

#S17 Talbert 225 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 S17 project was studied as a 225 MW capacity injection into the Talbert - Burches Hill 230 kV circuits. Project S17 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)

1. Normal System contribution of **25 MW** causes the normal overload of the Oak Grove - Bowie 230 kV circuit #23042 from **98% to 102%** of its **normal** rating (608 MVA).
2. Normal System contribution of **25 MW** causes the normal overload of the Bowie – Burtonsville 230 kV circuit #23042 from **98% to 102%** of its **normal** rating (608 MVA).
3. The Burtonsville – Sandy Spring 230 kV line #2334 is overloaded from **99% to 101%** of its emergency rating (923 MVA) for the outage of High Ridge – Sandy Springs – Burtonsville 230 kV line (Cont Id. BG_CKT2314). This project contributes approximately **18 MW** to cause the thermal violation.
4. The Burtonsville – Sandy Spring 230 kV line #2314 is overloaded from **99% to 101%** of its emergency rating (923 MVA) for the outage of High Ridge – Sandy Springs – Burtonsville 230 kV line (Cont Id. BG_CKT2334). This project contributes approximately **17 MW** to cause the thermal violation.
5. The Oak Grove - Bowie Sub 230 kV circuit #23045 from **98% to 102%** of its normal rating (608 MVA). This project contributes approximately **24 MW** to cause the thermal violation.
6. Normal System contribution of **24 MW** causes the normal overload of the Bowie – Burtonsville 230 kV circuit #23045 from **98% to 102%** of its **normal rating** (608 MVA).
7. The Brandon Shores – Hawkins Points Terminal 230 kV line #2344 from **99% to 100%** of its emergency rating (1153 MVA) for the outage of Hawkins Point – Sollers Point 230 kV line #2345 (Cont Id. BG26). This project contributes approximately **12 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)

No problems were identified.

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)

8. Contribution of **12 MW** further overloads the Sollers Point – Riverside 230 kV line #2344 from **101% to 102%** of its emergency rating (1131 MVA) for the outage of Riverside 230/115 kV transformer (Cont Id. BG31).
9. Contribution of **32 MW** further overloads the Oak Grove - Bowie Sub 230 kV circuit #23045 from **113% to 118%** of its emergency rating (730 MVA) for the **tower** outage of Chalk Point to Bowie 230 V line and Oak Grove to Burtonsville 230 kV line (Cont Id. 5PEPCO).
10. Contribution of **32 MW** further overloads the Bowie Sub – Burtonsville 230 kV circuit #23045 from **113% to 118%** of its emergency rating (730 MVA) for the **tower** outage of Chalk Point to Bowie 230 V line and Oak Grove to Burtonsville 230 kV line (Cont Id. 5PEPCO).
11. Contribution of **32 MW** further overloads the Oak Grove - Bowie Sub 230 kV circuit #23042 from **112% to 116%** of its emergency rating (730 MVA) for the **tower** outage of Bowie to Oak Grove 230 kV line and Oak Grove to Chalk Point 230 kV line (Cont Id. 7PEPCO).
12. Contribution of **32 MW** further overloads the Bowie Sub – Burtonsville 230 kV circuit #23042 is overloaded from **112% to 116%** of its emergency rating (730 MVA) for the **tower** outage of Bowie to Oak Grove 230 kV line and Oak Grove to Chalk Point 230 kV line (Cont Id. 7PEPCO).
13. Normal System contribution of **25 MW** further overloads the Kemptown – N. Northwest 500 kV line from **167% to 168%** of its **normal rating** (2078 MVA).
14. Contribution of **25 MW** further overloads the Kemptown – N. Northwest 500 kV line from **179% to 180%** of its emergency rating (2901 MVA) for the **tower** outage of Granite – High Ridge ckt #2312 and ckt#2332.
15. Contribution of **28 MW** further overloads the N. Northwest - Conastone 500 kV line from **101% to 107%** of its emergency rating (2901 MVA) for the outage of N. Northwest 500/230 kV transformer.
16. Contribution of **36 MW** further overloads the Conastone – Peach Bottom ckt#2 500 kV line from **121% to 122%** of its emergency rating (2598 MVA) for the outage of Conastone – Peach Bottom ckt#1 500 kV line (Cont Id. PJM17).
17. Contribution of **36 MW** further overloads the Conastone – Peach Bottom ckt#1 500 kV line from **121% to 122%** of its emergency rating (2598 MVA) for the outage of Conastone – Peach Bottom ckt#2 500 kV line (Cont Id. PJM17_2).

Short Circuit

18. The four Westinghouse 230 kV OCB's on bus No. 3 at Pepco's Burtonsville Substation are over-duty as a result of the addition of S17 queue.

Stability Analysis

Will be performed for the Impact Study.

NETWORK UPGRADE REQUIREMENTS

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

1. Oak Grove – Bowie upgrade - The estimated cost to upgrade the Oak Grove - Bowie 230 kV circuit (23042) is **\$5,000,000**. This cost represents the addition of a second 230kV conductor to circuit 23042 from Oak Grove to Bowie (approximately 12 miles).
This upgrade also satisfies Network Impact number 11.
2. Bowie – Burtonsville upgrade - The estimated cost to upgrade the Bowie - Burtonsville 230 kV circuit (23042) is **\$3,400,000**. This cost represents the addition of a second 230 kV conductor to circuit 23042 from Bowie to Burtonsville (approximately 8 miles).
This upgrade also satisfies Network Impact number 12.

In order to bundle the above circuits, the existing lattice tower line structures are required to be replaced with new steel poles, foundations and new conductors. Engineering design work will need to be performed as well as the regulatory work related to obtain the necessary CPCN (Certificate of Public Convenience and Need). The cost estimates include material (steel poles, conductor, shield wire, insulators/hardware/grounding), construction, engineering and CPCN filings.

