Generator Interconnection
System Impact Study Report

For

PJM Generation Interconnection Request
Queue Position #AB1-006

Meadow Lake 345 kV

November 2016

General

EDP Renewables North America LLC (EDPR) proposes to install a 200 MW (26 MW Capacity) wind generating facility on the American Electric Power (AEP) Transmission System. The proposed PJM Project #AB1-006 will connect to the existing Meadow Lake 345 kV switching station which was initially constructed for PJM Project #S06, and then expanded for PJM Projects #T-126 and #T-127 (see Figure 1). The proposed location of the generating facilities is located in White County, Indiana (see Figure 2).

The requested in-service date is December 15, 2017.

The objective of this System Impact Study is to determine budgetary cost estimates and approximate construction timelines for identified transmission facilities required to connect the proposed generating facilities to the AEP Transmission System. These reinforcements include the Attachment Facilities, Local Upgrades, and Network Upgrades required to maintain the reliability of the AEP Transmission System. Stability analysis is included as part of this study.

Attachment Facilities

To accommodate the interconnection, EDPR proposes to connect project AB1-006 at the same point of interconnection as T127 and S06 at the Meadow Lake 345 kV switching station by installing one (1) new 345 kV circuit breaker facing the Meadow Lake 345 kV switching station at the common connection point of the three projects (see Figure 1).

Station Cost:

- No AEP work is required if a circuit breaker facing Meadow Lake is installed at the customers collector station.

Protection and Relay Cost:

- The following protection options are available to EDPR for the addition of the 345 kV circuit breaker on the gen lead facing the Meadow Lake 345 kV switching station (between Meadow Lake and the common connection point for S06, T127, and AB1-006):
- **Option 1**
  - EDPR will move the existing relay package facing Meadow Lake and re-use it for the new 345 kV circuit breaker by developing a new protection scheme. This option will only require settings changes at AEP's Meadow Lake 345 kV switching station
  - **Estimated Cost for settings changes at Meadow Lake 345 kV switching station: $25,000**

- **Option 2**
  - EDPR will install new relay package for the new 345 kV circuit breaker on the gen lead facing the Meadow Lake 345 kV switching station at their facility.
  - AEP will install new relay package for the new 345 kV circuit breaker on the gen lead facing the Meadow Lake 345 kV switching station at the Meadow Lake 345 kV switching station.
  - **Estimated Cost for installation of new relay package at the Meadow Lake 345 kV switching station: $450,000**

Local and Network Impacts

The impact of the proposed generating facility on the AEP System was assessed for adherence with applicable reliability criteria. AEP planning criteria require that the transmission system meet performance parameters prescribed in the AEP FERC Form 715[1] and Connection Requirements for AEP Transmission System[2]. Therefore, these criteria were used to assess the impact of the proposed facility on the AEP System. The Queue Project AB1-006 was evaluated as a 200.0 MW (Capacity 26.0 MW) injection into the Meadowlake 345 kV substation in the AEP area. Project AB1-006 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AB1-006 was studied with a commercial probability of 100%.

Summer Peak Analysis - 2019

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

None

Multiple Facility Contingency
(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)

1. (AEP - AEP) The X2-052 TAP-05DUMONT 345 kV line (from bus 909144 to bus 243219 ckt 2) loads from 92.5% to 94.06% (AC power flow) of its emergency rating (1409 MVA) for the line fault with failed breaker contingency outage of '2978_C2_05DUMONT 765-B'. This project contributes approximately 21.9 MW to the thermal violation.

CONTINGENCY '2978_C2_05DUMONT 765-B'

[1] http://aep.com/about/codeofconduct/OASIS/TransmissionStudies/GuideLines/AEP_East_FERC_715_2016_Final_Part_4.pdf

[2] https://www.aep.com/about/codeofconduct/OASIS/TransmissionStudies/Requirements/AEP_Interconnection_Requirements_rev1.pdf

OPEN BRANCH FROM BUS 243206 TO BUS 907040 CKT 1 / 243206 05DUMONT 765 907040 X1-020 TAP 765 1
OPEN BRANCH FROM BUS 243206 TO BUS 270644 CKT 1 / 243206 05DUMONT 765 270644 WILTON ; 765 1
END

Please refer to Appendix 1 for a table containing the generators having contribution to this flowgate.

- The AB1 Queue overloads the X2-052 TAP – Dumont 345 kV line.

