#U2-006 Branchburg-Deans (Sentinel) 500kV

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 U2-006 was studied as a 1010MW (capacity) injection into the PSEG system. The project was modeled as a tap of the Branchburg – Deans 500kV substation. U2-006 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)

No problems 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 problems identified.

Short Circuit

1. **(PSEG)** The addition of the U2-006 project increases the short circuit duty of the Branchburg 230kV 41H circuit breaker from 98.9% to 101.6 % of its 60200.1 ampere rating.

2. **(PSEG)** The addition of the U2-006 project increases the short circuit duty of the Branchburg 230kV New circuit breaker from 98.9% to 101.61 % of its 60200.1 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. **(PPL/PENELEC)** The Lackawanna-Oxbow 230kV line loads from 112.34% to 117.30% (DC power flow) of its emergency rating (617MVA) for the single line contingency outage (PJM JEFF-LACK 500). This project contributes approximately 30.6MW to the thermal violation.

2. **(PENELEC)** The Oxbow-North Meshoppen 230kV line loads from 107.73% to 112.60% (DC power flow) of its emergency rating (617MVA) for the single line contingency outage (PJM JEFF-LACK 500). This project contributes approximately 30.1MW to the thermal violation.

3. **(PPL/PENELEC)** The Lackawanna-Oxbow 230kV line loads from 155.98% to 163.62% (DC power flow) of its normal rating (499MVA) for non-contingency condition. This project contributes approximately 38.1MW to the thermal violation.

4. **(PENELEC)** The Oxbow-North Meshoppen 230kV line loads from 150.01% to 157.51% (DC power flow) of its normal rating (499MVA) for non-contingency condition. This project contributes approximately 37.4MW to the thermal violation.

5. **(BGE/APS)** The Conastone-North Northwest 500kV line loads from 152.47% to 160.09% (DC power flow) of its emergency rating (2901MVA) for the single line contingency outage (PJM13B_NNWEST_A). This project contributes approximately 220.9MW to the thermal violation.

6. **(BGE/APS)** The Conastone-North Northwest 500kV line loads from 152.47% to 160.09% (DC power flow) of its emergency rating (2901MVA) for the single line contingency outage (U_queue_reinforcement_60). This project contributes approximately 220.9MW to the thermal violation.

7. **(BGE/APS)** The Conastone-North Northwest 500kV line loads from 132.90% to 139.30% (DC power flow) of its normal rating (2078MVA) for non-contingency condition. This project contributes approximately 132.9MW to the thermal violation.

8. **(BGE/APS)** The Conastone-North Northwest 500kV line loads from 132.90% to 139.30% (DC power flow) of its normal rating (2078MVA) for non-contingency condition. This project contributes approximately 132.9MW to the thermal violation.

9. **(BGE/PECO)** The Conastone-Peach Bottom 500kV circuits 1 and 2 have a loading increase of 4% (DC power flow) of their emergency rating (3734MVA) for the tower line outage of Conastone-Peach Bottom circuits 3 and 4. This project contributes approximately 148MW to the thermal violation.

10. **(BGE/PECO)** The Conastone-Peach Bottom 500kV circuits 3 and 4 have a loading increase of 4% (DC power flow) of their emergency rating (3734MVA) for the tower line outage of Conastone-Peach Bottom circuits 1 and 2. This project contributes approximately 148MW 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 overdutied condition of the Branchburg 41H 230kV circuit breaker can be alleviated by replacing the breaker with one of a higher rating at an estimated cost of **$500,000.**

2. The overdutied condition of the Branchburg New 230kV circuit breaker can be alleviated by replacing the breaker with one of a higher rating at an estimated cost of **$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. 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 3**.

2. The Oxbow – N. Meshopen 230kV line overload requires the rebuild of approximately 10.16 miles of transmission line This overload also requires the replacement of a disconnect switch and replacement of substation conductor at Oxbow substation. North Meshoppen substation requires the upgrade/replacement of two (2) CT circuits, substation conductor, and a line/wave trap. The total cost of the upgrade is estimated to be **$12.939M** and it would take **4-5 years** to complete the work. **This upgrade also mitigates Network Impact number 4**.

