#R24 Susquehanna - Alburtis 940 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 R24 was studied as a 940 MW (capacity) injection at a tap in the Susquehanna to Alburtis 500 kV line. The R24 project was evaluated for compliance with reliability criteria for summer peak conditions in 2011. Potential network impacts were as follows:

Generator Deliverability

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

1. The Peckville H5 – Blooming Grove H2 230 kV line is overloaded from 94% to 100% of its emergency rating (558 MVA) for the outage of Wescosville – R24 500 kV line (Cont Id. PJM66_WITH_R24A). The R24 contributes approximately 30 MW cause this thermal violation.
2. The Susquehanna 500/230 kV transformer is overloaded from 90% to 115% of its emergency rating (1165 MVA) for the outage of Wescosville – R24 500 kV line (Cont Id. PJM66_WITH_R24A). The R24 contributes approximately 293 MW cause this thermal violation.
3. The Alburtis - Hosensack 500 kV line is overloaded from 89% to 101% of its emergency rating (3145 MVA) for the outage of Alburtis – Branchburg 500 kV line (Cont Id. PJM5). The R24 contributes approximately 382 MW to cause this thermal violation.
4. The R24 - Wescosville 500 kV line is overloaded from 96% to 101% of its emergency rating (3113 MVA) for the outage of Sunbury – R26 500 kV line (Cont Id. PJM69_WITH_R26A). The R24 contributes approximately 755 MW to the overload.
5. The Wescosville – Alburtis 500 kV line is overloaded to 121% of its emergency rating (3113 MVA) for the outage of Sunbury – R26 500 kV line (Cont Id. PJM69_WITH_R26A). The R24 contributes approximately 733 MW to the overload.
6. The Sunbury – Juniata 500 kV line is overloaded to 117% of its emergency rating (3113 MVA) for the outage of Wescosville – R24 500 kV line (Cont Id. PJM66_WITH_R24A). The R24 contributes approximately 626 MW to the overload.
7. The Three Mile Island 500/230 kV transformer is overloaded from 99% to 106% of its emergency rating (1077 MVA) for the outage of Conastone to Peachbottom 500 kV line (Cont Id. PJM17). The R24 project contributes approximately 73 MW to cause the thermal violation.

Multiple Facility Contingency

(Double Circuit Towerline contingencies only. Stuck breaker and bus fault contingencies will be performed for the Impact Study)

No problems were identified

Short Circuit
Will be performed for the Queue R24 Impact Study.

Stability Analysis
Will be performed for the Queue R24 Impact Study.

Contribution to Previously Identified Overloads

(Queue R24 contributes to the following contingency overloads, i.e. Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

1. The Elroy – Branchburg 500 kV line is overloaded at 119% of its emergency rating (3040 MVA) for the outage of Alburtis – Branchburg 500 kV line (Cont Id. PJM5). The R24 project contributes approximately 52 MW to this overload.
2. The Alburtis – Branchburg 500 kV line is overloaded at 107% of its emergency rating (3734 MVA) for the outage of Hosensak - Elroy 500 kV line (Cont Id: PJM22). The R24 project contributes approximately 181 MW to this overload.
3. The Hosensack – Elroy 500 kV line is overloaded to 118% of its emergency rating (3734 MVA) for the outage of Alburtis – Branchburg 500 kV line (Cont Id. PJM5). The R24 contributes approximately 253 MW to this overload.
4. The Conastone - Mt Carmel (2322 line) 230 kV line is overloaded at 149% of its emergency rating (803 MVA) for the **tower outage** of Brighton to Doubs and Brighton to Conastone 500 kV line (Cont Id. AP5). The R24 project contributes approximately 47 MW to this overload.
5. The Conastone - Mt Carmel (2310 line) 230 kV line is overloaded at 128% of its emergency rating (923 MVA) for the **tower outage** of Brighton to Doubs and Brighton to Conastone 500 kV line (Cont Id. AP5). The R24 project contributes approximately 48 MW to this overload.
6. The Mt Carmel – Northwest (2322 line) 230 kV line is overloaded at 146% of its emergency rating (803 MVA) for the **tower outage** of Brighton to Doubs and Brighton to Conastone 500 kV line (Cont Id. AP5). The R24 project contributes approximately 47 MW to this overload.
7. The Mt Carmel – Northwest (2310 line) 230 kV line is overloaded at 128% of its emergency rating (923 MVA) for the **tower outage** of Brighton to Doubs and Brighton to Conastone 500 kV line (Cont Id. AP5). The R24 project contributes approximately 47 MW to this overload.