2. (AEP - AEP) The X2-052 TAP-05DUMONT 345 kV line (from bus 909144 to bus 243219 ckt 2) loads from 84.4% to 85.46% (AC power flow) of its emergency rating (1409 MVA) for the line fault with failed breaker contingency outage of '112-65-BT4-5__'. This project contributes approximately 17.37 MW to the thermal violation.

CONTINGENCY '112-65-BT4-5__'
TRIP BRANCH FROM BUS 270644 TO BUS 243206 CKT 1 / WILTO; 765 05DUMONT 765
TRIP BRANCH FROM BUS 275233 TO BUS 270644 CKT 1 / WILTO;4M 345 WILTO; 765
TRIP BRANCH FROM BUS 275233 TO BUS 270927 CKT 1 / WILTO;4M 345 WILTO; R 345
TRIP BRANCH FROM BUS 275233 TO BUS 275333 CKT 1 / WILTO;4M 345 WILTO;4C 33
END

- The AB1 Queue overloads the X2-052 TAP – Dumont 345 kV line.

3. (AEP - AEP) The X2-052 TAP-05DUMONT 345 kV line (from bus 909144 to bus 243219 ckt 2) loads from 84.39% to 85.45% (AC power flow) of its emergency rating (1409 MVA) for the line fault with failed breaker contingency outage of '112-65-BT3-4__'. This project contributes approximately 17.37 MW to the thermal violation.

CONTINGENCY '112-65-BT3-4__'
TRIP BRANCH FROM BUS 270644 TO BUS 243206 CKT 1 / WILTO; 765 05DUMONT 765
TRIP BRANCH FROM BUS 275232 TO BUS 270644 CKT 1 / WILTO;3M 345 WILTO; 765
TRIP BRANCH FROM BUS 275232 TO BUS 270926 CKT 1 / WILTO;3M 345 WILTO; B 345
TRIP BRANCH FROM BUS 275232 TO BUS 275332 CKT 1 / WILTO;3M 345 WILTO;3C 33
END

- The AB1 Queue overloads the X2-052 TAP – Dumont 345 kV line.

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)

1. (AEP - MISO NIPS) The 05MEADOW-17REYNOLDS 345 kV line (from bus 243878 to bus 255205 ckt 1) loads from 139.01% to 145.17% (DC power flow) of its emergency rating (1918 MVA) for the line fault with failed breaker contingency outage of '8648_C2_05JEFRSO 765-B'. This project contributes approximately 118.12 MW to the thermal violation.

CONTINGENCY '8648_C2_05JEFRSO 765-B'
OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1
OPEN BRANCH FROM BUS 243208 TO BUS 242865 CKT 1 / 243208 05JEFRSO 765 242865 05JEFRSO 345 1
OPEN BRANCH FROM BUS 242865 TO BUS 248000 CKT Z1 / 242865 05JEFRSO 345 248000 06CLIFTY 345 Z1
END

Please refer to Appendix 2 for a table containing the generators having contribution to this flowgate.

- The 2019 AB1 case does not have PJM Supplemental upgrade S1141 (loop the Meadowlake – Olive 345 kV circuit into Reynolds) or PJM Baseline upgrade B2449 (rebuild the Meadowlake – Reynolds 345 kV lines) modeled. The Meadowlake – Reynolds 345 kV line overloads are resolved with S1141 and B2449. AB1-006 will need S1141 and B2449 in-service in order to be fully deliverable to the PJM system. S1141 and B2449 are both presently due in-service in 2017. AB1-006 does not have any cost responsibility for these upgrades.

2. (AEP - MISO NIPS) The 05MEADOW-17REYNOLDS 345 kV line (from bus 243878 to bus 255205 ckt 1) loads from 118.46% to 119.56% (DC power flow) of its normal rating (1409 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 15.45 MW to the thermal violation.

CONTINGENCY '363_B2_TOR1682'
OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1
END

- The 2019 AB1 case does not have PJM Supplemental upgrade S1141 (loop the Meadowlake – Olive 345 kV circuit into Reynolds) or PJM Baseline upgrade B2449 (rebuild the Meadowlake – Reynolds 345 kV lines) modeled. The Meadowlake – Reynolds 345 kV line overloads are resolved with S1141 and B2449. AB1-006 will need S1141 and B2449 in-service in order to be fully deliverable to the PJM system. S1141 and B2449 are both presently due in-service in 2017. AB1-006 does not have any cost responsibility for these upgrades.

