#U2-040 Bridgewater-Middlesex Sw. 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 #U2-040 was studied as a(n) 650MW(Capacity=650MW) injection at substation in the PSEG area. Project #U2-040 was evaluated for compliance with reliability criteria for summer peak conditions in 2012. Potential network impacts were as follows:

Generator Deliverability

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

1. **(PECO)**The Concord-Lenape 230kV line (from bus 4643 to bus 4763 ckt 1) loads from 98.8% to 100.9% (DC power flow) of its emergency rating (1337MVA) for the single line contingency outage of the Keeney-Peach Bottom 500kV circuit (PJM27B). This project contributes approximately 27.9MW 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 Impact Study)

None

Short Circuit

2. The New BKR 1 at Branchburg 230kV station is required to interrupt 60218 amperes which is 100% of its 60200ampere rating.

3. The New BKR 2 at Branchburg 230kV station is required to interrupt 61709 amperes which is 102.5% of its 60200 ampere rating.

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. **(PENELEC)** The North Meshoppen 230/115kV transformer (from bus 414 to bus 560 ckt 3) loads from 174.56% to 180.6% (DC power flow) of its emergency rating (157MVA) for the single line contingency outage (PN47B). This project contributes approximately 9.5MW to the thermal violation.

2. **(PPL/PENELEC)**The Lackawanna-Oxbow 230kV line (from bus 3070 to bus 417 ckt 1) loads from 163.8% to 169.1% (DC power flow) of its normal rating (499MVA) for non-contingency condition. This project contributes approximately 26.4MW to the thermal violation.

3. **(PENELEC)** The Oxbow-North Meshoppen 230kV line (from bus 417 to bus 414 ckt 1) loads from 157.7% to 162.9% (DC power flow) of its normal rating (499MVA) for non-contingency condition. This project contributes approximately 26.0MW to the thermal violation

4. **(BGE/AP)**The Conastone-North Northwest 500kV line (from bus 4 to bus 119 ckt 2) loads from 160.23% to 165.1% (DC power flow) of its emergency rating (2901MVA) for the single line contingency outage (PJM13B_NNWEST_A). This project contributes approximately 140.2MW to the thermal violation

5. **(BGE/AP)**The Conastone-North Northwest 500kV line (from bus 4 to bus 119 ckt 1) loads from 160.23% to 165.1% (DC power flow) of its emergency rating (2901MVA) for the single line contingency outage (U_queue_reinforcement_59). This project contributes approximately 140.2MW to the thermal violation.

6. The U2-040 project contributes over 3% to the overdutied condition of the following 230kV circuit breakers at Branchburg substation: 101H, 102H, 61H, 32H, 52H, 72H, 81H and New Breaker.

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 overload on the Concord-Lenape 230kV circuit can be alleviated by replacing two disconnect switches on the Lenape terminal. The estimated cost is **$500,000.** The estimated time for construction is 24 months.

2. The overdutied condition of New Breaker #1 at Branchburg 230kV can be alleviated by replacing the breaker with a higher rated one. The estimated cost is **$500,000.**

3. The overdutied condition of New Breaker #2 at Branchburg 230kV can be alleviated by replacing the breaker with a higher rated one. The estimated cost is **$500,000.**

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 Impact Study)

1. N. Meshoppen 230/115 kV transformer #3: The rating for the North Meshoppen 230/115 kV #3 transformer is 146 MVA N/ 157 MVA E. This 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 2 years.

2. The overload on the Lackawanna-Oxbow 230kV circuit can be alleviated by the following:

   PPL PORTION:
   The Lackawanna – Oxbow 230 kV line overload requires that the existing 1033.3 kcmil ACSR conductors be replaced with 1590 kcmil ACSR conductors for a rating of 653/793 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 19-mile long transmission line from Lackawanna to Oxbow. Please note that the description of work and the cost estimates are preliminary without any field checks and extensive engineering review and therefore are subject to change. If for some reason FE decides to use a different conductor, PPL EU would have to reevaluate the cost estimate.

   The total estimated cost for the PPL portion of the upgrade is **$700,000.** The estimated time to complete is **24 months.**

   PENELEC PORTION:
   To alleviate the overload on the Lackawanna – Oxbow 230kV line, a rebuild of approximately 16.33 miles of transmission line would be required (estimated to cost approximately **$19,596,000**). This overload also requires the following terminal upgrades at Oxbow substation: replace substation conductor (estimated cost approximately **$125,000**) and replace a disconnect switch (estimated cost approximately **$85,000**).

3. The overload on the Oxbow-North Meshoppen 230kV circuit can be alleviated by rebuilding approximately 10.16 miles of transmission line required to support bundled conductor. Oxbow substation will require replacement of a disconnect switch and substation conductor. North Meshoppen substation will require the upgrade/replacement of two current transformer circuits, replacement of substation conductor, and replacement/upgrade of a line/wave trap. The work is estimated to cost approximately **$12,939,000** and to take **4-5 years** to complete after an ISA is executed.

4. The total estimated cost to alleviate the Conastone – N-Nwest 500kV overload is **$220,000,000.** The lead time required for construction is **120 months**. At this point in time this Queue's cost allocation is undetermined. If required, cost allocation will be performed for the Impact Study.

Upgrade description:
Construct 2 new single circuit lines 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 will be located 4 miles north of Northwest substation
Additional substation work to include:
• Expand North Northwest and Conastone substations to accommodate 2 new lines.

5. Same reinforcement as #4

6. The overdutied condition of the eight 230 breakers at Branchburg can be alleviated by replacing the circuit breakers with circuit breakers of a higher interrupting rating. The estimated cost is $500,000 each for a total cost of **$4,000,000.**