8. The Graceton – Bagley – Raphael Road 230 kV line is overloaded at 167% of its emergency rating (659 MVA) for the **tower outage** of Brighton to Doubs and Brighton to Conastone 500 kV line (Cont Id. AP5). The R24 project contributes approximately 57 MW to this overload.

Potential Problems

The Stanton – Lackawanna 230 kV line is loaded to 99% of its emergency rating (764 MVA) for the outage of Wescosville – R24 500 kV line (Cont Id. PJM66_WITH_R24A). The R24 contributes approximately 92 MW to this overload.

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e."Network Impacts", initially caused by the addition of Queue R24 generation)

1. Blooming Grove – Peckville 230kV line upgrade - The estimated magnitude cost for this upgrade including substation terminal equipment cost is **$76,000,000**.

   In order to provide additional capacity on the Blooming Grove-Peckville 230kV line, PPL EU is proposing to rebuild the existing single circuit 230kV line to a double-circuit 230kV line between the two substations. The new line will be 29 miles long and will travel the existing right of way. The 230kV lines will be constructed with 1590 Kcmil ACSR conductors for a 653/793 MVA summer normal/emergency ratings. The ratings are based on the conductor ratings and may be lower when the line is actually built.

2. Susquehanna 500/230kV Transformer #21 upgrade - The estimated magnitude cost to install the second 500/230kV transformer is **$10,000,000**.

   In order to provide additional 500/230kV Transformer capacity at the Susquehanna 500/230kV substation, PPL EU is proposing to install a second 500/230kV transformer similar in rating to the existing transformer #21 connected on the 500kV north bus. The transformers will be paralleled on the 230kV side.

3. Alburtis – Hosensack 500kV line upgrade - The estimated magnitude cost including the substation terminal equipment for this upgrade is **$39,000,000**.

In order to provide additional capacity on the Alburtis-Hosensack 500kV line, PPL EU is proposing to rebuild the existing Alburtis-Hosensack 500kV line from a single circuit to a double circuit 500kV line between the two substations. The total line length is approximately 5 miles and all owned by PPL EU. PPL EU will construct the new double circuit line with 1590 Kcmil ACSR triple bundle conductors for a 3000/3700 MVA summer normal/emergency ratings. The ratings are based on the conductor ratings and may be lower when the line is actually built. Cost also includes construction of a temporary 500kV line at the edge of the right of way during the double circuit 500kV construction.

4. R24 – Wescosville 500kV line upgrade - The estimated magnitude cost for this upgrade including terminal equipment is **$287,000,000**.

   In order to provide additional capacity on the R24-Wescosville 500kV line, PPL EU is proposing to rebuild the existing R24-Wescosville 500kV line from a single circuit to a double circuit 500kV line between the two substations. The total line length is approximately 42 miles and all owned by PPL EU. PPL EU will construct the new double circuit line with 1590 Kcmil ACSR triple bundle conductors for a 3000/3700 MVA summer normal/emergency ratings. The ratings are based on the conductor ratings and may be lower when the line is actually built. Additionally terminal equipment upgrades at Wescosville and R24 substation are also included in the cost. Wescosville 500kV substation is an existing GIS substation and its expansion poses some challenges due to the space limitation. Therefore additional expansion cost is added for the Wescosville 500kV substation. Cost also includes construction of a temporary 500kV line at the edge of the right of way during the double circuit 500kV construction.

5. Wescosville – Alburtis 500kV line upgrade - The estimated magnitude cost for this upgrade including the substation terminal equipment is $**85,000,000**.

   In order to provide additional capacity on the Wescosville-Alburtis 500kV line, PPL EU is proposing to rebuild the existing Wescosville-Alburtis 500kV line from a single circuit to a double circuit 500kV line between the two substations. The total line length is approximately 11 miles and owned by PPL EU. PPL EU will construct the new double circuit line with 1590 Kcmil ACSR triple bundle conductors for a 3000/3700 MVA summer normal/emergency ratings. The ratings are based on the conductor ratings and may be lower when the line is actually built. Additionally terminal equipment upgrades at Alburtis and Wescosville substation are also included in the cost. Wescosville 500kV substation is an existing GIS substation and its expansion poses some challenges due to space limitations. Therefore additional expansion cost is added for the Wescosville substation. Cost also includes construction of a temporary 500kV line at the edge of the right of way during the double circuit 500kV construction.

