Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AA2-106

Bluff Point 69 kV

August 2015

Preface

The intent of the Feasibility Study is to determine a plan, with high level estimated cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the IC. The IC may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the IC 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 IC is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by ITO, the costs may be included in the study.

General

Interconnection Customer (IC) proposes to interconnect a 20 MW Energy Storage project, utilizing battery technology, to the existing 69 kV bus at the Bluff Point 69 kV substation via a single 69 kV circuit breaker. Since a spare 69 kV bay is not available, a new 69 kV bay will be required for this interconnection (see Figure 1). To examine the load flow feasibility impact of the proposed battery project, the Queue Project AA2-106 was studied as a 20.0 MW (Capacity 0.0 MW) generation injection and a 20 MW load alternately at the Bluff Point 69kV substation. The location of the proposed facility is in Jay County, IN (see Figure 2).

The requested in service date is December 01, 2016.

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

Project AA2-106 will connect to the Bluff Point 69 kV substation via a single 69 kV circuit breaker. Since a spare 69 kV bay is not available, a new 69 kV bay will be required for this interconnection (see Figure 1). The station will also include 69 kV metering, SCADA, and associated equipment. Protection relays in the remote terminals (stations) need to be upgraded to coordinate with the addition of the new generation station.

A new 69 kV line extension will be required to connect the proposed facility to the 69 kV bus and a supplemental line easement may be required. It is expected that Interconnection Customer will obtain the supplemental easement.

The following work is required to connect PJM Project AA2-106 to the 69 kV side of the 138/69 kV Bluff Point Substation:

Station Cost:

- Construct a new 69 kV bus, 69 kV circuit breaker including installing associated disconnect switches, bus work, SCADA and 69 kV revenue metering.
- **Estimated Station Cost: $700,000**

Protection and Relaying Cost:

- Relays and controls for the new 69 kV circuit breaker, bus differentials, and line protection will need to be installed for the new battery storage plant point of interconnection. Estimated Cost: $100,000

- Line protection and controls at the 138 kV bus (primary side) will need to be upgraded to coordinate with the added new battery storage plant on the 69 kV bus (secondary side). Estimated Cost: $100,000

- Line protection and controls at Portland 69 kV substation will need to be upgraded to coordinate with the added new battery storage plant at 69 kV bus. Estimated Cost: $300,000

- Line protection and controls at 69/12 kV Bluff Point substation will need to be upgraded to coordinate with the added new battery storage plant at 69 kV bus. Estimated Cost: $100,000

- **Estimated Protection and Relaying Cost: $600,000**

It is understood that Interconnection Customeris responsible for all these connection costs associated with interconnecting the PJM project AA2-106 to AEP transmission system. The above costs are reimbursable to AEP. The cost of the battery storage plant and the costs for the line connecting the battery storage plant to the 138/69 kV Bluff Point substation are not included in this report, these costs are assumed to be the responsibility of the Interconnection Customer.

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

The impact of the proposed generating facility on the AEP Transmission 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 criterion were used to assess the impact of the proposed facility on the AEP System. PJM Queue # AA2-106 was studied as a 20 MW (0 MW capacity) injection to AEP system consistent with the interconnection application. PJM Project AA2-106 was evaluated for compliance with reliability criteria for summer peak conditions in 2019.

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1 https://www.aep.com/about/codeofconduct/OASIS/TransmissionStudies/GuideLines/2015_AEP_PJM_FERC_715_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:

Normal System (2019 Summer Conditions Capacity Output)

- Not Applicable

Single Contingency (2019 Summer Conditions Capacity Output)

- Not Applicable

Multiple Contingency (2019 Summer Conditions Capacity Output)

- Not Applicable

Contribution to Previously Identified Overloads (2019 Summer Conditions Capacity Output)

- Not Applicable

Normal System (2019 Summer Conditions Full Output)

- No problems identified

Single Contingency (2019 Summer Conditions Full Output)

Table 1 – Single Contingency (2019 Summer Conditions Full Output)

AEP Identified Overload Facility

#	Contingency Name	Contingency Description	Overload Facility Description	Limiting Element	Mitigation
1	'7003_B2_TOR 7801747'	CONTINGENCY '7003_B2_TOR7801747' OPEN BRANCH FROM BUS 243253 TO BUS 243319 CKT 1 / 243253 05BLUFFP 138 243319 05JAY 138 1 END	The 05Bluffpoint - 05Portland 69 kV line (from bus 246014 to bus 246022 ckt 1) loads from 96.9% to 111.2% of its normal rating (82 MVA) for single line outage of '7003_B2_TOR7801747'.	Portland Switching MOB "V"	Replace Portland (600A) Switch

