

#V2-019A Dumont 345kV **Generation Interconnection**

This analysis was completed to assess the reliability impact for the new generation interconnecting to the PJM system as a capacity resource.

Local AEP Impacts

Unlike PJM, AEP performs AC analysis for interconnection projects in the feasibility stage. In analyzing the V2-019A Project with all Wind Interconnection Projects in the AEP's footprint modeled at 13-20% (based on the queue position) of their total capacity, AEP discovered 153 new overloads on the AEP bulk electric system (100 kV and above) triggered by the proposed injection. Furthermore, there were several contingencies that did not converge and the proposed project contributed to several existing overload conditions on the AEP system as well. A detailed report of the AC Contingency analysis for V2-019A was shared with PJM.

Following are AEP's study assumptions:

- Modeled the merchant transmission (HVDC) as a direct injection of 7900 MW at AEP's Dumont 765 kV bus.
- AEP used a more realistic dispatch scenario where the peaking units in and around the study area were scaled down to accommodate the additional injection. As a result of this approach the following changes were made to the generation dispatch in the base case:

- 2000 MW of the 7900 MW is being consumed by AEP's internal load. This was attained by turning off certain peaking units and some base load units.

- The remaining 5900 MW was dispatched in the following systems surrounding and to the east of AEP: AE, DP&L, FE, NIPSCO, METC, ITC, TVA, PENELEC, BGE, and PJM500. Since this project is bringing generation resources from the West, AEP didn't find a need for reducing generation off to the west of the interconnection. Also, such an approach would fail to assess the worse impact on AEP's system.

- By reducing the output of the existing generation to accommodate the injection, the deliverability of these units may be impacted. AEP understands that PJM will perform a detailed analysis to ensure that the existing units are still deliverable.

- Four different scenarios were analyzed:

- Base case with all wind projects before V2-019A modeled at 13%

- All wind projects modeled before V2-019A modeled at 13% while the merchant transmission injection modeled at 7900 MW

- Base case with all wind projects before V2-019A modeled at 100%

- All wind projects before V2-019A modeled at 100% while the merchant transmission injection modeled at 7900 MW

Disclaimer:

It is not feasible to verify and address every identified overload in the short timeframe allowed for completion of the feasibility study. Also, since PJM does not perform an extensive contingency analysis during the feasibility stage of a project a collaborative verification of the results will not be possible at this time. A great number of overloads in the study resulted from C3 contingencies. Usually such overloads can be addressed by system readjustments after the first contingency. AEP does not have the ability to apply manual readjustments to every single contingency in the 3 months allowed for the feasibility study. In consultation with PJM, AEP is providing a high-level cost estimate for possible improvements that will address the impact of this Interconnection request on the AEP system. Please note that the project may still contribute to violations on the neighboring systems or other transmission facilities in PJM, Midwest ISO and TVA. AEP did not monitor those facilities in the feasibility study performed. Instantaneous Loss of 7,900 MW as a result of a tower outage of the bi-pole HVDC line may result in cascading outages on the eastern interconnect. The proposed network upgrades do not address this outage.

Network Upgrades:

To address the 153 overloads and non-convergent contingencies, AEP proposes a 765 kV overlay shown in Figure #2. A very high level feasibility cost of the overlay plan is shown below:

- 2250 MVA 765/345 kV Transformers Upgrade at Dumont Station = **\$70,000,000 (2010 Dollars)**
- Sullivan 765 kV Station Improvements = **\$40,000,000 (2010 Dollars)**
- Sullivan – Meadow Lake 765 kV Line = **\$375,000,000 (2010 Dollars)**
- Meadow Lake 765 kV Station = **\$85,000,000 (2010 Dollars)**
- Meadow Lake – Greentown 765 kV Line = **\$270,000,000 (2010 Dollars)**
- Greentown 765 kV Station Improvements = **\$25,000,000 (2010 Dollars)**
- Meadow Lake – Dumont 765 kV Line = **\$275,000,000 (2010 Dollars)**
- Dumont 765 kV Station Improvements = **\$35,000,000 (2010 Dollars)**
- DC Cook 765 kV Station Improvements = **\$40,000,000 (2010 Dollars)**

- DC Cook – Fostoria 765 kV Line = **\$500,000,000 (2010 Dollars)**
- Fostoria 765 kV Station = **\$70,000,000 (2010 Dollars)**
- Fostoria – South Canton 765 kV Line = **\$450,000,000 (2010 Dollars)**
- South Canton 765 kV Station Improvements = **\$45,000,000 (2010 Dollars)**

Additional 765 kV lines may be required from the AEP South Canton 765 kV Station and AEP Kammer 765 kV Station to the eastern neighbors. AEP is unable to provide cost estimates for these additional improvements as they would require a coordinated planning and engineering study with neighboring Transmission Owners and PJM to identify optimal points of interconnection.

- **Total Cost of Attachment facilities and Network upgrades = \$2,280,000,000 (2010 Dollars) excluding 765 kV lines to the East of AEP**

The above improvements may result in additional limitations on the system and analysis to identify those limitations will be performed as part of the detailed Impact Study effort. Also, some fixes on lower voltage systems may be required which were not identified in the feasibility analysis. The above improvements may also increase short circuit values at the various interconnections and may require replacement of breakers at those facilities. These estimates are preliminary in nature, as they were determined without the benefit of detailed engineering studies. Final estimates will require an on-site review and coordination with PJM and neighboring Transmission Owners to determine final construction requirements. It may take approximately 5 years after obtaining all authorizations and permits to construct the facilities as outlined above. The time required to obtain authorizations and permits prior to start of construction is difficult to predict, but experience suggests that at least two to three years could be required.