6. Sunbury – Juniata 500kV line upgrade - The estimated magnitude cost for this upgrade including the substation terminal equipment is **$261,000,000**.

In order to provide additional capacity on the Sunbury-Juniata 500kV line, PPL EU is proposing to rebuild the existing Sunbury-Juniata 500kV line from a single circuit to a double circuit 500kV line between the two substations. The total line length is approximately 38 miles and owned by PPL EU. PPL EU will construct the new double circuit line with 1590 Kcmil ACSR triple bundle conductors for a 3000/3700 MVA summer normal/emergency ratings. The ratings are based on the conductor ratings and may be lower when the line is actually built. Additionally terminal equipment upgrades at Sunbury and Juniata substation are also included in the cost. Sunbury 500kV substation expansion poses some challenges due to space limitations. Therefore additional expansion cost is added for the Sunbury 500kV substation. Cost also includes construction of a temporary 500kV line at the edge of the right of way during the double circuit 500kV construction.

7. TMI 500-230 kV transformer upgrade – The estimated cost to add a second 500-230 kV transformer is **$11,800,000** and the time required is approximately 20 months.

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by Queue R24. Queue R24 may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)

1. Elroy – Branchburg 500kV line Overload - The PECO system reinforcement for the Elroy-Branchburg 500kV line will require the replacement of Elroy substation equipment, including the circuit breakers. The cost for this work is approximately **$2,500,000** and it will take about 18 months to complete.

2. Alburtis – Branchburg 500kV line upgrade.

   PPL portion of the line (21 miles) and Alburtis terminal
   The estimated magnitude cost to upgrade for 21 miles of PPL EU owned line including the terminal cost at Alburtis, is **$140,000,000**.
   In order to provide additional capacity on the Alburtis-Branchburg 500kV line, PPL EU is proposing to rebuild the existing Alburtis-Branchburg 500kV line from a single circuit to a double circuit 500kV line between the two substations. PPL EU will construct its portion of 21 miles with 1590 Kcmil ACSR triple bundle conductors for a 3000/3700 MVA summer normal/emergency ratings. The ratings are based on the conductor ratings and may be lower when the line is actually built. Additionally terminal equipment upgrade at Alburtis is also included in the cost. Cost also includes construction of a temporary 500kV line at the edge of the right of way during the double circuit 500kV construction.

   PSE&G portion of the line (26 miles) and Branchburg terminal
   The estimated cost to upgrade PSE&G's portion (26 miles) of the Alburtis – Branchburg 500kV circuit (5016), including terminal equipment, is **$85,000,000.**
   It will be re-conductored. This estimate assumes no significant property, license

or permitting issues, and no temporary 500kV line construction. Because no detailed engineering analysis has been performed, it also assumes no significant structural reinforcements and a sustained outage feasibility schedule.

3. Hosensack – Elroy 500kV line upgrade.

   PPL portion of line (Hosensack 500 kV terminal)
   The PPL EU magnitude cost estimate to expand the Hosensack 500kV switchyard is **$3,000,000.**
   PECO portion of line (18 mi. 500kV line and Elroy terminal)
   A new line must be constructed. The cost for a new 18 mile long 500kV line and the associated work at Elroy substation will be about **$40,000,000** not including right of way costs. Acquisition of new right of way could take up to seven years. If right of way was available the project would take 42 months to complete.

4. Northwest - Mt Carmel - Conastone upgrade – This upgrade requires the construction of a new 500kV substation slightly north of the existing Northwest 230 kV station. This station will cut into the nearby Brighton – Conastone 500 kV line and consist of two 500/230kV transformers, four 500 kV circuit breakers, seven 230 kV circuit breakers, related substation equipment and land at a cost of **$70,000,000**. It also requires the reconductoring of the Conastone to Northwest #2322 line from the existing 1,272 kcmil ACSR to new 1,590kcmil ACSR with an estimated cost of **$8,210,000**. This work would take 3-4 years to build the substation and 18-24 months (concurrently) for the line work**. (Note: This upgrade will suffice for overloads 12, 13 and 14 as well).**

5. Graceton - Bagley - Raphael upgrade – This upgrade requires Graceton station to add 6-230kV breakers with an estimated cost of **$10,000,000** and Raphael Road station to add 6-230kV breakers **$10,000,000**. It also requires rebuilding Graceton to Raphael Rd to double circuit 2-conductor bundled with an estimated cost of **$30,000,000**. This work would take an estimate of 2-3 years for the substation work concurrently with 5-6 years for the line work.

Docs #419356