#S32 Perryman 550 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 Queue S32 project was studied as a 550 MW (capacity) injection at two possible POIs (Points of Interconnection) – Option #1 (Direct Connection to Perryman 115 kV substation) and Option #2 (Direct Connection to Perryman 230 kV substation). The project was evaluated for compliance with reliability criteria for summer peak conditions in 2012. Potential network impacts were as follows:

Option#1 – 115 kV

Generator Deliverability

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

1. The Raphael – Northeast 230 kV line #2337 is overloaded from 74% to 104% of its emergency rating (758 MVA) for the outage of Raphael – Northeast 230 kV line #2315 and Northeast 230/115 kV transformer (Cont Id. BG8). The project contributes approximately 233 MW to cause the thermal violation.

2. The Raphael – Northeast 230 kV line #2315 is overloaded from 73% to 103% of its emergency rating (758 MVA) for the outage of Raphael – Northeast 230 kV line #2337 (Cont Id. BG18). The project contributes approximately 230 MW to cause the 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)

3. The Northeast 230/115 kV transformer (230-3) is overloaded from 73% to 104% of its emergency rating (378 MVA) for the **tower** outage of Northeast - Riverside Ckts #2317 & #2339 (Cont Id. Northeast_Riverside). The project contributes approximately 119 MW to cause the thermal violation.

4. The Conastone – Ottercreek 230 kV line is overloaded from 99.97% to 104% of its emergency rating (632 MVA) for the **tower** outage of Conastone – Peach Bottom 500 kV ckt#1 and Conastone – Peach Bottom 500 kV ckt#2. The project contributes approximately 25 MW to cause the thermal violation.

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Short Circuit
No problems identified.

Stability Analysis
Will be performed for the Queue S32 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. Contribution of 85 MW further overloads the Conastone – Peach Bottom 500 kV ckt #2 from 134% to 137% of its emergency rating (2598 MVA) for the outage of Conastone – Peach Bottom 500 kV ckt #1 (Cont. PJM17).

6. Contribution of 85 MW further overloads the Conastone – Peach Bottom 500 kV ckt #1 from 134% to 137% of its emergency rating (2598 MVA) for the outage of Conastone – Peach Bottom 500 kV ckt #2 (Cont. PJM17_2).

7. Contribution of 65 MW further overloads the Graceton – Manor 230 kV line from 113% to 127% of its emergency rating (531 MVA) for the **tower** outage of Conastone – Peach Bottom 500 kV ckt #1 and Conastone – Peach Bottom 500 kV ckt #2.

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

1. **Raphael Rd - Northeast 230 kV Upgrade** - Replace both 230 kV breakers at Northeast substation. Estimated cost is $382,000 for each breaker or **$766,000**. (Note: This upgrade also satisfies impact #2).

2. Upgrade #1 above also satisfies the upgrade requirements for Network Impact #2.

3. **Northeast 230/115 kV Transformer Upgrade** - Replace transformer with a 500 MVA unit. Estimated cost is **$10,200,000**.

4. **Conastone – Otter Creek 230 kV Upgrade:**

   PPL upgrade
   The PPL portion of the Conastone to Otter Creek line (from Otter Creek to the point where ownership changes to BG&E) can be upgraded by reconductoring approximately 17.2 miles of 795 kcmil 30/19 ACSR conductor (Ratings 425/531 MVA Summer Normal/Emergency based on

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conductor temp @125^{O}C) with new 795 kcmil 30/19 ACSS (new ratings 516/632 MVA Summer Normal/Emergency, conductor operating temperature of 160^{O} C)

No terminal equipment upgrade is required at Otter Creek, it is currently built with 2000 amp rating equipment. The estimated cost of this upgrade is **$8,500,000.** Estimated construction time is **36 months.**

This upgrade will result in minimal change to the impedance of the line.
Existing Z = 0.0042 + j 0.0266 pu
New Z = 0.0048 + j 0.02676 pu

BG&E Upgrade

The BG&E portion of the Conastone to Otter Creek line can be upgraded by Reconducting from Gorsuch Mills to the Pennsylvania State Line (change of ownership to PPL). The existing circuit 2302 conductor is 1,590 kcmil 45/7 ACSR from Conastone to Gorsuch Mills and 795 kcm 30/19 ACSR from Gorsuch Mills to the PA State Line.
Assumptions:

- Reconductor with 1,590 kcm ACSR from Gorsuch Mills to PA line to match capability of remainder of line.
- Length of this line section is 1.7 miles.
- Towers can be reinforced instead of replaced.

The estimated cost of this upgrade is **$700,000**. Estimated construction time is **36 months**.

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. **Conastone – Peach Bottom 500 kV Upgrade:** To mitigate a 52% overload of the Conastone – Peach Bottom 500 kV circuit a second circuit will need to be built.

