#U1-012 Richmond 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

The U1-012 project was studied as a 700 MW Capacity injection into the Richmond 230 kV bus. Project U1-012 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 with all facilities in-service and Single, or N-1, contingencies for the Capacity portion only of the interconnection)

No problems identified.

Multiple Facility Contingency

(Double Circuit Tower Line, Line with Failed Breaker and Bus Fault contingencies for the full energy output)

No problems identified.

Short Circuit Analysis

The following circuit breakers were found to be overdutied (fault current exceeds interrupting rating) as a result of the addition of Queue U1-012 generation:

1. Richmond 230 kV CB # 525
2. Richmond 230 kV CB # 415
3. Waneeta 230 kV CB # 425
4. Waneeta 230 kV CB # 85

Also note that customer 230 kV breakers (Exelon Generation) Eddystone for unit #3 (CB #35) and #4 (CB #45) were also found to be overduty.

Stability Analysis

Will be performed for the Impact Study.

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)

5. The North Meshoppen 230/115kV transformer #3 loads from **212.76% to 218.37%** of its emergency rating (157MVA) for the single contingency outage of the North Meshoppen – East Towanda 230 kV line including North Meshoppen 230/115 kV transformer #4 (Contingency: PN47B). This project contributes approximately **8.8MW** to the thermal violation.

6. The Ridley - Morton 230kV line loads from **129.96% to 135.64%** of its emergency rating (613MVA) for the single contingency outage of the Foulk – Chichester 230kV line including the Foulk 230/13.8 kV transformer (Contingency: PE4). This project contributes approximately **34.8 MW** to the thermal violation.

7. The Conastone – North Northwest 500kV line loads from **196.55% to 202.28%** of its emergency rating (2901MVA) for the tower line outage of the Conastone – Mt Carmel – North Northwest 230 kV lines #2322 and #2310. (Contingency: CNSTN_NWEST_NNWEST_A). This project contributes approximately **166.2 MW** to the thermal violation.

8. The Rock Springs – Peach Bottom 500kV line loads from **103.90% to 106.42%** of its emergency rating (3112MVA) for the tower line outage (Contingency: 1PS). This project contributes approximately **78.2 MW** to the thermal violation.

9. The Northwest – Granite 230kV line # 2326 loads from **118.57% to 122.17%** of its emergency rating (1105MVA) for the single contingency outage of the Kemptown – North Northwest 500 kV line (Contingency: PJM13B_NNWEST_B). This project contributes approximately **39.8 MW** to the thermal violation.

10. The Northwest – Granite 230kV line # 2311 loads from **115.44% to 118.97%** of its emergency rating (1105MVA) for the single contingency outage of the Kemptown – North Northwest 500 kV line (Contingency: PJM13B_NNWEST_B). This project contributes approximately **39.0 MW** to the thermal violation.

11. The Peach Bottom - Conastone 500kV (existing) circuit 1 line loads from **114.23% to 118.00%** of its emergency rating (2598MVA) for the single contingency outage of the Peach Bottom - Conastone 500kV new circuit 2 line (Contingency: PJM17_2). This project contributes approximately **98.0 MW** to the thermal violation.

12. The Peach Bottom – Conastone 500kV (new) circuit 2 line loads from **114.23% to 118.00%** of its emergency rating (2598MVA) for the single line contingency outage of the Peach Bottom - Conastone 500kV (existing) circuit 1 line (Contingency: PJM17). This project contributes approximately **98.0 MW** to the thermal violation.

13. The Peach Bottom – Conastone 500kV (new) circuit 3 line loads from **222.77% to 229.62%** of its emergency rating (2598MVA) for the tower line outage of the Peach Bottom – Conastone (existing) circuit 1 and (new) circuit 2 lines (Contingency: CONAS_PB). This project contributes approximately **178.1 MW** to the thermal violation.

NETWORK UPGRADE REQUIREMENTS

General Notes pertaining to cost allocation rules for overloads: (also see the PJM Tariff and Manual 14)

The first project to cause an overload has cost responsibility.