The estimated construction time is approximately **four years**. This schedule assumes that all the necessary engineering work and issuance of the CPCN can be completed within the first year. The scheduling of outages will be very critical.

3. Sandy Spring – Burtonsville upgrade - Sandy Spring to Burtonsville 230 kV double circuit 2314/2334 is currently using 1590 ACSR conductor and is designed for 160 degC operation (923 MVA rating). The overload of 118% will require a 1089 MVA or greater rating.

The solution to the overload is to rebuild the existing line using double bundle 1033 ACSR @ 125 degC (1227 MVA) at an estimated cost of **\$540,000**. The estimated construction time is **5 years**.

Assumptions: Full structure replacement required, existing structure removal included, line length of 0.2 miles, and 2+ year CPCN process required.

This reinforcement also satisfies Network Impact number 4.

4. See Network Upgrade number 4.
5. Oak Grove – Bowie upgrade - The estimated cost to upgrade the Oak Grove - Bowie 230 kV circuit (23045) is **\$5,000,000**. This cost represents the addition of a second 230kV conductor to circuit 23045 from Oak Grove to Bowie (approximately 12 miles). **This upgrade also satisfies Network Impact 9.**
6. Bowie – Burtonsville upgrade - The estimated cost to upgrade the Bowie - Burtonsville 230 kV circuit (23045) is **\$3,400,000**. This cost represents the addition of a second 230kV conductor to circuit 23045 from Bowie to Burtonsville (approximately 8 miles). **This upgrade also satisfies Network Impact 10.**
7. Brandon Shores – Hawkins Points 230 kV upgrade - Install 1 additional Harbor Crossing cable Hawkins Point to Sollers Point and upgrade OH sections to 180C at an estimated cost of **\$40,250,000** and **8-10 years** to design and complete. **This upgrade also satisfies Network Impact 8.**

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)*

8. See Network Upgrade number 7.
9. See Network Upgrade number 5.
10. See Network Upgrade number 6.
11. See Network Upgrade number 1.
12. See Network Upgrade number 2.
13. Kempton – N. Northwest 500 kV upgrade – Construct two (2) new single circuit lines at an estimated cost of **\$279,000,000** and estimated time of **10 years** to construct. **Also satisfies Network Impact 14.**

Assumptions:

New 350 ft. wide R/W parallels existing Northwest to Mt Airy Tap R/W

Total R/W length = 28.3 miles
3 - bundle 1,590 kcm conductor
Kempton located 1/4 mile west of Mt Airy Tap
North Northwest located 4 miles north of Northwest

Substation Terminations:
NNW - Install a 3 breaker bay **\$7,700,000**
Kempton - Install a 3 breaker bay **\$7,700,000**

14. See Network Upgrade number 13.

15. Conastone to North Northwest 500 kV upgrade – construct one new single circuit line at an estimated cost of **\$109,000,000** and estimated time of **10 years**.

Assumptions:
New 200 ft. wide R/W parallels existing Conastone to Northwest R/W
Total R/W length = 19.6 miles
3 - bundle 1,590 kcm conductor
North Northwest located 4 miles north of Northwest

Substation Terminations:
Conastone - Install a 1 breaker bay **\$3,200,000**
N. Northwest - Install a 2 breaker bay **\$6,400,000**

16. and 17.

Conastone – Peach Bottom 500 kV Upgrade: To mitigate a 52% overload of the Conastone – Peach Bottom 500 kV circuit(s), an additional circuit will need to be built.

IF RIGHT OF WAY CAN BE ACQUIRED:

PECO portion of the Conastone – Peach Bottom line:

Substation work at Peach Bottom	\$ 2,500,000
Construct 6.25 miles of 500kV line	<u>\$10,000,000</u>
Total	\$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.

Note: PJM Queue P04 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 the Pennsylvania State Line at an estimated cost of **\$48,000,000** and a construction time of approximately **84 months**.

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

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

If RIGHT OF WAY CAN'T BE ACQUIRED:

The line from Graceton to Peach Bottom is about 7.5 miles long and has a normal rating of 528MVA. Assuming that this rating could be maintained with a single 230kV pipe type cable (and that may not be possible), the new underground installation would cost about **\$31,000,000** for the circuit and terminal modifications. It is assumed that the underground line will not need 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 \$3.5M per mile. The line is 16.5 miles long. Total cost **\$58,000,000**.

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

Note: Future work is being done to come up with reinforcements to further mitigate the Conastone – Peach Bottom 500 kV overload. The additional reinforcements may include the following:

Conastone – Otter Creek 230 kV Upgrade:

PPL portion of Conastone – Otter Creek

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^oC) with new 795 kcmil 30/19 ACSS (new ratings 516/632 MVA Summer Normal/Emergency, conductor operating temperature of 160^oC)

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 portion of Conastone – Otter Creek.

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

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.

High Ridge – Howard 230 kV Upgrade - The existing circuit 2332-A has 1590 Kcmil conductor which will need to be replaced. The estimated cost to rebuild the structures to accommodate new 2167 Kcmil ACSR conductor is **\$16,000,000** and it will take approximately **60 months**.

Assumptions:

- Length of line 8.0 miles
- 2+ year CPCN process at a cost of \$500,000
- Existing tower removal at a cost of \$1M included.

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.

The Queue S17 MW contribution on the Graceton - Bagley - Raphael overload is 76 MW.

Short Circuit Reinforcement Requirements

The four over-duty 230 kV Westinghouse OCB's at Burtonsville, rated at 50 kA interrupting capability will require replacement with 63kA rated breakers. The cost of each breaker replacement is \$1,500,000. The total estimated cost is **\$6,000,000** and will take approxima