PJM Generator Interconnection Request
Queue AB2-080
Marysville-Flatlick 765 kV
Feasibility Study Report

August 2016

Preface

The intent of the feasibility study is to determine a plan, with ballpark cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the Interconnection Customer. The Interconnection Customer may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: (1) Direct Connections, which are new facilities and/or facilities upgrades needed to connect the generator to the PJM network, and (2) Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system.

In some instances a generator interconnection may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection, may also contribute to the need for the same network reinforcement. The possibility of sharing the reinforcement costs with other projects may be identified in the feasibility study, but the actual allocation will be deferred until the impact study is performed.

The Feasibility Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. The project developer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

General

The Interconnection Customer (IC) proposes to install two 346.0 MW (346.0 MW Capacity) natural gas combustion turbines and a 508.0 MW (508.0 MW Capacity) natural gas steam turbine in a 2x1 Combined Cycle configuration in its generating facility in Pickaway County, OH (see Figure 2). The total facility output will be 1200.0 MW (1200.0 MW Capacity). The primary point of interconnection for the generating facility will be to interconnect to a newly proposed three (3) breaker 765 kV switching station connecting to AEP's Marysville – Flatlick 765 kV line (See Figure 1). The secondary point of interconnection for the generating facility will be to interconnect to a newly proposed three (3) breaker 345 kV switching station connecting to AEP's Bixby – Biers Run 345 kV line (See Figure 3).

The requested Backfeed date is June 1, 2020.
The requested in-service date is June 1, 2021.

The objective of this Feasibility 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 not included as part of this study.

Attachment Facilities

Primary Point of Interconnection (Marysville – Flatlick 765 kV Line)

To accommodate the interconnection on the Marysville – Flatlick 765 kV line a new three (3) circuit breaker 765 kV switching station physically configured in a breaker and half bus arrangement but operated as a ring-bus will be constructed 63 miles from the Marysville 765 kV substation (see Figure 1). Installation of associated protection and control equipment, 765 kV line risers, SCADA, and 765 kV revenue metering will also be required. The new interconnection switching station will be expandable to accommodate future projects in the area.

New Switching Station Work and Cost:

- Construct a new three (3) breaker 765 kV switching station physically configured in a breaker and half bus arrangement but operated as a ring-bus. Installation of associated protection and control equipment, 765 kV line risers, SCADA, and 765 kV revenue metering will also be required.
- **Estimated Station Cost: $30,000,000**

Protection and Relay Work and Cost:

- Install line protection and controls at the new 765 kV switching station.

- **Estimated Cost: $2,000,000**

- Upgrade line protection and controls at the Marysville 765 kV substation to coordinate with the new 765 kV switching station.

- **Estimated Cost: $1,000,000**

- Upgrade line protection and controls at the Flatlick 765 kV substation to coordinate with the new 765 kV switching station.

- **Estimated Cost: $1,000,000**

IC is expected to obtain, at its cost, a 1200' x 500' station site for the new 765 kV switching station and all necessary permits. Ownership of the new 765 kV switching station and associated equipment shall be transferred from IC to AEP upon successful completion of the required work.

A 765 kV line extension is required to loop through the proposed 765 kV switching station. The proposed 765 kV switching station is assumed to be located immediately adjacent to the existing transmission lines. A supplemental line easement for the tap structures will be required. It is expected that IC will obtain the supplemental easement when the station property is purchased.

It is understood that IC is responsible for all costs associated with this interconnection. The costs above are reimbursable to AEP. The cost of IC's generating plant and the costs for the line connecting the generating plant to IC's switching station are not included in this report; these are assumed to be IC's responsibility.

The Generation Interconnection Agreement does not in or by itself establish a requirement for American Electric Power to provide power for consumption at the developer's facilities. A separate agreement may be reached with the local utility that provides service in the area to ensure that infrastructure is in place to meet this demand and proper metering equipment is installed. It is the responsibility of the developer to contact the local service provider to determine if a local service agreement is required.

Secondary Point of Interconnection (Bixby – Biers Run 345 kV Line)

To accommodate the interconnection on the Bixby – Biers Run 345 kV line a new three (3) circuit breaker 345 kV switching station physically configured in a breaker and half bus arrangement but operated as a ring-bus will be constructed 9 miles north of the Biers Run 345 kV substation (see Figure 3). Installation of associated protection and control equipment, 345 kV line risers, SCADA, and 345 kV revenue metering will also be required. The new interconnection switching station will be expandable to accommodate future projects in the area.

<u>New Switching Station Work:</u>

- Construct a new three (3) breaker 345 kV switching station physically configured in a breaker and half bus arrangement but operated as a ring-bus. Installation of

associated protection and control equipment, 345 kV line risers, SCADA, and 345 kV revenue metering will also be required.