Multiple Contingency (2019 Summer Conditions Full Output)

- No problems identified

Contribution to Previously Identified Overloads (2019 Summer Conditions Full Output)

Table 2 – PJM Identified Contributions to Previously Identified Overloads (2019 Summer Conditions Energy Output)

#	Contingency Name	Contingency Description	Overload Facility Description	Limiting Element	Mitigation
1	'6872'	CONTINGENCY '6872' OPEN BRANCH FROM BUS 243218 TO BUS 243225 CKT 1 / 243218 05DESOTO 345 243225 05KEYSTN 345 1 OPEN BRANCH FROM BUS 243218 TO BUS 243232 CKT 2 / 243218 05DESOTO 345 243232 05SORENS 345 2 OPEN BRANCH FROM BUS 243218 TO BUS 247508 CKT 1 / 243218 05DESOTO 345 247508 U2-090 C 345 1. END	The 05DESOTO-05JAY 138 kV line (from bus 243278 to bus 243319 ckt 1) loads from 120.17% to 122.75% **(DC power flow)** of its emergency rating (302 MVA) for the tower line contingency outage of '6872'.	Breaker G (1200A) Oil at Jay 138 kV station	Replace Breaker G at Jay Station – Circuit Breaker G will be replaced June 2016. No work is required.
2	'2965_C2_05DESOTO 345-A2'	CONTINGENCY '2965_C2_05DESOTO 345-A2' OPEN BRANCH FROM BUS 243218 TO BUS 243222 CKT 1 / 243218 05DESOTO 345 243222 05FALL C 345 1 OPEN BRANCH FROM BUS 243218 TO BUS 243278 CKT 1 / 243218 05DESOTO 345 243278 05DESOTO 138 1 END	The 05HOGAN-05DELAWR 138 kV line (from bus 243311 to bus 243275 ckt 1) loads from 112.8% to 114.04% **(DC power flow)** of its emergency rating (179 MVA) for the line fault with failed breaker contingency outage of '2965_C2_05DESOTO 345-A2'.	ACSR ~ 397.5 ~ 30/7 ~ Lark (Entire Delaware – Hogan 138 Line)	Correct Ratings: S/N = 167 MVA and S/E= 238 MVA No work is required.

Short Circuit Analysis

- No problems identified

Stability Analysis

- To be determined during System Impact Study

Voltage Variations

- No problems identified.

Flicker Study

- The voltage related visual effects of the +/- 20 MW swing for charging and discharging of the battery is to be determined during the System Impact study.

Additional Limitations of Concern

- None

Local/Network Upgrades

Table 1 – Single Contingency (2019 Summer Conditions Full Output)

AEP Identified Overload Facility

#	Contingency Name	Contingency Description	Overload Facility Description	Limiting Element	Mitigation	Cost ($)	Schedule
1	'7003_B2_TOR7801747'	CONTINGENCY '7003_B2_TOR7801747' OPEN BRANCH FROM BUS 243253 TO BUS 243319 CKT 1 / 243253 05BLUFFP 138 243319 05JAY 138 1 END	The 05Bluffpoint - 05Portland 69 kV line (from bus 246014 to bus 246022 ckt 1) loads from 96.9% to 111.2% of its normal rating (82 MVA) for single line outage of '7003_B2_TOR7801747',	Portland Switching MOB "V"	Replace Portland (600A) Switch	$250,000	The estimated time required for construction is between 12 to 24 months after signing an interconnection agreement.

Schedule

It is anticipated that the time between receipt of executed agreements and Commercial Operation may range from 18 to 24 months.

Conclusion

Based upon the results of this Feasibility Study, the construction of the 20 MW battery storage facility of Interconnection Customer(PJM Project #AA2-106) will require the following additional interconnection charges. This plan of service will interconnect the proposed battery storage facility in a manner that will provide operational reliability and flexibility to both the AEP system and the Interconnection Customer battery storage facility.

Estimated Interconnection Cost: $700,000
Estimated Protection and Relaying Cost: $600,000
Estimated 600A Switch replacement Cost: $250,000

Total Estimated Cost for Project AA2-106: $1,550,000

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.

