PJM Generator Interconnection Request
Queue AB2-146
Axton 138 kV
Feasibility Study Report

September 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 PJM Project #AB2-146, a 382.0 MW (382.0 MW Capacity) 1x1 Combined Cycle natural gas generating facility connecting to the American Electric Power (AEP) Transmission system at two (2) alternative points located in Pittsylvania County, Virginia. The primary point of interconnection is located at the Axton 138 kV substation. The secondary point of interconnection will be to interconnect to a newly proposed three (3) circuit breaker 138 kV switching station connecting to AEP's Axton #2 – Danville #1 138 kV line. The generator will be located in Pittsylvania County, Virginia

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

Attachment Facilities

Primary Point of Interconnection (Axton 138 Substation)

To accommodate the interconnection at the Axton 138 kV Substation, the substation will have to be expanded requiring the installation of two (2) new 138 kV circuit breakers. Installation of associated protection and control equipment, SCADA, and 138 kV revenue metering will also be required.

Direct Connection to the Axton 138 kV Substation Work and Cost:

- Expand the substation; install two (2) new 138 kV circuit breakers. Installation of associated protection and control equipment, SCADA, and 138 kV revenue metering will also be required.
- **Estimated Station Cost: $3,000,000**

Protection and Relay Work and Cost:

- Install line protection and controls at the Axton 138 kV Substation.
- **Estimated Cost: $200,000**

Secondary Point of Interconnection (Axton #2 – Danville #1 138 kV Line)

To accommodate the interconnection on the Axton #2 – Danville #1 138 kV line a new three (3) circuit breaker 138 kV switching station physically configured in a breaker and half bus arrangement but operated as a ring-bus will be constructed east of the Axton 138 kV substation. Installation of associated protection and control equipment, 138 kV line risers, SCADA, and 138 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:

- Construct a new three (3) circuit breaker 138 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, 138 kV line risers, SCADA, and 138 kV revenue metering will also be required.

Protection and Relay Work:

- Install line protection and controls at the new 138 kV switching station.
- Upgrade line protection and controls at the Axton 138 kV substation to coordinate with the new 138 kV switching station.
- Upgrade line protection and controls at the Danville 138 kV substation to coordinate with the new 138 kV switching station.

It is understood that The Interconnection Customer (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.

Local and Network Impacts for the Primary Point of Interconnection

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 AB2-146 was evaluated as a 382.0 MW (Capacity 382.0 MW) injection at the Axton 138kV substation in the AEP area. Project AB2-146 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AB2-146 was studied with a commercial probability of 53%.

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

Potential network impacts were as follows:

Summer Peak Analysis – 2020 for Primary Point of Interconnection

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)

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)

1. (AEP - AEP) The 05MOUNTN-05BELMON 765 kV line (from bus 242516 to bus 242920 ckt 1) loads from 103.83% to 104.49% (**DC power flow**) of its normal rating (4047 MVA) for the single line contingency outage of '707_B2_TOR8315_B'. This project contributes approximately 60.33 MW to the thermal violation.

CONTINGENCY '707_B2_TOR8315_B'
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.

Please refer to Appendix 1- “Primary Point of Interconnection” for a table containing the generators having contribution to this flowgate.

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.

None

Local and Network Impacts for the Secondary Point of Interconnection

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[3] and Connection Requirements for AEP Transmission System[4]. Therefore, these criteria were used to assess the impact of the proposed facility on the AEP System. The Queue Project AB2-146 was evaluated as a 382.0 MW (Capacity 382.0 MW) injection tapping the Axton-Danville 138kV line in the AEP area. Project AB2-146 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AB2-146 was studied with a commercial probability of 53%.

Potential network impacts were as follows:

Summer Peak Analysis – 2020 for Secondary Point of Interconnection

Generator Deliverability

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

3 https://www.aep.com/about/codeofconduct/OASIS/TransmissionStudies/GuideLines/AEP_East_FERC_715_2016_Final_Part_4.pdf

4 https://www.aep.com/about/codeofconduct/OASIS/TransmissionStudies/Requirements/AEP_Interconnection_Requirements_rev1.pdf

1. (AEP - AEP) The 05STOCKT-05MARTN1 138 kV line (from bus 242816 to bus 242711 ckt 1) loads from 83.77% to 106.63% (**DC power flow**) of its emergency rating (202 MVA) for the single line contingency outage of '5461_B2_TOR156B_MOAB'. This project contributes approximately 46.18 MW to the thermal violation.

CONTINGENCY '5461_B2_TOR156B_MOAB'
OPEN BRANCH FROM BUS 242544 TO BUS 242712 CKT 1 / 242544 05AXTON 138 242712 05MARTN2 138 1
END

- The Martinsville Breaker C (800A) is the limiting element on this line.

Please refer to Appendix 1- “Secondary Point of Interconnection” for a table containing the generators having contribution to this flowgate.

2. (AEP - AEP) The 05STOCKT-05MARTN1 138 kV line (from bus 242816 to bus 242711 ckt 1) loads from 80.88% to 103.5% (**DC power flow**) of its emergency rating (202 MVA) for the single line contingency outage of '5459_B2_TOR156_WOMOAB'. This project contributes approximately 45.7 MW to the thermal violation.

