#S29 Morgantown – Oak Grove 900 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 S29 project was studied as a 900 MW capacity injection into the four Morgantown – Oak Grove 230 kV circuits. Project S29 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. The R17/S29 - Talbert Tap 230 kV circuit #23086 loading increases from **87% to 121%** of its emergency rating (730 MVA) for the outage of Oak Grove – Talbert – R17/S29 230 kV line #23082 (Cont Id. PP47_R17_S17A). This project contributes approximately **249 MW** to cause the thermal violation.
2. The R17TAP87 - Talbert Tap 230 kV circuit #23087 loading increases from **90% to 117%** of its normal rating (559 MVA). This project contributes approximately **151 MW** to cause the thermal violation.
3. The Talbert Tap – Oak Grove 230 kV circuit #23066 loading increases from **90% to 117%** of its normal rating (559 MVA). This project contributes approximately **151 MW** to cause the thermal violation.
4. The Talbert Tap – Oak Grove 230 kV circuit #23087 loading increases from **90% to 117%** of its normal rating (559 MVA). This project contributes approximately 151 MW to cause the thermal violation.
5. The R17TAP85 - Talbert Tap 230 kV circuit #23085 loading increases from **78% to 109%** of its normal rating (608 MVA). This project contributes approximately 183 MW to cause the thermal violation.
6. The R17TAP85 - Talbert Tap 230 kV circuit #23085 loading increases from **87% to 121%** of its emergency rating (730 MVA) for the outage of S17 – Talbert 230 kV line #23081 (Cont Id. PP50_R17_S17A). This project contributes approximately **254 MW** to cause the thermal violation.
7. The R17TAP86 - Talbert Tap 230 kV circuit #23086 loading increases from **78% to 108%** of its normal rating (608 MVA). This project contributes approximately **183 MW** to cause the thermal violation.
8. The R17TAP84 - Talbert Tap 230 kV circuit #23084 loading increases from **83% to 107%** of its normal rating (608 MVA). This project contributes approximately **151 MW** to cause the thermal violation.

9. The Talbert Tap – Oak Grove 230 kV circuit #23067 loading increases from **93% to 100%** of its emergency rating (680 MVA) for the outage of Burches – Possum 500 kV line. This project contributes approximately **54 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)

10. The R17TAP87 - Talbert Tap 230 kV circuit #23087 loading increases from **96% to 126%** of its emergency rating (680 MVA) for the **tower** outage of Morgantown – Chalk Point circuit (Cont Id. 11PEPCO). This project contributes approximately **205 MW** to cause the thermal violation.
11. The Talbert Tap – Oak Grove 230 kV circuit #23066/23084 loading increases from **96% to 126%** of its emergency rating (680 MVA) for the **tower** outage of Morgantown – Chalk Point circuit (Cont Id. 11PEPCO). This project contributes approximately **205 MW** to cause the thermal violation.
12. The Talbert Tap – Oak Grove 230 kV circuit #23087 loading increases from **96% to 126%** of its emergency rating (680 MVA) for the **tower** outage of Morgantown – Chalk Point circuit (Cont Id. 11PEPCO). This project contributes approximately **205 MW** to cause the thermal violation.
13. The R17TAP84 - Talbert Tap 230 kV circuit #23084 loading increases from **89% to 117%** of its emergency rating (730 MVA) for the **tower** outage of Morgantown – Chalk Point circuit (Cont Id. 11PEPCO). This project contributes approximately **205 MW** to cause the thermal violation.
14. The R17TAP85 - Talbert Tap 230 kV circuit #23085 loading increases from **85% to 118%** of its emergency rating (730 MVA) for the **tower** outage of Morgantown – Chalk Point circuit (Cont Id. 11PEPCO). This project contributes approximately **241 MW** to cause the thermal violation.
15. The Chalk Point - Oak Grove 230 kV circuit #23054/23064 loading increases from **98% to 106%** of its emergency rating (730 MVA) for **tower** outage of Bowie to Oak Grove 230 kV line and Oak Grove to Chalk Point 230 kV line (Cont Id. 7PEPCO). This project contributes approximately **60 MW** to cause the thermal violation.
16. The Chalk Point - Oak Grove 230 kV circuit #23053 loading increases from **98% to 106%** 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). This project contributes approximately **60 MW** to cause the thermal violation.
17. The Oak Grove - Bowie Sub 230 kV circuit #23054/23044 loading increases from **98% to 106%** 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). This project contributes approximately **60 MW** to cause the thermal violation.
18. The Oak Grove - Bowie Sub 230 kV circuit #23053/23043 loading increases from **97% to 106%** 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). This project contributes approximately **62 MW** to cause the thermal violation.