PJM Analysis

Network Impacts

The Queue Project AA2-106 was studied as a 20.0 MW (Capacity 0.0 MW) injection at the Bluff Point 69kV substation in the AEP area. Project AA2-106 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AA2-106 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis - 2019

System Reinforcement responsible by Transmission Owner

1. **Existing supplemental project.**

(This project contributes to the following contingency overload, and there is an existing PJM supplemental project to fix the following overload.)

1. (AEP - AEP) The 05DESOTO-05JAY 138 kV line (from bus 243278 to bus 243319 ckt 1) loads from 120.17% to 122.75% (**DC power flow**) of its emergency rating (302 MVA) for the tower line contingency outage of '6872'. This project contributes approximately 7.8 MW to the thermal violation.

CONTINGENCY '6872'
OPEN BRANCH FROM BUS 243218 TO BUS 243225 CKT 1 / 243218 05DESOTO 345 243225 05KEYSTN 345 1
OPEN BRANCH FROM BUS 243218 TO BUS 243232 CKT 2 / 243218 05DESOTO 345 243232 05SORENS 345 2
OPEN BRANCH FROM BUS 243218 TO BUS 247508 CKT 1 / 243218 05DESOTO 345 247508 U2-090 C 345 1
END

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

PJM supplemental project (s0737) will eliminate the identified overload. The scheduled in service date for s0737 is 12/31/2018.

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)

None

Steady-State Voltage Requirements
(Results of the steady-state voltage studies should be inserted here)

To be determined

Short Circuit
(Summary of impacted circuit breakers)

Not Required

Affected System Analysis & Mitigation

To be determined

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 - AEP) The 05BLUFFP 138/69 kV transformer (from bus 243253 to bus 246014 ckt 1) loads from 93.22% to 104.78% (**DC power flow**) of its emergency rating (81 MVA) for the single line contingency outage of '7003_B2_TOR7801747'. This project contributes approximately 9.36 MW to the thermal violation.

CONTINGENCY '7003_B2_TOR7801747'

OPEN BRANCH FROM BUS 243253 TO BUS 243319 CKT 1 / 243253 05BLUFFP 138 243319 05JAY 138 1
END

2. (AEP - AEP) The 05HOGAN-05DELAWR 138 kV line (from bus 243311 to bus 243275 ckt 1) loads from 104.7% to 105.97% (**DC power flow**) of its emergency rating (179 MVA) for the single line contingency outage of '674_B3_05DESOTO 345-1_WOMOP'. This project contributes approximately 2.28 MW to the thermal violation.

CONTINGENCY '674_B3_05DESOTO 345-1_WOMOP'
OPEN BRANCH FROM BUS 243218 TO BUS 243278 CKT 1 / 243218 05DESOTO 345 243278 05DESOTO 138 1
END

Light Load Analysis - 2019

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

System Reinforcements

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

To be determined

Stability and Reactive Power Requirement
(Results of the dynamic studies should be inserted here)

To be determined

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)

None

Light Load 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)

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.