   If RIGHT OF WAY can be acquired the following is the Reinforcement and Cost Estimates:

   PECO portion of the Conastone – Peach Bottom line:

Substation work at Peach Bottom	$ 2,500,000
Construct 6.25 miles of 500kV line	$10,000,000
	$12,500,000

   This estimate does not include the cost of new right of way. Construction of the new line will take approximately **30 months** after the right of way is acquired.

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Note: It should be noted that PJM Queue P04 project also requires widening of about two miles of this right of way for their direct connection line and would use the last remaining terminal position that exists at Peach Bottom substation. If Queue P04 proceeds with their project it may complicate right of way acquisition and double the substation costs at Peach Bottom.

BGE portion of the Conastone – Peach Bottom line:
Build a new 500 kV line adjacent to existing circuit 5012 from Conastone to Pennsylvania State Line at an estimated cost of **$48,000,000** and a construction time of approximately **84 months.**

Assumptions:

- Acquire 150 ft. wide R/W adjacent to existing R/W, mostly rural land at $100,000 per acre
- 2 to 3 year CPCN process prior to land acquisition
- Length of line 9.6 miles

Install one 500kV breaker at Conastone **$1,500,000**. Breaker installation can be completed concurrently with the line construction.

If RIGHT OF WAY cannot be acquired the following is the Reinforcement and Cost Estimates:

The line from Graceton to Peach Bottom is about 7.5 miles long and has a normal rating of 528MVA. Assuming that we could maintain this rating with a single 230 kV pipe type cable (and we may not be able to do this), the new underground installation would cost about **$30,000,000** plus another **$1,000,000** for terminal modifications. It is assumed that the underground line will not have to cross any rivers or large creeks. If a cable rating of 450 MVA is insufficient, it will cost an **additional $30,000,000** for a second cable.

Removal of the existing 230 kV tower line is about **$1,500,000**.

Construction of a double circuit 500kV line from Conastone to Peach Bottom would be about $3,500,000 per mile. The line is 16.5 miles long. Total cost **$58,000,000**.

Substation additions and modifications at Peach Bottom would cost about $10M.

Note: Future work is being done by PECO and BG&E to come up with reinforcements to further mitigate the overload.

6. **Upgrade #5 above also satisfies the upgrade requirements for Network Impact #6.**

7. **Graceton to Manor 230 kV line upgrade –** To mitigate the Graceton to Manor contingency overload the emergency rating will need to be increased by upgrading the line as follows:

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BGE Upgrade
Reconductor from Graceton to PA line - **$700,000 ~ 3 yrs.**
Existing:
Circuit 2303 is 795 kcm 30/19 ACSR @ 125 C.
Assumptions:

- Reconductor with 1,590 kcm ACSR from Graceton to PA line.
- Length of this line section is 1.4 miles.
- Towers can be reinforced instead of replaced.

PPL Upgrade - The estimated magnitude cost for this upgrade including substation terminal equipment cost is **$31,000,000**.

Description of Work:

In order to provide additional capacity on the Graceton – Manor 230kV line, PPL EU is proposing to rebuild the existing single circuit 230kV line and replace the existing 795 ACSR conductor. This rebuild will require new custom embedded steel poles to accommodate the larger conductor size. The new line will be 1590 Kcmil ACSR conductor (1 per phase) designed and operated at 230 kV. The 230 kV lines will be rated for summer normal/emergency of 653/793 MVA respectively. These ratings are based on the conductor ratings and may be lower when the line is actually built. The rebuild will be 14.4 miles long and will travel the existing right of way.

Option#2 – 230 kV

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

1. The Raphael – Northeast 230 kV line #2337 is overloaded from 75% to 106% of its emergency rating (758 MVA) for the outage of Raphael – Northeast 230 kV line #2315 and Northeast 230/115 kV transformer (Cont Id. BG8). The project contributes approximately 235 MW to cause the thermal violation.

2. The Raphael – Northeast 230 kV line #2315 is overloaded from 75% to 106% of its emergency rating (758 MVA) for the outage of Raphael – Northeast 230 kV line #2337 (Cont Id. BG18). The project contributes approximately 234 MW to cause the 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)

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3. The Northeast 230/115 kV transformer (230-3) is overloaded from 74% to 106% of its emergency rating (378 MVA) for the **tower** outage of Northeast - Riverside Ckts #2317 & #2339 (Cont Id. Northeast_Riverside). The project contributes approximately 119 MW to cause the thermal violation.

4. The Conastone – Ottercreek 230 kV line is overloaded from 98.36% to 102% of its emergency rating (632 MVA) for the **tower** outage of Conastone – Peach Bottom 500 kV ckt #1 and Conastone – Peach Bottom 500 kV ckt #2. The project contributes approximately 25 MW to cause the thermal violation.

Short Circuit

No problems identified.

Stability Analysis

Will be performed for the Queue S32 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. Contribution of 84 MW further overloads the Conastone – Peach Bottom 500 kV ckt #2 from 137% to 140% of its emergency rating (2598 MVA) for the outage of Conastone – Peach Bottom 500 kV ckt #1 (Cont. PJM17).

