Generation Interconnection System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AA2-106

Bluff Point 69 kV

January 2018

Preface

The intent of the System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. 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. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

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 or merchant transmission upgrade, 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 System Impact Study is performed.

The System Impact 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

NextERA Energy Resources, LLC proposes to interconnect a 20 MW Energy Storage project, utilizing battery technology to the American Electric Power (AEP) transmission facility. The point of interconnection is a direct connection to the Bluff Point 69 kV station (see Figure 1). The Queue Project AA2-106 was evaluated as a 20.0 MW (Capacity 0.0 MW) injection/withdrawal at the Bluff Point 69 kV 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 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

Project AA2-106 will connect directly 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 interconnection will also require a 69 kV metering package, SCADA RTU, control relays, and associated equipment. The customer owned/constructed 69 kV line is required to include fiber optic communication cable either in the form of OPGW or ADSS. The customer must work with AEP Protection & Control when deciding on its own relaying devices to make sure they can properly work together with AEP's relaying.

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 NextERA Energy Resources, LLC will obtain the supplemental easement if required.

AEP is required to periodically take 69 kV breakers out of service for regular maintenance. These requirements are applicable to the proposed breaker(s) at Bluff Point 69 kV that would serve AA2-106. The required schedule involves outage of the breaker every 6 years for trip checking and every 3-12 years for inspection (depending on breaker) with a typical duration of 1-2 days each assuming extensive corrections are not needed. These schedules could change. During these outages the AA2-106 will be unable to deliver to the PJM market.

The AEP construction scope includes:

- Expanding the Bluff Point 138/69 kV Switching Station by installing a new 69 kV bus, 69 kV circuit breaker including associated disconnect switches, bus work, and SCADA: **$700,000 (Network Upgrade #n5502)**
- Protection and Control: **$200,000 (Network Upgrade #n5503)**
- Customer Revenue Metering Package: **$200,000 (Network Upgrade #n5504)**

Total Attachment Facilities Cost:

Estimated Cost: - $1,100,000

It is understood that NextERA Energy Resources, LLC is 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 69 kV Bluff Point substation are not included in this report, these costs are assumed to be the responsibility of NextERA Energy Resources, LLC.

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 according to 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 AA2-106 was evaluated as a 20.0 MW (Capacity 0.0 MW) injection/withdrawal at the Bluff Point 69 kV 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 100%.

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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 - 2019

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)

- No problems identified

Multiple Contingency (2019 Summer Conditions Full Output)

- No problems identified

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

1. (AEP - AEP) The 05DESOTO-05JAY 138 kV line (from bus 243278 to bus 243319 ckt 1) loads from 119.51% to 122.2% (AC 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

- All the limiting elements identified will be replaced as part of the Jay Area Improvement project (B2163) In-Service Date: June 2016.

2. (AEP - AEP) The 05HOGAN-05DELAWR 138 kV line (from bus 243311 to bus 243275 ckt 1) loads from 113.46% to 114.7% (AC 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

- Correct Ratings: S/N = 167 MVA and S/E= 238 MVA

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 05HOGAN-05DELAWR 138 kV line (from bus 243311 to bus 243275 ckt 1) loads from 104.95% to 106.32% (AC 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

Short Circuit Analysis

- Not required

Stability Analysis

- No problems identified

Voltage Variations

- The stability analysis assumed a worst case scenario of 30 changes of charge/dis-charge state per-minute. According to IEEE 1453-2015, Table 4, the maximum allowable voltage change is 0.895% with 30 changes per-minute. Based upon these assumptions, the stability analysis resulted in the following voltage deviations:
  - In a base case scenario, the short circuit level at the Bluff Point 69kV bus was 706.3 MVA with a maximum voltage deviation of 4.1%.
  - After taking the worst-case contingency from a short circuit standpoint (the loss of the Bluff Point 138/69 kV Transformer), the short circuit level at the Bluff Point 69kV bus drops to 296.9 MVA with a maximum voltage deviation of 7.6%

Additional Limitations of Concern

- None

Local/Network Upgrades

In order to mitigate the flicker concerns, there are two alternatives:

1. SVC (Static VAR Compensator) or STATCOM (Static Synchronous Compensator). Depending on the number of number of changes per minute, the SVC/STATCOM manufacturer will be engaged in determining if the SVC/STATCOM can mitigate flicker and will also determine the required size and price for the corresponding FACTS device. **Anticipated Cost: $10M - $50M**
2. NextERA Energy Resources, LLC to install regulation in order to limit the number of changes per minute, and/or the magnitude of those changes, such that the combination of voltage change magnitude and frequency of occurrence is acceptable according to IEEE 1453-2015, Table 4.