3. (AEP - MISO NIPS) The 05MEADOW-17REYNOLDS 345 kV line (from bus 243878 to bus 255205 ckt 1) loads from 100.43% to 101.48% (AC power flow) of its normal rating (1409 MVA) for the single line contingency outage of '362_B2_TOR1680'. This project contributes approximately 14.44 MW to the thermal violation.

CONTINGENCY '362_B2_TOR1680'
OPEN BRANCH FROM BUS 243207 TO BUS 243208 CKT 1 / 243207 05GRNTWN 765 243208 05JEFRSO 765 1
END

- The 2019 AB1 case does not have PJM Supplemental upgrade S1141 (loop the Meadowlake – Olive 345 kV circuit into Reynolds) or PJM Baseline upgrade B2449 (rebuild the Meadowlake – Reynolds 345 kV lines) modeled. The Meadowlake – Reynolds 345 kV line overloads are resolved with S1141 and B2449. AB1-006 will need S1141 and B2449 in-service in order to be fully deliverable to the PJM system. S1141 and B2449 are both presently due in-service in 2017. AB1-006 does not have any cost responsibility for these upgrades.

Delivery of Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of this interconnection request. Any 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 Merchant Transmission Interconnection request.
Only the most severely overloaded conditions are listed. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed, which will study all overload conditions associated with the overloaded element(s) identified.

1. (AEP - OVEC) The 05JEFRSO-06CLIFTY 345 kV line (from bus 242865 to bus 248000 ckt Z1) loads from 95.17% to 96.09% (AC power flow) of its normal rating (2354 MVA) for the single line contingency outage of '709_B2_TOR546'. This project contributes approximately 27.43 MW to the thermal violation.

CONTINGENCY '709_B2_TOR546'
OPEN BRANCH FROM BUS 242924 TO BUS 243208 CKT 1 / 242924 05HANG R 765 243208 05JEFRSO 765 1
END

2. (AEP - MISO DEM) The 05EUGENE-08CAYSUB 345 kV line (from bus 243221 to bus 249504 ckt 1) loads from 86.29% to 87.29% (**DC power flow**) of its normal rating (1374 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 16.04 MW to the thermal violation.

CONTINGENCY '363_B2_TOR1682'
OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1
END

3. (AEP - AEP) The 05MEADOW-05OLIVE 345 kV line (from bus 243878 to bus 243229 ckt 1) loads from 120.73% to 127.42% (AC power flow) of its normal rating (971 MVA) for the single line contingency outage of '8695_B2'. This project contributes approximately 65.23 MW to the thermal violation.

CONTINGENCY '8695_B2'
OPEN BRANCH FROM BUS 243878 TO BUS 255205 CKT 1 / 243878 05MEADOW 345 255205 17REYNOLDS 345 1
END

4. (AEP - MISO NIPS) The 05MEADOW-17REYNOLDS 345 kV line (from bus 243878 to bus 255205 ckt 1) loads from 182.87% to 191.3% (**DC power flow**) of its normal rating (1409 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 118.88 MW to the thermal violation.

CONTINGENCY '363_B2_TOR1682'
OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1
END

- The 2019 AB1 case does not have PJM Supplemental upgrade S1141 (loop the Meadowlake – Olive 345 kV circuit into Reynolds) or PJM Baseline upgrade B2449 (rebuild the Meadowlake – Reynolds 345 kV lines) modeled. The Meadowlake – Reynolds 345 kV line overloads are resolved with S1141 and B2449. AB1-006 will need S1141 and B2449 in-service in order to be fully deliverable to the PJM system. S1141 and B2449 are both presently due in-service in 2017. AB1-006 does not have any cost responsibility for these upgrades.

5. (AEP - AEP) The X2-052 TAP-05DUMONT 345 kV line (from bus 909144 to bus 243219 ckt 2) loads from 84.27% to 85.33% (AC power flow) of its normal rating (1409 MVA) for the single line contingency outage of '695_B2'. This project contributes approximately 17.37 MW to the thermal violation.

CONTINGENCY '695_B2'
OPEN BRANCH FROM BUS 243206 TO BUS 270644 CKT 1 / 243206 05DUMONT 765 270644 WILTO; 765 1
END

Light Load Analysis - 2019

1. (AEP - MISO NIPS) The 05MEADOW-17REYNOLDS 345 kV line (from bus 243878 to bus 255205 ckt 1) loads from 112.55% to 118.93% (AC power flow) of its normal rating (1409 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 94.95 MW to the thermal violation.