6. Contribution of 84 MW further overloads the Conastone – Peach Bottom 500 kV ckt #1 from 137% to 140% of its emergency rating (2598 MVA) for the outage of Conastone – Peach Bottom 500 kV ckt #2 (Cont. PJM17_2).

7. Contribution of 66 MW further overloads the Graceton – Manor 230 kV line from 108% to 120% of its emergency rating (531 MVA) for the **tower** outage of Conastone – Peach Bottom 500 kV ckt #1 and Conastone – Peach Bottom 500 kV ckt #2.

New System Reinforcements

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

1. **Raphael Rd - Northeast 230 kV Upgrade** – Replace both 230kV breakers at Northeast substation at an estimated cost of $382,000 per breaker or **$766,000**. (Note: This upgrade will suffice overload #2 too).

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2. Upgrade #1 above also satisfies the upgrade requirements for Network Impact #2.

3. **Northeast 230/115 kV Transformer Upgrade** - Replace the existing transformer with 500 MVA unit at an estimated cost of **$10,200,000**.

4. **Conastone – Otter Creek 230 kV Upgrade:**

   PPL upgrade

   The PPL portion of the Conastone to Otter Creek line (from Otter Creek to the point where ownership changes to BG&E) can be upgraded by reconductoring approximately 17.2 miles of 795 kcmil 30/19 ACSR conductor (Ratings 425/531 MVA Summer Normal/Emergency based on conductor temp @125^{O}C) with new 795 kcmil 30/19 ACSS (new ratings 516/632 MVA Summer Normal/Emergency, conductor operating temperature of 160^{O} C)

   No terminal equipment upgrade is required at Otter Creek, it is currently built with 2000 amp rating equipment. The estimated cost of this upgrade is **$8,500,000.** Estimated construction time is **36 months.**

   This upgrade will result in minimal change to the impedance of the line.
   Existing Z = 0.0042 + j 0.0266 pu
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   Assumptions:
   - Reconductor with 1,590 kcm ACSR from Gorsuch Mills to PA line to match capability of remainder of line.
   - Length of this line section is 1.7 miles.
   - Towers can be reinforced instead of replaced.

   The estimated cost of this upgrade is **$700,000**. Estimated construction time is **36 months**.

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. **Conastone – Peach Bottom 500 kV Upgrade**: To mitigate a 52% overload of the Conastone – Peach Bottom 500 kV circuit a second circuit will need to be built.

   If RIGHT OF WAY can be acquired following is the Reinforcement and Cost Estimates:

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PECO portion of the Conastone – Peach Bottom line:

Substation work at Peach Bottom	$ 2,500,000
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This estimate does not include the cost of new right of way.
Construction of the new line will take approximately **30 months** after the right of way is acquired.

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Assumptions:

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The line from Graceton to Peach Bottom is about 7.5 miles long and has a normal rating of 528MVA. Assuming that we could maintain this rating with a single 230 kV pipe type cable (and we may not be able to do this), the new underground installation would cost about $30,000,000 plus another $1,000,000 for terminal modifications. I assume that the underground line will not have to cross any rivers or large creeks. If a cable rating of 450 MVA is insufficient, it will cost an additional $30,000,000 for a second cable.

Removal of the existing 230 kV tower line is about $1,500,000.

Construction of a double circuit 500kV line from Conastone to Peach Bottom would be about $3,500,000 per mile. The line is 16.5 miles long. Total cost $58,000,000.

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Substation additions and modifications at Peach Bottom would cost about $10,000,000.

Note: Future work is being done by the TOs to come up with reinforcements to further mitigate the overload.

6. **Upgrade #5 above also satisfies the upgrade requirements for Network Impact #6.**

7. **Graceton to Manor 230 kV line Upgrade** – A line overload of 130% of the Emergency Rating of 531MVA will require upgrade to at least 691 MVA as follows:

   BGE Upgrade
   Reconductor from Graceton to PA line - **$700,000 ~ 3 yrs**.
   Existing: Circuit 2303 is 795 kcm 30/19 ACSR @ 125 C.
   Assumptions:
   - Reconductor with 1,590 kcm ACSR from Graceton to PA line.
   - Length of this line section is 1.4 miles.
   - Towers can be reinforced instead of replaced.

   PPL Upgrade - The estimated magnitude cost for this upgrade including substation terminal equipment cost is **$31,000,000**.

   Description of Work:
   In order to provide additional capacity on the Graceton – Manor 230kV line, PPL EU is proposing to rebuild the existing single circuit 230kV line consisting of 795 ACSR. This rebuild will require new custom embedded steel poles to accommodate the larger conductor size of the new conductor. The new line will be 1590 Kcmil ACSR conductors (1 per phase) designed and operated at 230 kV. The 230 kV lines will be rated for summer normal/emergency of 653/793 MVA respectively. These ratings are based on the conductor ratings and may be lower when the line is actually built.

   The rebuild will be 14.4 miles long and will travel the existing right of way.

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