If this Queue is not the first project to cause the overload, a threshold of;

(a) 1% increase in overloaded facility loading must be caused by the this Queue generation,

and

(b) This Queue's MW contribution of 5.0 MW or greater are both required for cost allocation responsibility.

And

If this Queue is not the first project to cause the overload but both conditions (a) and (b) above are met, then a threshold of Either of the following are also required for cost allocation responsibility;

(c) A 5% generator DFAX (5 MW contribution for a generation request size of 100 MW),*

or

(d) This Queue's generation must cause an increase of 5% (230 kV) or 10% (500 kV) to the overloaded facility loading

** DFAX may not be equal to this Queue's contribution divided by generator MW size in some cases.*

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

1. Upgrade Richmond CB #525 to 50kA interrupting rating at an estimated cost of $85,000 and a required construction lead time of 18 months. At this point of time this Queue has a 100% cost allocation.

2. Upgrade Richmond CB #415 to 50kA interrupting rating at an estimated cost of $85,000 and a required construction lead time of 18 months. At this point of time this Queue has a 100% cost allocation.

3. Replace Waneeta CB #425 with a 63kA interrupting rating CB at an estimated cost of $250,000 and a required construction lead time of 24 months. At this point of time this Queue has a 100% cost allocation.

4. Upgrade Waneeta CB #85 to 50kA interrupting rating at an estimated cost of $85,000 and and required construction lead time of 18 months. At this point of time this Queue has a 100% cost allocation.

Contribution to Previously Identified System Reinforcements
(This project contributes to the Network Impact causing the need for these Network Upgrades. This project will be allocated a cost to be determined during the Impact Study)

5. **Increased Overload (212.76% to 218.37%) to the Previously Overloaded North Meshoppen 230/115kV Transformer #3:**

   The total estimated cost of the upgrade is **$4,000,000.** The lead time required for construction is **24 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: This overload would require replacement of transformer #3 and associated equipment (circuit breaker, substation conductor, CT circuits).

6. **Increased Overload (129.96% to 135.64%) to the Previously Overloaded Ridley – Morton 230 kV Line:**

   The total estimated cost of the upgrade is **$8,300,000.** The lead time required for construction is **42 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: The Ridley - Morton 230kV line overload can be alleviated by adding a second 230kV pipe type cable.

7. **Increased Overload (196.55% to 202.28%) to the Previously Overloaded Conastone – North Northwest 500 kV Line:**

   The total estimated cost of the upgrade 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 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

8. **Increased Overload (103.9% to 106.42%) to the Previously Overloaded Rock Springs – Peach Bottom 500 kV Line:**

   The total estimated cost of the upgrade is **$8,000,000.** The lead time required for construction is **36 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: The Rock Springs – Peach Bottom 500kV line overload can be alleviated by replacing terminal equipment at Peach Bottom.

9. **Increased Overload (118.57% to 122.17%) to the Previously Overloaded Northwest - Granite 230 kV #2326 Line:**

   The total estimated cost of the upgrade is **$27,000,000.** The lead time required for construction is **72 months**. At this point in time this Queue's cost allocation is undetermined. If required, cost allocation will be performed for the Impact Study.

   This upgrade also satisfies number 10 below.

Upgrade description: The Northwest – Granite 230kV Line #2326 and #2311 overloads would require building a double circuit transmission line consisting of a bundle of two 1033 ACSR conductors designed for 125°C operation to attain a Summer Emergency rating of 1240 MVA. The existing conductor is 1590 45/7 ACSR which is rated at 160°C. The line is 8.7 miles long.

10. **Increased Overload (115.44% to 118.97%) to the Previously Overloaded Northwest - Granite 230 kV #2311 Line:**

    See Upgrade 9 above which also satisfies this overload.

11. 12 and 13 **Increased Overload to the Previously Overloaded Peach Bottom – Conastone (existing) circuit 1 and (new) circuits 2&3 500 kV Lines:**

    The total estimated cost of the upgrade is **$515,800,000.** The lead time required for construction is **84 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:

    BG&E portion of the Conastone – Peach Bottom lines:

    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.