CONTINGENCY '363_B2_TOR1682'
OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1
END

- The 2019 AB1 case does not have PJM Supplemental upgrade S1141 (loop the Meadowlake – Olive 345 kV circuit into Reynolds) or PJM Baseline upgrade B2449 (rebuild the Meadowlake – Reynolds 345 kV lines) modeled. The Meadowlake – Reynolds 345 kV line overloads are resolved with S1141 and B2449. AB1-006 will need S1141 and B2449 in-service in order to be fully deliverable to the PJM system. S1141 and B2449 are both presently due in-service in 2017. AB1-006 does not have any cost responsibility for these upgrades.

2. (AEP - MISO NIPS) The 05MEADOW-17REYNOLDS 345 kV line (from bus 243878 to bus 255205 ckt 1) loads from 100.37% to 107.37% (AC power flow) of its normal rating (1409 MVA) for the single line contingency outage of '8808_B2'. This project contributes approximately 108.61 MW to the thermal violation.

CONTINGENCY '8808_B2'
OPEN BRANCH FROM BUS 243229 TO BUS 243878 CKT 1 / 243229 05OLIVE 345 243878 05MEADOW 345 1
END

- The 2019 AB1 case does not have PJM Supplemental upgrade S1141 (loop the Meadowlake – Olive 345 kV circuit into Reynolds) or PJM Baseline upgrade B2449 (rebuild the Meadowlake – Reynolds 345 kV lines) modeled. The Meadowlake – Reynolds 345 kV line overloads are resolved with S1141 and B2449. AB1-006 will need S1141 and B2449 in-service in order to be fully deliverable to the PJM system. S1141 and B2449 are both presently due in-service in 2017. AB1-006 does not have any cost responsibility for these upgrades.

Short Circuit
(Summary of impacted circuit breakers)

No problems identified

Affected System Analysis & Mitigation

LGEE Impacts:

None

MISO Impacts:

MISO Impacts to be determined during the Facilities Study phase.

Duke, Progress & TVA Impacts:

None

OVEC Impacts:

None

Stability Analysis

To be performed as part of the Facilities Study

Voltage Variations

No problems identified

Additional Limitations of Concern

None

Summer Peak Load Flow Analysis Reinforcements

New System Reinforcements

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

None

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)

1. To resolve the X2-052 Tap – Dumont 345 kV line overloads: The upgrade is to perform a sag study which shows remediation work will include the replacement of tower 20 with a custom steel pole and the removal of swing angle brackets on 2 structures (PJM Network Upgrade N4512). Cost estimate is $1.0775M. New SE rating to be 1868 MVA. This overload is caused by the AB1 Queue and the AB1 queue will share the cost as follows:

Queue	MW contribution	Percentage of Cost	$ cost ($1.0775 M)
AB1-006	21.9	5.44%	0.059*($63,600)
AB1-080	22.5	5.59%	0.060
AB1-089	41.0	10.18%	0.110
AB1-090	41.0	10.18%	0.110
AB1-091	43.6	10.83%	0.117
AB1-121	142.5	35.39%	0.381
AB1-122	90.2	22.40%	0.241

2. To resolve the Meadowlake – Reynolds 345 kV line overloads: The 2019 AB1 case does not have PJM Supplemental upgrade S1141 (loop the Meadowlake – Olive 345 kV circuit into Reynolds) or PJM Baseline upgrade B2449 (rebuild the Meadowlake – Reynolds 345 kV lines) modeled. The Meadowlake – Reynolds 345 kV line overloads are resolved with S1141 and B2449. S1141 and B2449 are both presently due in-service in 2017. In summer 2018, with the MISO Reynolds MVP project in-service, the MISO-end ratings become 3585/3585 MVA SN/SE. AB1-006 will need the S1141, B2449, and MISO Reynolds MVP project in-service in order to be fully deliverable to the PJM system. AB1-006 does not have any cost responsibility for these upgrades.

Schedule

It is anticipated that the time between receipt of executed agreements and Commercial Operation may range from 12 to 18 months if no line work is required. If line work is required, construction time would be between 24 to 36 months after signing an interconnection agreement.

Conclusion

Based upon the results of this System Impact Study, the construction of the 200 MW (26 MW Capacity) wind generating facility of EDPR (PJM Project #AB1-006) will require the following additional interconnection charges. This plan of service will interconnect the proposed wind generating facility in a manner that will provide operational reliability and flexibility to both the AEP system and the EDPR generating facility.