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 System Impact Study, the construction of the 20 MW battery storage facility of NextERA Energy Resources, LLC (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 NextERA Energy Resources, LLC battery storage facility.

Estimated Attachment Facilities Cost: $700,000

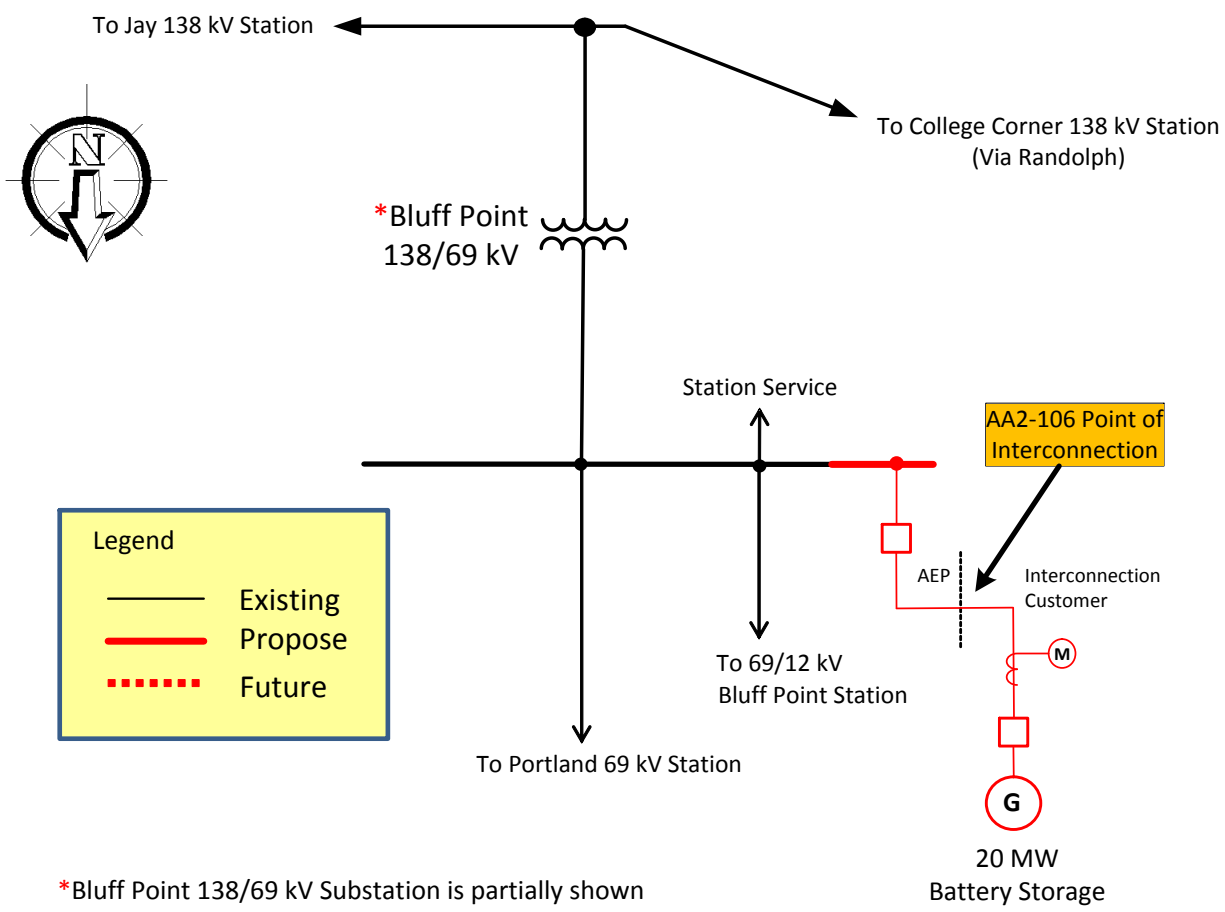
Estimated Protection and Relaying Cost: $200,000

Estimated Customer Revenue Metering Package Cost: $200,000

Total Estimated Cost for Project AA2-106: $1,100,000

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.

Figure 1: PJM Queue AA2-106 POI
(Bluff Point 69 kV)



*Bluff Point 138/69 kV Substation is partially shown

Figure 2: PJM Queue AA2-106 POI
(Bluff Point 69 kV Station)