Network Impacts

The queue V2-019A project is a merchant transmission request involving the construction of 2 new HVDC lines which originate in the South Dakota Western Iowa area and terminate at AEP's Dumont 765kV substation. For operational reasons the line transfer amounts will be limited to 7900MW. The project was therefore studied as a 7900MW injection into the Dumont 765kV substation. V2-019A was evaluated for compliance with reliability criteria for summer peak conditions in 2013. Potential network impacts were as follows:

PJM utilizes a DC analysis to determine thermal overloads in the Feasibility Study stage of a project.

Generator Deliverability

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

1. (ComEd) The Collins 765/345kV 3-winding transformer (from bus 36255 to bus 36021 ckt 1) loads from 98.53% (DC power flow) to 102.98% of its emergency rating (1380MVA) for the single line contingency outage (765-L2315___-S) as a result of V2-019A's **firm injection**. This project contributes approximately 61.4MW to cause this thermal violation.
2. (AEP) The Dumont 765/345kV transformer #2 (from bus 22660 to bus 22659 ckt 2) loads from 56.42% (DC power flow) to 131.30% of its emergency rating (1752MVA) for the single line contingency outage (05DUMONT 765 - 05DUMONT 345 - 1) as a result of V2-019A's **firm injection**. This project contributes approximately 1311.8MW to cause this thermal violation.
3. (AEP-NIPSCO) The Dumont-Stillwell 345kV line (from bus 22659 to bus 255113 ckt 1) loads from 71.26% (DC power flow) to 112.19% of its emergency rating (1598MVA) for the single line contingency outage (05DUMONT 765 - WILTO; 765 - 1) as a result of V2-019A's **firm injection**. This project contributes approximately 654MW to cause this thermal violation.
4. (AEP) The Dumont 765/345kV transformer #1 (from bus 22660 to bus 22659 ckt 1) loads from 53.87% (DC power flow) to 110.98% of its emergency rating (2070MVA) for the single line contingency outage (05DUMONT 765 - WILTO; 765 - 1) as a result of V2-019A's **firm injection**. This project contributes approximately 1182MW to cause this thermal violation.

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

(Summary form of Cost allocation for breakers will be inserted here if any)

Not determined.

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)

Not determined

New System Reinforcements

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

See Network Upgrades above.

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)

(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

Not determined

Potential Congestion due to Local Energy Deliverability

(PJM also studied the delivery of the energy portion of the surrounding generation. Any potential problems identified below are likely to 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 Transmission Interconnection Request. Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full deliverability for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which analyzes all overload conditions associated with the identified overloaded element(s). As a result of the aggregate energy resources in the area, the following violations were identified:

5. (ComEd) The Collins 765/345kV 3-winding transformer (from bus 36255 to bus 36021 ckt 1) loads from 213.05% (DC power flow) to 217.50% of its emergency rating (1380MVA) for the operational contingency outage (765-L2315___-S) as a result of V2-019A's **non-firm injection**. This project contributes approximately 61.4MW to cause this thermal violation.

6. (AEP-FE) The Howard-Brookside 138kV line (from bus 23158 to bus 238586 ckt 1) loads from 128.43% (DC power flow) to 133.22% of its normal rating (133MVA) for non-contingency, operational conditions as a result of V2-019A's **non-firm injection**. This project contributes approximately 6.4MW to cause this thermal violation.

7. (AEP-FE) The Howard-Brookside 138kV line (from bus 23158 to bus 238586 ckt 1) loads from 114.43% (DC power flow) to 119.64% of its emergency rating (173MVA) for the operational contingency outage (02BEAVER 345 - 02DAV-BE 345 - 1) as a result of V2-019A's **non-firm injection**. This project contributes approximately 9.0MW to cause this thermal violation.

8. (AEP) The R60_Tap-East Lima 345kV line segment (from bus 96566 to bus 22603 ckt 1) loads from 141.07% (DC power flow) to 148.90% of its emergency rating (1022MVA) for the operational contingency outage (05DUMONT 765 - 05MARYSV 765 - 1) as a result of V2-

019A's **non-firm injection**. This project contributes approximately 80MW to cause this thermal violation.

9. (AEP) The Dumont 765/345kV transformer #2 (from bus 22660 to bus 22659 ckt 2) loads from 56.13% (DC power flow) to 131.00% of its emergency rating (1752MVA) for the operational contingency outage (05DUMONT 765 - 05DUMONT 345 - 1) as a result of V2-019A's **non-firm injection**. This project contributes approximately 1311.8MW to cause this thermal violation.

10. (AEP) The Dumont 765/345kV transformer #1 (from bus 22660 to bus 22659 ckt 1) loads from 49.65% (DC power flow) to 106.76% of its emergency rating (2070MVA) for the operational contingency outage (05DUMONT 765 - WILTO; 765 - 1) as a result of V2-019A's **non-firm injection**. This project contributes approximately 1182.1MW to cause this thermal violation.

11. (AEP) The North Nelphos-East Side (from bus 23181 to bus 23134 ckt 1) loads from 97.45% (DC power flow) to 103.79% of its normal rating (108MVA) for non-contingency, operational conditions as a result of V2-019A's **non-firm injection**. This project contributes approximately 6.9MW to cause this thermal violation.