CONTINGENCY '5459_B2_TOR156_WOMOAB'
OPEN BRANCH FROM BUS 242544 TO BUS 242712 CKT 1 / 242544 05AXTON 138 242712 05MARTN2 138 1
OPEN BRANCH FROM BUS 242614 TO BUS 242638 CKT 1 / 242614 05COLLIN 138 242638 05FIELDALE1 138 1
OPEN BRANCH FROM BUS 242614 TO BUS 242712 CKT 1 / 242614 05COLLIN 138 242712 05MARTN2 138 1
OPEN BRANCH FROM BUS 242712 TO BUS 243977 CKT 1 / 242712 05MARTN2 138 243977 05MART 115 34.5 1
OPEN BRANCH FROM BUS 243977 TO BUS 243979 CKT 1 / 243977 05MART 115 34.5 243979 05MART2-30 34.5 1
OPEN BRANCH FROM BUS 243977 TO BUS 243980 CKT 1 / 243977 05MART 115 34.5 243980 05MORRIS-N 34.5 1
END

- The Martinsville Breaker C (800A) is the limiting element on this line.

3. (DVP - DVP) The 8ROGERS RD-8CARSON 500 kV line (from bus 314940 to bus 314902 ckt 1) loads from 99.87% to 101.53% (**DC power flow**) of its emergency rating (3424 MVA) for the single line contingency outage of 'LN 511'. This project contributes approximately 56.72 MW to the thermal violation.

CONTINGENCY 'LN 511'

OPEN BRANCH FROM BUS 314902 TO BUS 314936 CKT 1 /*
8CARSON 500.00 - 8RAWLINGS 500.00
END

Please refer to Appendix 2- “Secondary Point of Interconnection” for a table containing the generators having contribution to this flowgate.

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.

None

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 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 Feasibility Study, the construction of the 382.0 MW (382.0 MW Capacity) 1x1 combined cycle natural gas generating facility of The Interconnection Customer (IC) (PJM Project #AB2-146) will require the following additional interconnection charges. This plan of service will interconnect the proposed natural gas generating facility in a manner that will provide operational reliability and flexibility to both the AEP system and the Interconnection Customer's natural gas generating facility.

Cost Breakdown for the Primary Point of Interconnection (Axton 138 kV Substation):

Estimated Cost to connect to the Axton 138 kV Substation: $3,000,000
Estimated Protection and Relay Cost: $200,000
Estimated Local/Network Upgrades Cost: $582,945

Total Estimated Cost for Project AB2-085: $3,782,945

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 Primary Point of Interconnection

(AEP - AEP) The 05MOUNTN-05BELMON 765 kV line (from bus 242516 to bus 242920 ckt 1) loads from 102.7% to 103.83% (**DC power flow**) of its normal rating (4047 MVA) for the single line contingency outage of '707_B2_TOR8315_B'. This project contributes approximately 101.48 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 for Secondary Point of Interconnection

(AEP - AEP) The 05STOCKT-05MARTN1 138 kV line (from bus 242816 to bus 242711 ckt 1) loads from 83.77% to 106.63% (**DC power flow**) of its emergency rating (202 MVA) for the single line contingency outage of '5461_B2_TOR156B_MOAB'. This project contributes approximately 46.17 MW to the thermal violation.

CONTINGENCY '5461_B2_TOR156B_MOAB'
OPEN BRANCH FROM BUS 242544 TO BUS 242712 CKT 1 / 242544 05AXTON 138 242712 05MARTN2 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
924911	*AB2-145 OP*	*53.32*
924921	*AB2-146 OP*	*46.17*

Appendix 2 for Secondary Point of Interconnection

(DVP - DVP) The 8ROGERS RD-8CARSON 500 kV line (from bus 314940 to bus 314902 ckt 1) loads from 100.06% to 101.72% (**DC power flow**) of its emergency rating (3424 MVA) for the single line contingency outage of 'LN 511'. This project contributes approximately 56.9 MW to the thermal violation.

CONTINGENCY 'LN 511'
OPEN BRANCH FROM BUS 314902 TO BUS 314936 CKT 1 /*
8CARSON 500.00 - 8RAWLINGS 500.00
END

Bus Number	*Bus Name*	*Full Contribution*
315102	*1BRUNSWICKG1*	*30.91*
315103	*1BRUNSWICKG2*	*30.91*
315104	*1BRUNSWICKG3*	*30.91*
315105	*1BRUNSWICKS1*	*64.22*
315150	*1BUGGS 1*	*2.38*
315151	*1BUGGS 2*	*2.38*
315153	*1CLOVER1*	*35.37*
315154	*1CLOVER2*	*34.74*
315159	*1KERR 2*	*1.46*
315164	*1KERR 7*	*1.43*
315266	*1PLYWOOD A*	*2.25*
314429	*3JTRSVLE*	*0.42*
916301	*Z1-086 C*	*194.25*
LTF	*Z2-067*	*34.01*
LTF	*AA1-058*	*1.11*
921172	*AA1-064 C*	*23.99*
LTF	*AA2-074*	*9.56*
924021	*AB2-043 C OP*	*5.82*
924251	*AB2-069 C OP*	*2.72*
LTF	*AB2-075*	*4.51*
LTF	*AB2-076*	*5.24*
924301	*AB2-077 C OP*	*2.23*
924311	*AB2-078 C OP*	*2.23*
924321	*AB2-079 C OP*	*2.23*
924401	*AB2-089 C*	*1.59*
924411	*AB2-090 C*	*3.64*
924921	*AB2-146 OP*	*56.9*
925221	*AB2-176 C*	*1.5*