Protection and Relay Work:

- Install line protection and controls at the new 345 kV switching station.
- Upgrade line protection and controls at the Bixby 345 kV substation to coordinate with the new 345 kV switching station.
- Upgrade line protection and controls at the Biers Run 345 kV substation to coordinate with the new 345 kV switching station.

Local and Network Impacts for the Primary Point of Interconnection

The impact of the proposed wind 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 AB2-080 was evaluated as a 1200.0 MW (Capacity 1200.0 MW) injection tapping the Marysville-Flatlick 765 kV line in the AEP area. Project AB2-080 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AB2-080 was studied with a commercial probability of 53%.

Potential network impacts were as follows:

Summer Peak Analysis - 2020

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

1. (AEP - AEP) The 05MOUNTN-05BELMON 765 kV line (from bus 242516 to bus 242920 ckt 1) loads from 92.66% to 102.7% (**DC power flow**) of its normal rating (4047 MVA) for the single line contingency outage of '707_B2_TOR8315_B'. This project contributes approximately 407.33 MW to the thermal violation.

CONTINGENCY '707_B2_TOR8315_B'

1 https://www.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 924330 TO BUS 242928 CKT 1 / 924330 AB2-080 TAP 242928 05MARYSV 765 1
END

- To relieve the Mountaineer – Belmont 765 kV line overload: Replace the Mountaineer 765 kV Wavetrap.

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

None

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)

None

Short Circuit
(Summary of impacted circuit breakers)

None

Stability Analysis

To be determined in the System Impact Study

Voltage Variations

None

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.

Not Applicable

Local and Network Impacts for the Secondary Point of Interconnection

The impact of the proposed wind 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 and Connection Requirements for AEP Transmission System. Therefore, these criteria were used to assess the impact of the proposed facility on the AEP System. The Queue Project AB2-080 was evaluated as a 1200.0 MW (Capacity 1200.0 MW) injection tapping the Biers Run-Bixby 345 kV line in the AEP area. Project AB2-080 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AB2-080 was studied with a commercial probability of 53%.

Potential network impacts were as follows:

Summer Peak Analysis - 2020

Generator Deliverability

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

1. (AEP - AEP) The 05HARRIS-05OBETZ 138 kV line (from bus 243522 to bus 243550 ckt 1) loads from 65.75% to 99.33% (**DC power flow**) of its emergency rating (179 MVA) for the single line contingency outage of '6763_B2_TOR5200548_B'. This project contributes approximately 60.11 MW to the thermal violation.

CONTINGENCY '6763_B2_TOR5200548_B'
OPEN BRANCH FROM BUS 924330 TO BUS 243454 CKT 1 / 924330 AB2-080 TAP OP2 345 243454 05BIXBY 345 1
END

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

- To relieve the Harrison – Obetz 138 kV line overload: Replace the bus work from CB Switches to Wavetrap (Sub cond 300 MCM CU 37 Str).

2. (OVEC - AEP) The 06KYGER-05SPORN 345 kV line (from bus 248005 to bus 242528 ckt 2) loads from 97.69% to 101.37% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '349_B2_TOR21'. This project contributes approximately 79.43 MW to the thermal violation.

CONTINGENCY '349_B2_TOR21'

OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 1 / 242528 05SPORN 345 248005 06KYGER 345 1
END

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

- To relieve the Kyger – Sporn #2 345 kV line overload: Rebuild the Kyger Creek – Sporn 345 kV ACSR/PE 1414 62/16 conductor & replace Kyger Creek risers. The new ratings will be 1524/1598 MVA SN/SE.
  - This line is overloaded prior to the Y2 Queue on the 2016 base case and is presently considered a 2016 potential baseline upgrade: B2470.1, B2480.2. This is an AEP-OVEC tie line therefore; PJM is going to have to coordinate this upgrade with OVEC.

3. (AEP - AEP) The AB2-080 TAP-05BIXBY 345 kV line (from bus 924330 to bus 243454 ckt 1) loads from 48.79% to 105.22% (**DC power flow**) of its normal rating (1409 MVA) for the single line contingency outage of '6781_B3_05BIERSR 345-1'. This project contributes approximately 795.0 MW to the thermal violation.

CONTINGENCY '6781_B3_05BIERSR 345-1'
OPEN BRANCH FROM BUS 246888 TO BUS 246889 CKT 1 / 246888 05BIERSR 345 246889 05BIERSR 138 1
END

- To relieve the AB2-080 – Bixby 345 kV line overload: Rebuild/Reconductor the ACSR 954 45/7 Rail conductor section 1, ACSR 954 54/7 Cardinal conductor section 3, and the ACAR 983.1 30/7 Rail5 conductor section 2.

Please refer to Appendix 3 for a table containing the generators having contribution to this flowgate.

