#R36 Bethany 601 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 #R36 project was studied as a 600 MW (120 MW capacity) injection at Bethany 138 kV substation. Project #R36 was evaluated for compliance with reliability criteria for summer peak conditions in 2011. Potential network impacts were as follows:

NETWORK IMPACTS

Generator Deliverability

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

1. The N.Seaford – Taylor 69kV line is overloaded to 101% of its emergency rating (64 MVA) for the outage of S.Harrington 138/69kV. The R36 project contributes **3 MVA** to this overload. No problems were 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)

2. The Milford - Steele 230 kV line is overloaded from 48% to 115% of its emergency rating (551 MVA) for the **tower** outage of Red Lion - Cedar Creek 230 kV line and Red Lion - Cartanza 230 kV line (Cont Id. DBL_4NC). The R36 contributes approximately **371 MW** to cause the thermal violation.

Short Circuit

Will be performed for the Queue R36 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)

3. The Linwood – Chichester ckt#2 230 kV line is overloaded at 106% of its emergency rating (904 MVA) for the outage of Linwood – Chichester ck#t. 1 230 kV line (Cont. PE39). The R36 project contributes approximately **21 MW** to this overload.

4. The Linwood – Chichester ckt#1 230 kV line is overloaded at 105% of its emergency rating (904 MVA) for the outage of Linwood – Chichester ckt#2 230

kV line (Cont. PE43). The R36 project contributes approximately **21 MW** to this overload.

5. The Ridley – Printz 230 kV line is overloaded at 104% of its emergency rating (1432 MVA) for the outage of Eddyston - IslandR6 - IslandRD7-813.8 230 kV line (Cont. PE23). The R36 project contributes approximately **8 MW** to this overload.

6. The Island Road - Eddystone 230 kV line is overloaded at 101% of its emergency rating (1411 MVA) for the outage of Ridley to Morton to Macdade 230 kV line (Cont. PE46). The R36 project contributes approximately **8 MW** to this overload.

7. The Conastone – Mt Carmel (2322 line) 230 kV line is overloaded at 162% of its emergency rating (803 MVA) for the **tower** outage of Brighton to Doubs 500 kV line and Brighton to Conastone 500 kV line (Cont. AP5). The R36 project contributes approximately **36 MW** to this overload.

8. The Conastone - Mt Carmel (2310 line) 230 kV line is overloaded at 144% of its emergency rating (923 MVA) for the **tower** outage of Brighton to Doubs and Brighton to Conastone 500 kV line (Cont Id. AP5). The R36 project contributes approximately **37 MW** to this overload.

9. The Northwest - Mt Carmel (2322 line) 230 kV line is overloaded at 159% of its emergency rating (803 MVA) for the **tower** outage of Brighton to Doubs and Brighton to Conastone 500 kV line (Cont Id. AP5). The R36 project contributes approximately **36 MW** to this overload.

10. The Northwest - Mt Carmel (2310 line) 230 kV line is overloaded at 142% of its emergency rating (923 MVA) for the **tower** outage of Brighton to Doubs and Brighton to Conastone 500 kV line (Cont Id. AP5). The R36 project contributes approximately **37 MW** to this overload.

11. The Graceton – Bagley - Raphael Road 230 kV line is overloaded at 187% of its emergency rating (659 MVA) for the **tower** outage of Brighton to Doubs 500 kV line and Brighton to Conastone 500 kV line (Cont. AP5). The R36 project contributes approximately **42 MW** to this overload.

12. The Three Mile Island 500/230 kV transformer is overloaded at 120% of its emergency rating (1077 MVA) for the outage of Conastone to Peach Bottom 500 kV line (Cont Id. PJM17). The R36 project contributes approximately **15 MW** to this overload.

NETWORK UPGRADE REQUIREMNTS

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 N.Seaford – Taylor 69kV line overload requires re-tensioning of the line to increase the temperature rating of the existing conductor at an estimated cost of **$400,000.** It would take **12 to 18 months** assuming no major regulatory or environmental impacts.

2. Milford - Steele 230 kV Overload – This overload requires to rebuild the existing conductor at an estimated cost of **$12,000,000**. It would take **18 to 24 months** assuming no major regulatory or environmental impacts.