5. The Conastone – North Northwest 500kV line overload can be alleviated by the following upgrade:

2 new single circuit line 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 is located 4 miles north of Northwest substation

Additional substation work to include:
Expand NNW substation to accommodate 2 new lines for $10M
Expand Conastone substation to accommodate 2 new lines for $8M

The total estimated cost of this upgrade, which includes breakers and terminations, is **$220M**. The upgrade will take approximately **10 years** to complete. **This upgrade also mitigates Network Impact number 6, 7, and 8**.

9. The Peach Bottom – Conastone 500kV overload can be alleviated by a large upgrade which was originally proposed in the R queue, but has since grown and expanded:

BG&E portion of the Conastone – Peach Bottom line:
Conastone Substation - **3 - 4 years** to complete – total estimate for this work is $**39M**
• Rebuild 3 existing bays to 4000A (also add breaker in one of the existing bays)
• Build new 4000A bay and install 3 breakers
• Relocate Hunterstown 500kV line
• Replace 4 inch bus with 5 inch

Transmission Line Component - **7 years** to build after notice to proceed - total estimate for this work is **$320.2M**
• 2 - Double Circuit 500 kV OH lines from Conastone - Graceton - MD line
• 2 - UG 230 kV circuits from Conastone - Graceton *
• 3 - UG 230 kV circuits from Graceton - MD line
• 1 - UG 115 kV circuit from Graceton - Five Forks
• Acquire additional 50 ft. wide R/W Graceton - MD line
• Remove existing OH lines/structures

* assumes RTEP project b0497 Install a second Conastone - Graceton 230 kV circuit

PECO portion of the Conastone – Peach Bottom line:
Assumes 500 kV lines with ratings equal to the rating of the 4 inch diameter aluminum bus work at Peach Bottom, i.e. 3366 MVA normal and 4183 MVA emergency are able to be built.

• Relocate Peach Bottom to Graceton 220-08 line to underground to facilitate construction of additional 500kV lines in the Conastone to Peach Bottom right of way. The estimated cost to perform this work is **$29.6M**

• The underground line will require parallel pipe type cables to achieve a rating of 800MVA. The estimated cost to perform this work is **$61M** and **36 months** to complete.

Note: the 220-08 line is an offsite source for the Peach Bottom Atomic Power Station and its integrity must be maintained.

• Remove existing 220-08 line towers to clear the north side of the right of way for 500kV construction. The estimated cost to perform this work is **$1.5M** and **6 months** to complete.

• Construct new double circuit 500kV line on the north side of the 300 foot wide Peach Bottom to Maryland state line right of way. The estimated cost to perform this work is **$17M** and **30 months** to complete after the removal of the existing 230 kV tower line.

• Remove existing 5012 line towers to clear the south side of the right of way for new higher capacity 500kV lines. The estimated cost to perform this work is **$1.5M** and **6 months** to complete.

• Construct second new double circuit 500kV line on the south side of the Peach Bottom to Maryland state line right of way. The estimated cost to perform this work is **$17M** and **30 months** to complete after the removal of the existing 500 kV tower line.

• Upgrade 5012 line substation equipment to achieve the new higher rating. The estimated cost to perform this work is **$3M** and **18 months** to complete.

• Expand the 500kV substations (North and South) at Peach Bottom to accommodate three additional 500kV lines. The estimated cost to perform this work is **$18M** ($6M per new line) and **30 months** to complete.

• Build a third new (fourth overall) 500kV overhead line for an estimated cost of $15.0M. The Peach Bottom 500kV substation also needs to be expanded for an estimated cost of $10M. The total estimated cost of this portion of the upgrade is **$25.0M** and the time estimate to build the upgrade is **8 years**.

Note: The substation work may have to be coordinated with refueling outages at the Peach Bottom Atomic Power Station and that the overall project may overstress several 500 kV circuit breakers.

These estimates do not include the cost for the new right-of-way required to build the new lines. It should be noted that this right-of-way could be very difficult or even impossible to acquire. If the proper right-of-way is not available this project would be essentially infeasible based on the current system model.

This upgrade also mitigates Network Impact number 10.