Estimated Network Upgrade Cost: $1,077,500 (Unallocated)
Estimated Network Upgrade Cost: $63,600 (Allocated)

Estimated Protection and Relay Cost: $475,000

Total Estimated Cost for Project AB1-006 unallocated: $1,552,500
Total Estimated Cost for Project AB1-006 with allocation: $538,600

The estimates are preliminary in nature, as they were determined without the benefit of detailed engineering studies. The cost of remediation for the sag study and line reconductoring is not included in this estimate. Final estimates will require an on-site review and coordination to determine final construction requirements.

Additional Interconnection Customer Responsibilities

1. An Interconnection Customer entering the New Services Queue on or after October 1, 2012 with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

2. The Interconnection Customer may be required to install and/or pay for metering as necessary to properly track real time output of the facility as well as installing metering which shall be used for billing purposes. See Section 8 of Appendix 2 to the Interconnection Service Agreement as well as Section 4 of PJM Manual 14D for additional information.

3. The Interconnection Customer seeking to interconnect a wind generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per item 5.iv. of Schedule H to the Interconnection Service Agreement.

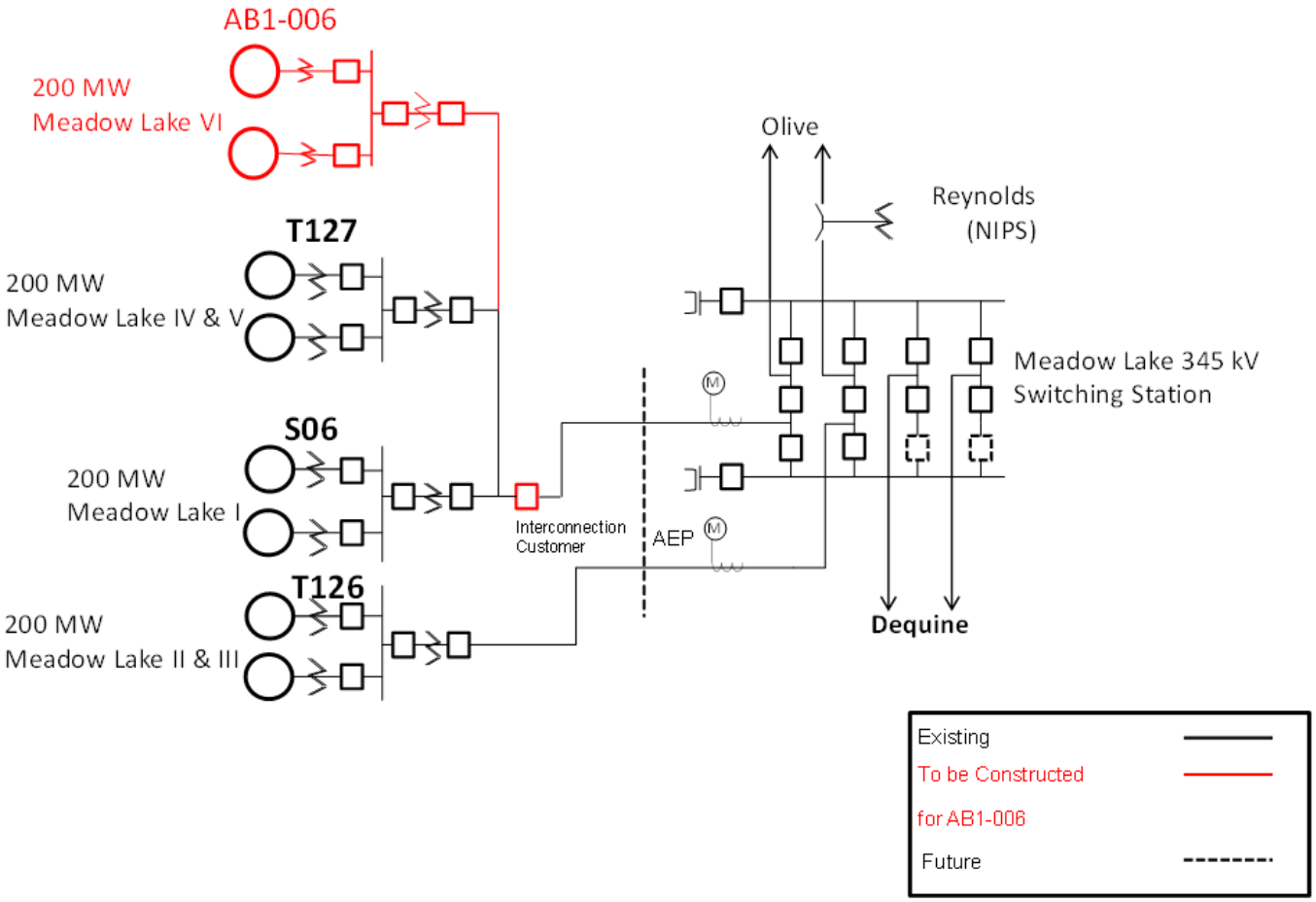

Figure 1: Point of Interconnection (Meadow Lake 345 kV Switching Station) Single-Line Diagram

