's portion of the project is 36 months. The estimated cost for First Energy's portion of the new 230 kV line (approximately 21.5 miles) is \$32,250,000. The estimated cost to build the new 500/230 kV switchyard is estimated to be \$50,000,000. It must be noted that this is a very rough estimate which involved little engineering review. The total estimated cost of this upgrade is **\$85,250,000** and the construction will take **36-48 months**.
- 3.** See Upgrade description number 2 above.
- 4.** See Upgrade description number 2 above.

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)

5. **(PPL / FE)** The Lackawanna – Oxbow 230 kV line overload requires the following upgrades:

PPL portion: The existing line will be rebuilt for double circuit using 2-1590 kcmil ACSR conductors for a rating of 1306/1586 MVA summer normal/summer emergency. Terminal equipment at Lackawanna 230kV substation would also be replaced with higher ratings than the conductor. PPL EU owns approximately 0.2 miles of this transmission line from Lackawanna to Oxbow. The total estimated cost for the PPL portion of the upgrade is \$900,000. The estimated time to complete is 24 months.

Penelec portion: The upgrade will require the replacement of a disconnect switch (estimated to cost approximately \$85,000) at Oxbow Substation and the reconductor of approximately 16.33 miles of transmission line (estimated to cost approximately \$8,165,000).

The total estimated cost is **\$ 9,150,000**. Total construction time is **24-36 months**.

6. To alleviate the overload on the Oxbow – North Meshoppen 230kV line, a rebuild of approximately 10.16 miles of transmission line would be required to support bundled conductor. Oxbow substation would require replacement of a disconnect switch and substation conductor. North Meshoppen substation would require the upgrade/replacement of two CT circuits, replacement of substation conductor, and replacement/upgrade of a line/wave trap. The estimated cost is approximately \$12,939,000 and it will take 48-60 months to complete. The overload also requires the rearranging of the North Meshoppen 230 kV bus to prevent the loss of tapped 230/115 kV transformer #4 along with the loss of North Meshoppen - East Towanda 230 kV line. This will require the addition of two 230 kV breakers and re-configuration of the North Meshoppen 230 kV station to a ring bus to place transformer #4 on its own bus position. The estimated cost for the upgrade is \$1,500,000. The estimated time to complete is 42 months.

The total estimated cost for the upgrade is **\$14,439,000** and it will take **48-60 months** to complete.

7. See Upgrade description number 2 above.
8. See Upgrade description number 2 above.
9. See Upgrade description number 2 above.

10. See Upgrade description number 2 above.
11. The Lenox - Tiffany 115 kV overload can be mitigated by an operating procedure to open the Tiffany - Goudey 115 kV line. This is consistent with existing FirstEnergy operating procedures to control thermal limits that occur on the Penelec/NY-ISO tie lines.
12. The Lenox – Laurel Lake 115kV overload can be mitigated by an operating procedure to open the Tiffany - Goudey 115 kV line. This is consistent with existing FirstEnergy procedures to control thermal limits that occur on the Penelec/NY-ISO tie lines.

Short Circuit Upgrades

13. Queue U2-099 will be responsible for a cost allocation toward the replacement of the following 230 kV breakers at Martins Creek Substation:
 - a) G2-Northwood
 - b) Gen 2
 - c) LMBE-Portland

The total cost for the breaker replacements is \$566,700 each.