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)

3. Chichester - Linwood 230kV ckts#1 and #2 Overloads – This overload requires line reconductoring and an upgrade substation terminal equipment to increase the emergency rating. The estimated cost is $8,000,000 for each ckt. or **$16,000,000** total. This upgrade will take **24-36 months** to complete. **(Note: This upgrade will also suffice for upgrade 4 below)**.

4. See number 3 above.

5. Ridley - Printz 230kV Overload - This overload requires the replacement of terminal equipment at Ridley and Prince to increase emergency rating. The estimated cost is **$4,000,000**. This upgrade will take **24-36 months** to complete.

6. Island Road - Eddystone 230kV Overload – This overload requires the replacement of terminal equipment at Island Road and Eddystone to increase emergency rating for an estimated cost of **$4,000,000**. This upgrade will take **24-36 months** to complete.
7. Northwest - Mt Carmel - Conastone 230 kV Overload – This overload requires the construction of a new "North Northwest" substation (2-500/230kV transformers, 4-500kV breakers, 7-230kV breakers, related substation equipment and land) at an estimated cost of **$70,000,000**. It also requires the reconductoring of the Conastone – Northwest (line #2322) from 1,272 kcmil ACSR to 1,590 kcmil ACSR at an additional estimated cost of **$8,210,000**. This work would take 36-48 months to complete**. (Note: This upgrade will suffice the overloads 8, 9 and 10 too)**.

8. See Upgrade number 7.

9. See Upgrade number 7.

10. See Upgrade number 7.

11. Graceton - Bagley - Raphael Overload – This overload requires the addition of 6-230kV breakers at Graceton with an estimated cost of **$10,000,000** and 6-230kV breakers at Raphael Road also at an estimated cost of **$10,000,000**. It also requires rebuilding the Graceton to Raphael Rd line to double circuit 2-conductor bundled with an estimated cost of **$30,000,000**. This work is estimated to take 24 to 36 months for the substation work and **60 to 72 months** for the line work.

12. TMI 500-230 kV Transformer Overload – Requires the addition of a second 500-230 kV transformer. Estimated cost is **$11,800,000** and the time required is approximately **20 months**.

Delivery of Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below may result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

As a result of the aggregate energy resources in the area, the following violations were identified:

1. The Milford – Cool Springs 230 kV line is overloaded to 158% of its emergency rating (679 MVA) for the outage of Indian River – Milford 230 kV line (Cont Id. CKT23069). The R36 contributes approximately 359 MW to this overload. This overload can requires to reconductor the existing line at an estimated cost of $9M. It would take 18 to 24 months assuming no major regulatory or environmental impacts.

2. The Milford – Indian River 230 kV line is overloaded from 56% to 105% of its emergency rating (679 MVA) for the outage of Cool Springs – Milford 230 kV line (Cont Id. CKT23034A). The R36 contributes approximately 332 MW to cause the thermal violation. This violation should be removed because the emergency rating of this line is actually 805 MVA.

3. The Chichester ckt2 – Linwood 230 kV line is overloaded at 117% of its emergency rating (904 MVA) for the outage of Chichester – Linwood ckt. 1 230

kV line (Cont. PE39). The R36 project contributes approximately 103 MW to this overload.

4. The Ridley – Printz 230 kV line is overloaded at 108% of its emergency rating (1432 MVA) for the outage of Eddyston - IslandR6 - IslandRD7-813.8 230 kV line (Cont. PE23). The R36 project contributes approximately 40 MW to this overload.

5. The Island Road - Eddystone 230 kV line is overloaded at 104% of its emergency rating (1411 MVA) for the outage of Ridley to Morton to Macdade 230 kV line (Cont. PE46). The R36 project contributes approximately 41 MW to this overload.

6. The Graceton – Bagley 230 kV line is overloaded at 137% of its emergency rating (659 MVA) for the outage of Five Forks to Graceton 115 kV line (Cont. 110510). The R36 project contributes approximately 29 MW to this overload.

7. The Raphael Rd. – Bagley 230 kV line is overloaded at 125% of its emergency rating (659 MVA) for the outage of Five Forks to Graceton 115 kV line (Cont. 110510). The R36 project contributes approximately 29 MW to this overload.

8. The Conastone – Peach Bottom 500 kV line is overloaded at 141% of its normal rating (2338 MVA) for with the R36 project contributes approximately 239 MW to this overload.