19. The Graceton – Manor 230 kV line loading increases **from 97% to 105%** of its emergency rating (531 MVA) for the **tower** outage of Conastone – Peach Bottom 500 kV ckt#1 and ckt#2. (Cont Id. Conas_PB). This project contributes approximately **40 MW** to cause the thermal violation.

Short Circuit Analysis

Will be performed for the Impact Study.

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)

20. Contribution of **67 MW** further overloads the Sandy Spring Tap – High Ridge 230 kV line #2314 from **102% to 108%** of its emergency rating (923 MVA) for the outage of Kemptown – N. Northwest 500 kV line (Cont Id. PJM13B).
21. Contribution of **67 MW** overloads the Sandy Spring Tap – High Ridge 230 kV line #2334 from **93% to 99.97%** of its emergency rating (923 MVA) for the outage of Kemptown – N. Northwest 500 kV line (Cont Id. PJM13B).
22. Contribution of **242 MW** further overloads the S17Tap81230 – Burches Hill 230 kV line #23081 from **183% to 217%** of its emergency rating (730 MVA) for the outage of Oak Grove – Talbert – R17/S29 230 kV line #23082 (Cont Id. PP47_R17_S17A). This project contributes approximately **656 MW** to cause the thermal violation.
23. Contribution of **111 MW** further overloads the Oak Grove - Bowie Sub 230 kV circuit #23045 from **122% to 140%** of its normal rating (608 MVA).
24. Contribution of **111 MW** further overloads the Bowie Sub – Burtonsville 230 kV circuit #23045 from **122% to 140%** of its normal rating (608 MVA).
25. Contribution of **112 MW** further overloads the Oak Grove - Bowie Sub 230 kV circuit #23042 from **122% to 141%** of its normal rating (608 MVA).
26. Contribution of **112 MW** further overloads the Bowie Sub – Burtonsville 230 kV circuit #23042 from **122% to 141%** of its normal rating (608 MVA).
27. Contribution of **52 MW** further overloads the Sollers Point – Riverside 230 kV line #2344 from **106% to 111%** of its emergency rating (1131 MVA) for the outage of Riverside 230/115 kV transformer (Cont Id. BG31).
28. Contribution of **52 MW** further overloads the Brandon Shores – Hawkins Points Terminal 230 kV line #2344 from **109% to 114%** of its emergency rating (1153

MVA) for the outage of Hawkins Point – Sollers Point 230 kV line #2345 (Cont Id. BG26).

29. Contribution of **154 MW** further overloads the S17Tap82230 – Burches Hill 230 kV line #23082 from **168% to 208%** of its emergency rating (730 MVA) for the outage of Chalk Pt – Burches Hill 500 kV line (Cont Id. PJM1D).
30. Contribution of **155 MW** further overloads the S17Tap81230 – Burches Hill 230 kV circuit #23081 from **112% to 137%** of its normal rating (608 MVA).
31. Contribution of **155 MW** further overloads the S17Tap82230 – Burches Hill 230 kV circuit #23082 from **111% to 137%** of its normal rating (608 MVA).
32. Contribution of **77 MW** further overloads the Burtonsville – Sandy Spring 230 kV line #2334 from **108% to 116%** of its emergency rating (923 MVA) for the outage of High Ridge – Sandy Springs – Burtonsville ckt #2314.
33. Contribution of **77 MW** further overloads the Burtonsville – Sandy Spring 230 kV line #2314 from **108% to 116%** of its emergency rating (923 MVA) for the outage of High Ridge – Sandy Springs – Burtonsville ckt #2334.
34. Contribution of **96 MW** further overloads the Kemptown – Conastone 500 kV line from **165% to 170%** of its normal rating (2078 MVA).
35. Contribution of **76 MW** further overloads the High Ridge - Howard (line #2332-A) 230 kV line from **103% to 110%** of its emergency rating (923 MVA) for the outage of Kemptown – N. Northwest 500 kV line (Cont Id. PJM13B).
36. Contribution of **63 MW** further overloads the Peach Bottom – Limerick 500 kV line from **107% to 110%** of its emergency rating (3221 MVA) for the outage of Keeney – Peach Bottom 500 kV line (Cont Id. PJM27B).
37. Contribution of **144 MW** further overloads the Conastone – Peach Bottom 500 kV ckt#1 from **125% to 131%** of its emergency rating (2598 MVA) for the outage of Conastone – Peach Bottom 500 kV ckt#2 (Cont Id. PJM17_2).
38. Contribution of **144 MW** further overloads the Conastone – Peach Bottom 500 kV ckt#2 from **125% to 131%** of its emergency rating (2598 MVA) for the outage of Conastone – Peach Bottom 500 kV ckt#1 (Cont Id. PJM17).
39. Contribution of **148 MW** further overloads the Oak Grove - Bowie Sub 230 kV circuit #23045 from **139% to 159%** 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).
40. Contribution of **148 MW** further overloads the Bowie Sub – Burtonsville 230 kV circuit #23045 from **139% to 159%** 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).
41. Contribution of **149 MW** further overloads the Oak Grove - Bowie Sub 230 kV circuit #23042 from **139% to 159%** 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).
42. Contribution of **149 MW** further overloads the Bowie Sub – Burtonsville 230 kV circuit #23042 from **139% to 159%** 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).