4. (AEP - AEP) The AB2-080 TAP-05BIXBY 345 kV line (from bus 924330 to bus 243454 ckt 1) loads from 47.32% to 100.28% % (**DC power flow**) of its normal rating (1409 MVA) for the single line contingency outage of '762_B2_TOR8072'. This project contributes approximately 746.27 MW to the thermal violation.

CONTINGENCY '762_B2_TOR8072'
OPEN BRANCH FROM BUS 243453 TO BUS 253110 CKT 1 / 243453 05BEATTY 345 253110 09ADKINS 345 1
END

- To relieve the AB2-080 – Bixby 345 kV line overload: Rebuild/Reconductor the ACSR 954 45/7 Rail conductor section 1, ACSR 954 54/7 Cardinal conductor section 3, and the ACAR 983.1 30/7 Rail5 conductor section 2.

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 AB2-080 TAP-05BIXBY 345 kV line (from bus 924330 to bus 243454 ckt 1) loads from 48.37% to 104.79% (**DC power flow**) of its emergency rating (1409 MVA) for the line fault with failed breaker contingency outage of '8125_C2_05BIERSR 138-I'. This project contributes approximately 794.96 MW to the thermal violation.

CONTINGENCY '8125_C2_05BIERSR 138-I'
OPEN BRANCH FROM BUS 246888 TO BUS 246889 CKT 1 / 246888 05BIERSR 345 246889 05BIERSR 138 1
OPEN BRANCH FROM BUS 246889 TO BUS 246890 CKT 1 / 246889 05BIERSR 138 246890 05HOPETN 138 1
END

- To relieve the AB2-080 – Bixby 345 kV line overload: A sag check will be required on the ACSR 954 45/7 Rail conductor section 1, and the ACAR 983.1 30/7 Rail5 conductor section 2 to determine if the line sections can be operated above its emergency rating of 1409 MVA .

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)

None

Short Circuit
(Summary of impacted circuit breakers)

None

Stability Analysis

To be determined in the System Impact Study

Voltage Variations

None

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.

Not Applicable

Additional Limitations of Concern

None

Local/Network Upgrades

1. Replace the Mountaineer 765 kV Wavetrap.
    - **Estimated Cost to replace the Mountaineer 765 kV Wavetrap: $582,945**

Schedule

It is anticipated that the time between receipt of executed agreements and Commercial Operation may range from 18 to 24 months if no line work is required. If line work is required, construction time would be between 36 to 48 months after signing an interconnection agreement.

Conclusion

Based upon the results of this Feasibility Study, the construction of the 1200.0 MW (1200.0 MW Capacity) combined cycle natural gas generating facility of IC (PJM Project #AB2-080) 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 IC natural gas generating facility.

Cost Breakdown for the Primary Point of Interconnection (Marysville – Flatlick 765 kV Line):

Estimated Cost for the new 765 kV Switching Station: $30,000,000
Estimated Protection and Relay Cost: $4,000,000
Estimated Local/Network Upgrades Cost: $582,945

Total Estimated Cost for Project AB2-080: $34,582,945

The 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 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.

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 for Option 1

(AEP - AEP) The 05MOUNTN-05BELMON 765 kV line (from bus 242516 to bus 242920 ckt 1) loads from 92.66% to 102.7% (**DC power flow**) of its normal rating (4047 MVA) for the single line contingency outage of '707_B2_TOR8315_B'. This project contributes approximately 409.13 MW to the thermal violation.

Note to TOs: AEP Rate A should be applied to this overload

CONTINGENCY '707_B2_TOR8315_B'
OPEN BRANCH FROM BUS 924330 TO BUS 242928 CKT 1 / 924330 AB2-080 TAP 242928 05MARYSV 765 1
END

Bus Number	*Bus Name*	*Full Contribution*
242891	*05AMG1*	*44.7*
242892	*05AMG2*	*40.21*
242893	*05AMG3*	*72.64*
246859	*05CER G2*	*3.54*
246861	*05CER G3*	*3.54*
246862	*05CER G4*	*3.54*
246864	*05CER G5*	*3.54*
246865	*05CER G6*	*3.54*
247216	*05FLATG1*	*11.14*
247217	*05FLATG2*	*11.15*
247218	*05FLATG3*	*11.14*
247219	*05FLATG4*	*11.14*
247220	*05FLATG5*	*11.16*
247224	*05FTHLG1*	*8.29*
247225	*05FTHLG2*	*8.29*
243186	*05GVG1*	*88.02*
243187	*05GVG2*	*90.42*
247245	*05HRKG1A*	*8.38*
247246	*05HRKG1B*	*8.38*
247247	*05HRKG1S*	*12.43*
247248	*05HRKG2A*	*8.38*
247249	*05HRKG2B*	*8.38*
247250	*05HRKG2S*	*12.43*
242894	*05MTG1*	*91.97*
247230	*05RIVRG1*	*8.18*
247231	*05RIVRG2*	*8.18*
247232	*05RIVRG3*	*8.18*
244873	*05WINFIELD*	*0.87*
242903	*CIR_Y3-38_39*	*7.4*
247609	*W3-128*	*137.55*
247615	*Y1-006 C*	*1.71*