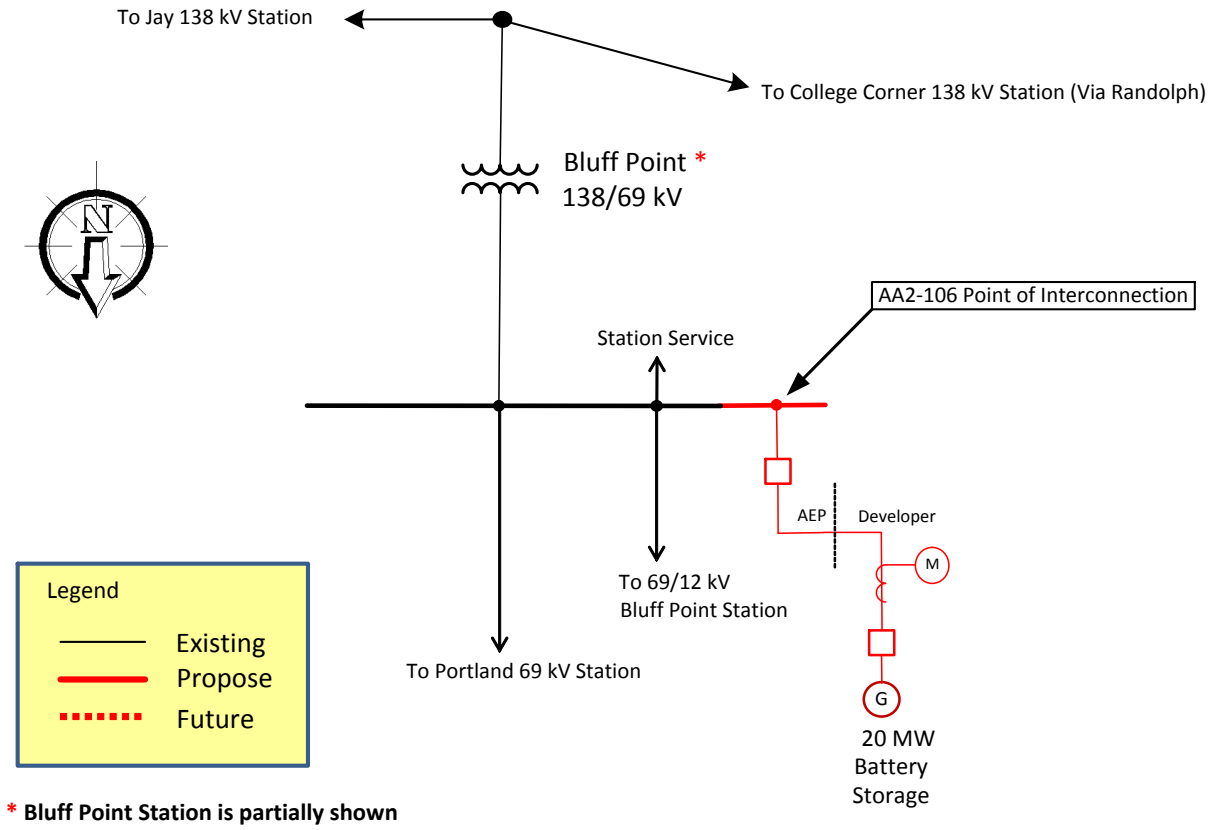

Figure 1

Figure 2

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 05DESOTO-05JAY 138 kV line (from bus 243278 to bus 243319 ckt 1) loads from 120.17% to 122.75% (**DC power flow**) of its emergency rating (302 MVA) for the tower line contingency outage of '6872'. This project contributes approximately 7.8 MW to the thermal violation.

CONTINGENCY '6872'
OPEN BRANCH FROM BUS 243218 TO BUS 243225 CKT 1 / 243218 05DESOTO 345 243225 05KEYSTN 345 1
OPEN BRANCH FROM BUS 243218 TO BUS 243232 CKT 2 / 243218 05DESOTO 345 243232 05SORENS 345 2
OPEN BRANCH FROM BUS 243218 TO BUS 247508 CKT 1 / 243218 05DESOTO 345 247508 U2-090 C 345 1
END

Bus Number	*Bus Name*	*Full Contribution*
247914	*05WLD G1 E*	*4.26*
247958	*05WLD G2 E*	*4.47*
247920	*U2-090 E*	*11.06*
247543	*V3-007 C*	*1.65*
247935	*V3-007 E*	*11.06*
247544	*V3-008 C*	*1.65*
247936	*V3-008 E*	*11.06*
247545	*V3-009 C*	*1.65*
247937	*V3-009 E*	*11.06*
247515	*V4-033 C*	*2.36*
247923	*V4-033 E*	*15.83*
920102	*AA2-106 E*	*7.8*

Appendix 2

(AEP - AEP) The 05HOGAN-05DELAWR 138 kV line (from bus 243311 to bus 243275 ckt 1) loads from 112.8% to 114.04% (**DC power flow**) of its emergency rating (179 MVA) for the line fault with failed breaker contingency outage of '2965_C2_05DESOTO 345-A2'. This project contributes approximately 2.21 MW to the thermal violation.

CONTINGENCY '2965_C2_05DESOTO 345-A2'
OPEN BRANCH FROM BUS 243218 TO BUS 243222 CKT 1 / 243218 05DESOTO 345 243222 05FALL C 345 1
OPEN BRANCH FROM BUS 243218 TO BUS 243278 CKT 1 / 243218 05DESOTO 345 243278 05DESOTO 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
246991	*05WLD G1 C*	*0.21*
247914	*05WLD G1 E*	*16.74*
247255	*05WLD G2 C*	*0.22*
247958	*05WLD G2 E*	*17.56*
247588	*W4-004 C*	*0.97*
247946	*W4-004 E*	*6.49*
247589	*W4-008 C*	*0.97*
247953	*W4-008 E*	*6.49*
920102	*AA2-106 E*	*2.21*
920501	*AA2-148 C OP*	*1.89*
920502	*AA2-148 E OP*	*12.55*