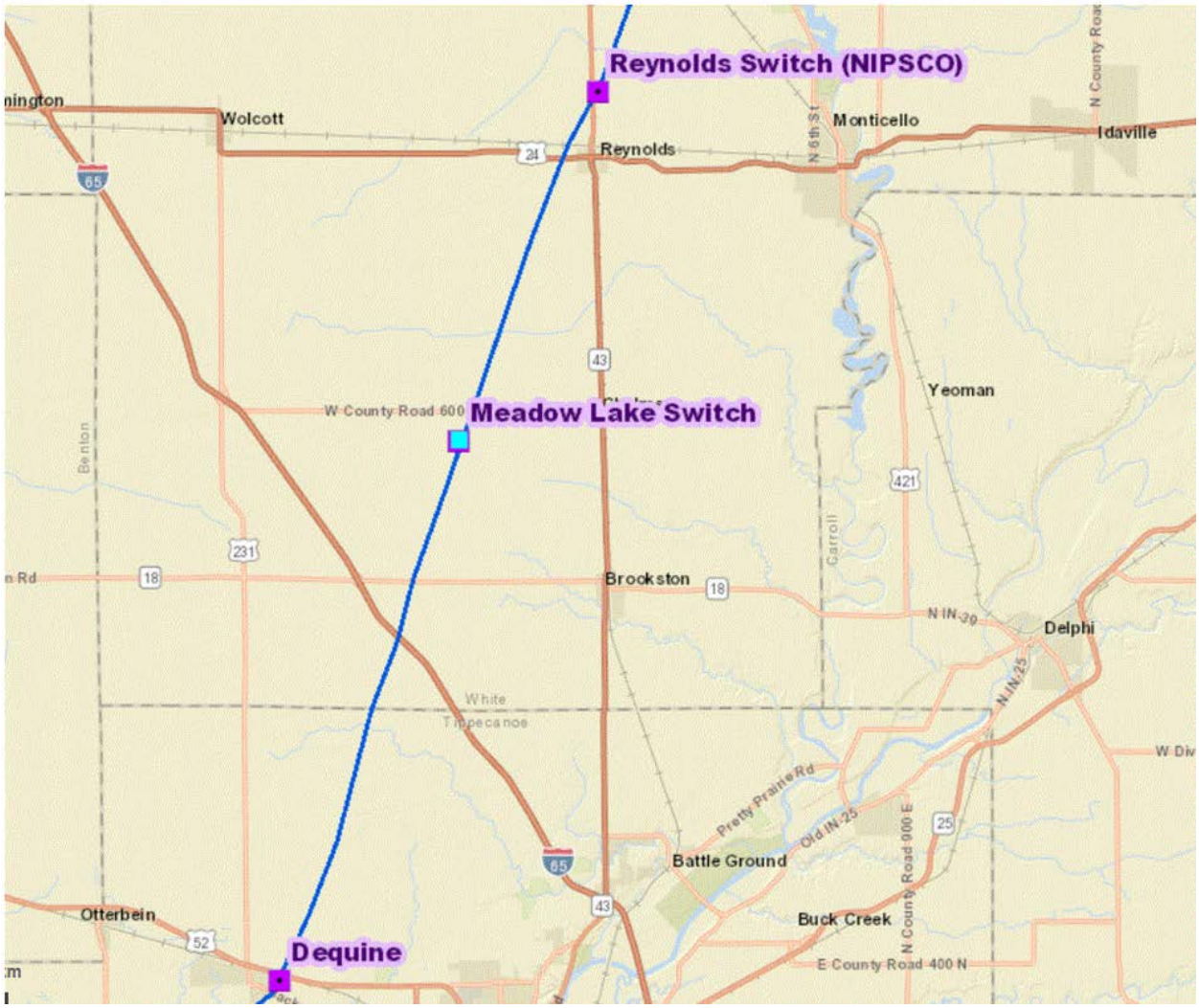

Figure 2: Point of Interconnection (Meadow Lake 345 kV Switching Station)

Appendices

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact.