LTF	*Y2-006*	*29.25*
920422	*Y2-045*	*0.29*
247623	*Y3-036*	*2.4*
247624	*Y3-037*	*2.01*
LTF	*Z1-046*	*31.4*
920742	*Z2-042 C*	*3.3*
LTF	*Z2-067*	*17.05*
LTF	*AA1-001*	*8.71*
LTF	*AA1-004*	*27.77*
920902	*AA1-013*	*2.4*
922272	*AA2-137*	*10.81*
922282	*AA2-138*	*10.81*
LTF	*AB1-023*	*14.62*
922772	*AB1-058*	*3.74*
923112	*AB1-109*	*12.8*
923632	*AB1-180 C*	*0.46*
LTF	*AB2-005*	*18.62*
923761	*AB2-010 C*	*0.48*
923771	*AB2-011 C*	*0.48*
LTF	*AB2-075*	*5.74*
LTF	*AB2-076*	*7.04*
924331	*AB2-080 OP*	*409.13*
924911	*AB2-145 OP*	*101.48*
924921	*AB2-146 OP*	*60.33*

Appendix 1 Option 2

(AEP - AEP) The 05HARRIS-05OBETZ 138 kV line (from bus 243522 to bus 243550 ckt 1) loads from 65.75% to 99.33% (**DC power flow**) of its emergency rating (179 MVA) for the single line contingency outage of '6763_B2_TOR5200548_B'. This project contributes approximately 60.11 MW to the thermal violation.

CONTINGENCY '6763_B2_TOR5200548_B'
OPEN BRANCH FROM BUS 924330 TO BUS 243454 CKT 1 / 924330 AB2-080 TAP OP2 345 243454 05BIXBY 345 1
END

Bus Number	*Bus Name*	*Full Contribution*
924331	*AB2-080 OP*	*60.11*
924351	*AB2-083 C OP*	*3.73*

Appendix 2 Option 2

(OVEC - AEP) The 06KYGER-05SPORN 345 kV line (from bus 248005 to bus 242528 ckt 2) loads from 97.69% to 101.37% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '349_B2_TOR21'. This project contributes approximately 79.43 MW to the thermal violation.

Note to TOs: AEP Rate A should be applied to the AEP side of this overload

CONTINGENCY '349_B2_TOR21'
OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 1 / 242528 05SPORN 345 248005 06KYGER 345 1
END

Bus Number	*Bus Name*	*Full Contribution*
251936	*08BCKJD4*	*20.21*
251937	*08BCKJD5*	*31.17*
251966	*08WSDLE5*	*1.79*
251967	*08WSDLE6*	*1.79*
253038	*09KILLEN*	*15.83*
253058	*09OHH C.*	*5.24*
342910	*1DALE 3G*	*5.69*
342911	*1DALE 4G*	*5.87*
247536	*S-071 C*	*1.64*
247543	*V3-007 C*	*1.92*
247515	*V4-033 C*	*4.04*
247592	*W4-036*	*0.98*
916261	*Z1-079*	*11.33*
922002	*AA2-100*	*0.53*
922372	*AA2-148 C*	*1.8*
922612	*AB1-014 C*	*5.31*
923522	*AB1-169 C OP*	*114.39*
923881	*AB2-028 C*	*1.77*
924101	*AB2-054*	*49.08*
924211	*AB2-065 C*	*1.27*
924331	*AB2-080 OP*	*79.43*
924351	*AB2-083 C OP*	*1.84*
924371	*AB2-085 C OP*	*5.89*
924541	*AB2-103 C OP*	*2.78*
925001	*AB2-156*	*5.57*

Appendix 3 Option 2

(AEP - AEP) The AB2-080 TAP-05BIXBY 345 kV line (from bus 924330 to bus 243454 ckt 1) loads from 48.79% to 105.22% (**DC power flow**) of its normal rating (1409 MVA) for the single line contingency outage of '6781_B3_05BIERSR 345-1'. This project contributes approximately 795.0 MW to the thermal violation.

Note to TOs: AEP Rate A should be applied to this overload

CONTINGENCY '6781_B3_05BIERSR 345-1'
OPEN BRANCH FROM BUS 246888 TO BUS 246889 CKT 1 / 246888 05BIERSR 345 246889 05BIERSR 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
253038	*09KILLEN*	*6.4*
924331	*AB2-080 OP*	*795.*