9. The Indian River – Nelson 138 kV line is overloaded from 56% to 100% of its emergency rating (193 MVA) for the outage of Milford – Steele 230 kV line (Cont Id. CKT23076). The R36 contributes approximately 72 MW to cause the thermal violation. This overload requires to increase the temperature rating of the existing conductor at an estimated cost of $2M. It would take 18 to 24 months assuming no major regulatory or environmental impacts.

10. The Indian River – Cool Springs 230 kV line is overloaded from 71% to 113% of its emergency rating (679 MVA) for the outage of Indian River – Milford 230 kV line (Cont Id. CKT23069). The R36 contributes approximately 280 MW to cause the thermal violation. This overload requires to increase the temperature rating of the existing conductor at an estimated cost of $4M. It would take 18 to 24 months assuming no major regulatory or environmental impacts.
11. The Bethany – 138th St 138 kV line is overloaded at 105% of its emergency rating (348 MVA) for the outage of Indian River – Bethany 138 kV line. The R36 contributes approximately 18 MW to cause the thermal violation. This overload requires to rebuild the line at an estimated cost of $4.3M. It would take 18 to 24 months assuming no major regulatory or environmental impacts.

12. The Bethany – Omar 138 kV line is overloaded at 111% of its emergency rating (336 MVA) for the outage of Bethany – 138th St 138 kV line. The R36 contributes

approximately 37 MW to cause the thermal violation. This overload requires to rebuild the line at an estimated cost of $4.7M. It would take 18 to 24 months assuming no major regulatory or environmental impacts.

13. The Indian River – Omar 138 kV line is overloaded at 106% of its emergency rating (336 MVA) for the outage of Bethany – 138th St 138 kV line. The R36 contributes approximately 20 MW to cause the thermal violation. This overload requires to rebuild the line at an estimated cost of $4.4M. It would take 18 to 24 months assuming no major regulatory or environmental impacts.

14. The N.Seaford - Taylor 69 kV line is overloaded at 116% of its emergency rating (64 MVA) for the outage of S.Harrington 138/69kV. The R36 contributes approximately 10 MW to cause the thermal violation. This overload requires to increase the temperature rating of the existing conductor at an estimated cost of $0.4M. It would take 12 to 18 months assuming no major regulatory or environmental impacts.

15. The Maridel – Ocean Bay 69 kV line is overloaded at 110% of its emergency rating (137 MVA) for the outage of Bishop to Worcester 138kV. The R36 contributes approximately 14 MW to cause the thermal violation. This overload requires to reconductor the existing line at an estimated cost of $2M. It would take 12 to 18 months assuming no major regulatory or environmental impacts.

16. The Worcester – Ocean Pines 69 kV line is overloaded at 111% of its normal rating (64 MVA). The R36 contributes approximately 7 MW to cause the thermal violation. This overload requires to rebuild the line at an estimated cost of $0.7M. It would take 12 to 18 months assuming no major regulatory or environmental impacts.

17. The Maridel – Ocean City 69 kV line is overloaded at 110% of its emergency rating (116 MVA) for the outage of Bishop to Worcester 138kV. The R36 contributes approximately 11 MW to cause the thermal violation. This overload requires to reconductor the existing line.

18. The Culver – Ocean City 69 kV line is overloaded at 110% of its emergency rating (93 MVA) for the outage of Bishop to Worcester 138kV. The R36 contributes approximately 9 MW to cause the thermal violation. This overload requires to reconductor the existing line.
19. The Todd – Vienna 69 kV line is overloaded at 103% of its emergency rating (111 MVA) for the outage of Vienna to West Cambridge 69kV. The R36 contributes approximately 3 MW to cause the thermal violation. This overload requires that terminal equipment be replaced.

20. The Taylor – Bridgeville 69 kV line is overloaded at 103% of its emergency rating (64 MVA) for the outage of S. Harrington 138/69kV. The R36 contributes

approximately 2 MW to cause the thermal violation. This overload requires to reconductor the existing line.

21. The Harrington – S.Harrington 69 kV line is overloaded at 111% of its emergency rating (91 MVA) for the outage of Kent to Cheswold 69kV. The R36 contributes approximately 10 MW to cause the thermal violation. This overload requires to reconductor the existing line.

22. The Harrington – Wells 69 kV line is overloaded at 112% of its emergency rating (59 MVA) for the outage of Kent to Cheswold 69kV. The R36 contributes approximately 7 MW to cause the thermal violation. This overload requires to reconductor the existing line.

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