43. Contribution of **124 MW** further overloads the N. Northwest - Conastone 500 kV line from **108% to 114%** of its normal rating (2078 MVA).
44. Contribution of **137 MW** further overloads the Kemptown – N. Northwest 500 kV line from **186% to 190%** of its emergency rating (2901 MVA) for the **tower** outage of Granite – High Ridge ckt #2312 and ckt #2332.

NETWORK UPGRADE REQUIREMENTS

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 cost to upgrade Talbert – Kelson Ridge circuit #23086 is approximately **$5.3 million** (13 miles). **This also satisfies Network Impact number 7.**

2. The cost to upgrade Talbert – Kelson Ridge circuit #23087 is approximately **$5.3 million** (13 miles). **This also satisfies Network Impact number 10.**

3. See Network Reinforcement number 11**.**

4. The cost to upgrade Oak Grove- Talbert circuit #23087 is approximately **$4.1 million** (10 miles).

5. The cost to upgrade Talbert – Kelson Ridge circuit # 23085 is approximately **$5.3 million** (13 miles) **This also satisfies Network Impact number 6.**

6. See Network Reinforcement number 5.

7. See Network Reinforcement number 1.

8. The cost to upgrade Talbert – Kelson Ridge circuit # 23084 is approximately **$5.3 million** (13 miles)

9. The cost to upgrade Oak Grove- Talbert circuit #23067 is approximately **$4.1 million (10 miles).**

10. See Network Reinforcement number 2.

11. The cost to upgrade Oak Grove- Talbert circuits #23066 and #23084 is approximately $4.1 million each (10 miles) or **$8.2 million** total. **This also satisfies Network Impact number 3.**

12. See Network Reinforcement number 4.

13. See Network Reinforcement number 8.

14. See Network Reinforcement number 6.

15. The cost to add a second conductor to Chalk Point - Oak Grove 230kV circuits #23054 and #23064 is approximately **$20 million**.

16. The cost to add a second conductor to the Chalk Point - Oak Grove 230kV circuit #23053 is approximately **$10 million**.

17. The cost to add a second conductor to Oak Grove - Bowie 230kV circuits #23054 and #23044 is approximately $5 million each for a total of **$10 million**.

18. The cost to add a second conductor to Oak Grove - Bowie 230kV circuits #23053 and #23043 is approximately $5 million each for a total of **$10 million**.

19. Graceton to Manor 230 kV line Upgrade. An overload of 130% will require an increase is the summer emergency rating from 531MVA to a minimum of 691 MVA. The following reinforcements will be required for the PPL and BGE portions of this line:

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

    Based on previous estimate by R.W.M. for PJM (B48) study on circuit 22008, and Conastone to Ottercreek 2302 estimate.

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

    In order to provide additional capacity on the Graceton – Manor 230kV line, PPL EU is proposing to rebuild the existing 795 kcmil ACSR single circuit 230kV line. This rebuild will require new custom embedded steel poles to accommodate a larger conductor size. The new line will be 1590 kcmil ACSR conductors (1 per phase) designed and operated at 230 kV. The new summer normal/emergency rating will be 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.

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)*

20. and 21.