It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

Appendix 1

(AEP - AEP) The X2-052 TAP-05DUMONT 345 kV line (from bus 909144 to bus 243219 ckt 2) loads from 92.5% to 94.06% (AC power flow) of its emergency rating (1409 MVA) for the line fault with failed breaker contingency outage of '2978_C2_05DUMONT 765-B'. This project contributes approximately 21.9 MW to the thermal violation.

CONTINGENCY '2978_C2_05DUMONT 765-B'
OPEN BRANCH FROM BUS 243206 TO BUS 907040 CKT 1 / 243206 05DUMONT 765 907040 X1-020 TAP 765 1
OPEN BRANCH FROM BUS 243206 TO BUS 270644 CKT 1 / 243206 05DUMONT 765 270644 WILTON ; 765 1
END

Bus Number	*Bus Name*	*Full Contribution*
247900	*05FR-11G E*	*7.53*
247901	*05FR-12G E*	*7.41*
247902	*05FR-21G E*	*7.92*
247903	*05FR-22G E*	*7.58*
247904	*05FR-3G E*	*15.35*
247905	*05FR-4G E*	*11.54*
246909	*05MDL-1G C*	*0.5*
247906	*05MDL-1G E*	*17.48*
246910	*05MDL-2G C*	*0.25*
247907	*05MDL-2G E*	*8.67*
246976	*05MDL-3G C*	*0.25*
247912	*05MDL-3G E*	*9.06*
246979	*05MDL-4G C*	*0.5*
247913	*05MDL-4G E*	*8.65*
274859	*EASYR;U1 E*	*6.96*
274860	*EASYR;U2 E*	*6.96*
290051	*GSG-6; E*	*6.53*
275149	*KEMPTON ;1E*	*11.17*
274881	*KEMPTON ;1U*	*2.79*
290108	*LEEDK;1U E*	*15.08*
274850	*MENDOTA H;RU*	*3.76*
275148	*MILKS GRV;1E*	*11.17*
274880	*MILKS GRV;1U*	*2.79*
293061	*N-015 E*	*9.61*
293644	*O-022 E1*	*6.28*
293645	*O-022 E2*	*12.18*
290021	*O-050 E*	*12.15*
294392	*P-010 E*	*12.21*
294763	*P-046 E*	*5.88*

274830	*PWR VTREC;1U*	*3.78*
274831	*PWR VTREC;2U*	*3.78*
274722	*S-055 E*	*6.91*
884780	*S-058 C*	*27.03*
884782	*S-058 C1*	*27.03*
884781	*S-058 E*	*89.14*
884783	*S-058 E1*	*89.14*
295111	*SUBLETTE E*	*1.7*
890570	*U3-026 C1*	*19.*
890571	*U3-026 C2*	*19.*
291984	*U4-033*	*0.49*
274814	*UNIV PK N;0U*	*0.57*
274805	*UNIV PK N;1U*	*0.57*
274806	*UNIV PK N;2U*	*0.57*
274807	*UNIV PK N;3U*	*0.57*
274808	*UNIV PK N;4U*	*0.57*
274809	*UNIV PK N;5U*	*0.57*
274810	*UNIV PK N;6U*	*0.57*
274811	*UNIV PK N;7U*	*0.57*
274812	*UNIV PK N;8U*	*0.57*
274813	*UNIV PK N;9U*	*0.57*
274815	*UNIV PK N;XU*	*0.57*
274816	*UNIV PK N;YU*	*0.57*
900371	*V4-046*	*1.48*
900381	*V4-047*	*1.48*
900391	*V4-048*	*1.68*
900401	*V4-049*	*1.68*
903432	*W3-046*	*3.99*
903434	*W3-046*	*3.69*
903435	*W3-046*	*3.99*
903436	*W3-046*	*3.69*
274873	*WALNR;1U*	*1.52*
294500	*WALNR;1U E*	*6.07*
274874	*WALNR;2U*	*1.52*
294502	*WALNR;2U E*	*6.07*
295109	*WESTBROOK E*	*3.5*
909145	*X2-052*	*43.56*
914321	*Y2-103*	*27.63*
915011	*Y3-013 1*	*2.3*
915021	*Y3-013 2*	*2.3*
915031	*Y3-013 3*	*2.3*
LTF	*Z1-043*	*18.73*
916502	*Z1-106 E1*	*0.77*
916504	*Z1-106 E2*	*0.77*