High Ridge to Sandy Spring 230 kV double circuit 2314/2334 Upgrade
Existing circuits using 1590 ACSR @ 160 degC
Overload of 108% on 923 MVA rating = 996 MVA
Rebuild existing line using double bundle 1033 ACSR @ 125 degC (1227 MVA) at a cost of **$10 million** and it will take **5 years** to complete.

Assumptions:

-Full structure replacement required
-Existing structure removal included
-Line length of 3.61 miles
-2+ year CPCN process required

22. The cost to add a second conductor to the S17 – Burches Hill 230 kV circuit #23081 is approximately **$2 million**. (approximately 4.43 miles). **This upgrade also satisfies Network Impact 30.**

23. The estimated cost to upgrade the Oak Grove - Bowie 230 kV circuit (23045) is **$5 million**. 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 39.

24. The estimated cost to upgrade the Bowie - Burtonsville 230 kV circuit (23045) is **$3.4 million**. This cost represents the addition of a second 230kV conductor to circuit 23045 from Bowie to Burtonsville (approximately 8 miles).
This upgrade also satsfies Network Impact 40.

25. The estimated cost to upgrade the Oak Grove - Bowie 230 kV circuit (23042) is **$5 million**. 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 41.

26. The estimated cost to upgrade the Bowie - Burtonsville 230 kV circuit (23042) is **$3.4 million**. This cost represents the addition of a second 230kV conductor to circuit 23042 from Bowie to Burtonsville (approximately 8 miles).
This upgrade also satisfies Network Impact 42.

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.

27. Sollers Pt - Riverside 230 kV line and Brandon Shores - Hawkings Pt 230 kV line Upgrades.

    Install 1 additional Harbor Crossing cable Hawkins Point to Sollers Point, re-rate new overhead sections to 180C. estimated cost is **$40.25 million.** It will take **8-10 years** to design and construct. **This upgrade also satisfies Network Impact 27.**

28. See Network Reinforcement number 27.

29. The cost to add a second conductor to the S17 – Burches Hill 230 kV circuit #23082 is approximately **$2 million**. (approximately 4.43 miles). **This upgrade also satisfies Network Impact 31.**

30. See Network Reinforcement number 22.

31. See Network Reinforcement number 29.

32. and 33.

    Sandy Spring to Burtonsville 230 kV double circuit 2314/2334 Upgrade.
    Existing circuits using 1590 ACSR @ 160 degC. An overload of 118% requires the summer emergency rating to increase from 923 MVA rating to 1089 MVA. This will require rebuild of the existing double circuit line using double bundle 1033 ACSR @ 125 degC (1227 MVA) at a cost of **$0.54 million** and will take **5 years** to complete.

    Assumptions:
    -Full structure replacement required
    -Existing structure removal included
    -Line length of 0.2 miles
    -2+ year CPCN process required

33. Kemptown – Conastone 500 kV line Upgrade. Upgrade plan, cost and time estimate will be provided for the Impact Study if required..

35. High Ridge – Howard 230 kV Upgrade: The existing circuit 2332-A has 1590 Kcmil conductor which will need to be replaced with 2167 kcmil. The estimated

cost to reconductor and rebuild the structures to accommodate new 2167 kcmil ACSR conductor is **$16 million** 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.

36. Peach Bottom – Limerick 500 kV Upgrade: Upgrade plan, cost and time estimate will be provided for the Impact Study if required at that time.

37. and 38.

Conastone – Peach Bottom 500 kV Upgrade: Upgrade plan, cost and time estimate will be provided for the Impact Study if required at that time.

Note: The system model used to evaluate Queue S29 interconnection already assumed a second Conastone to Peach Bottom 500 kV line. This overload will either require the addition of a third Conastone – Peach Bottom line or some other alternative if right of way cannot be secured for a third line. At this point in the interconnection process Queue S29 would have a cost allocation for the second and third Conastone – Peach Bottom 500 kV lines.

39. See Network Reinforcement number 23.

40. See Network Reinforcement number 24.

41. See Network Reinforcement number 25.

42. See Network Reinforcement number 26.

43. North Northwest to Conastone 500 kV line Upgrade. Upgrade plan, cost and time estimate will be provided for the Impact Study if required at that time.

44. Kemptown to North Northwest 500 kV line Upgrade. - 2 new single circuit 500 kV lines will be required at an estimated cost of **$279 million** and estimated time of **10 yrs**.