916512	*Z1-107 E*	*1.6*
916522	*Z1-108 E*	*1.53*
LTF	*Z1-112*	*6.56*
916651	*Z1-127 1*	*1.02*
916652	*Z1-127 2*	*0.6*
917451	*Z2-081*	*1.02*
917531	*Z2-090 C*	*0.03*
917532	*Z2-090 E*	*0.34*
917711	*Z2-114 C*	*0.4*
917712	*Z2-114 E*	*0.4*
918051	*AA1-018 C OP*	*1.55*
918052	*AA1-018 E OP*	*10.4*
918251	*AA1-040 1*	*0.78*
918261	*AA1-040 2*	*0.79*
LTF	*AA1-071*	*4.37*
918611	*AA1-078*	*2.36*
918972	*AA1-116 E*	*1.6*
918982	*AA1-117 E*	*1.6*
919591	*AA2-035 C OP*	*79.96*
919811	*AA2-067 OP*	*0.75*
920112	*AA2-107 E*	*1.52*
920272	*AA2-123 E*	*1.51*
930041	*AB1-006 C*	*2.85*
930042	*AB1-006 E*	*19.05*
930391	*AB1-080*	*22.51*
930442	*AB1-085 E*	*1.55*
930481	*AB1-089 C*	*40.96*
930491	*AB1-090 C*	*40.96*
930501	*AB1-091 C OP*	*43.6*
933011	*AB1-121*	*73.13*
933012	*AB1-121*	*69.36*
930761	*AB1-122 CT1*	*45.07*
930762	*AB1-122 CT2*	*45.09*
930972	*AB1-146 E*	*0.15*
931221	*AB1-172*	*0.5*

Appendix 2

(AEP - MISO NIPS) The 05MEADOW-17REYNOLDS 345 kV line (from bus 243878 to bus 255205 ckt 1) loads from 139.01% to 145.17% (DC power flow) of its emergency rating (1918 MVA) for the line fault with failed breaker contingency outage of '8648_C2_05JEFRSO 765-B'. This project contributes approximately 118.12 MW to the thermal violation.

CONTINGENCY '8648_C2_05JEFRSO 765-B'
OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1
OPEN BRANCH FROM BUS 243208 TO BUS 242865 CKT 1 / 243208 05JEFRSO 765 242865 05JEFRSO 345 1
OPEN BRANCH FROM BUS 242865 TO BUS 248000 CKT Z1 / 242865 05JEFRSO 345 248000 06CLIFTY 345 Z1
END

Bus Number	*Bus Name*	*Full Contribution*
243859	*05FR-11G C*	*1.1*
247900	*05FR-11G E*	*38.45*
243862	*05FR-12G C*	*1.09*
247901	*05FR-12G E*	*37.81*
243864	*05FR-21G C*	*1.16*
247902	*05FR-21G E*	*40.41*
243866	*05FR-22G C*	*1.11*
247903	*05FR-22G E*	*38.69*
243870	*05FR-3G C*	*2.25*
247904	*05FR-3G E*	*78.37*
243873	*05FR-4G C*	*1.74*
247905	*05FR-4G E*	*58.92*
246909	*05MDL-1G C*	*2.71*
247906	*05MDL-1G E*	*94.32*
246910	*05MDL-2G C*	*1.35*
247907	*05MDL-2G E*	*46.77*
246976	*05MDL-3G C*	*1.35*
247912	*05MDL-3G E*	*48.9*
246979	*05MDL-4G C*	*2.71*
247913	*05MDL-4G E*	*46.66*
243442	*05RKG1*	*25.15*
243443	*05RKG2*	*24.77*
927331	*J196 C*	*0.92*
927332	*J196 E*	*3.68*
997772	*J453 E*	*1.01*
998111	*J468*	*18.07*
998120	*J515*	*55.49*

900404	*X3-028 C*	*249.27*
900405	*X3-028 E*	*332.36*
915151	*Y3-038*	*5.98*
LTF	*Z1-007*	*5.09*
LTF	*Z1-029*	*3.13*
LTF	*AA1-001*	*5.15*
930041	*AB1-006 C*	*15.36*
930042	*AB1-006 E*	*102.76*
930461	*AB1-087 C OP*	*91.4*
930471	*AB1-088 C OP*	*91.4*