Generation Interconnection

Feasibility Study Report

for

Queue Project AF1-049

BERRY HILL 138 KV

75 MW Capacity / 125 MW Energy

January, 2020

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1 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. Cost allocation rules for network upgrades can be found in PJM Manual 14A, Attachment B. 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 Interconnection Customer seeking to interconnect a wind or solar generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per Schedule H to the Interconnection Service Agreement and Section 8 of Manual 14D.

An Interconnection Customer 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.

PJM utilizes manufacturer models to ensure the performance of turbines is properly captured during the simulations performed for stability verification and, where applicable, for compliance with low voltage ride through requirements. Turbine manufacturers provide such models to their customers. The list of manufacturer models PJM has already validated is contained in Attachment B of Manual 14G. Manufacturer models may be updated from time to time, for various reasons such as to reflect changes to the control systems or to more accurately represent the capabilities turbines and controls which are currently available in the field. Additionally, as new turbine models are developed, turbine manufacturers provide such new models which must be used in the conduct of these studies. PJM needs adequate time to evaluate the new models in order to reduce delays to the System Impact Study process timeline for the Interconnection Customer as well as other Interconnection Customers in the study group. Therefore, PJM will require that any Interconnection Customer with a new manufacturer model must supply that model to PJM, along with a $10,000 fully refundable deposit, no later than three (3) months prior to the starting date of the System Impact Study (See Section 4.3 for starting dates) for the Interconnection Request which shall specify the use of the new model. The Interconnection Customer will be required to submit a completed dynamic model study request form (Attachment B-1 of Manual 14G) in order to document the request for the study.

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.

2 General

The Interconnection Customer (IC), has proposed a Solar generating facility located in Pittsylvania County, Virginia. The installed facilities will have a total capability of 125 MW with 75 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is 11/25/2022. This study does not imply a TO commitment to this in-service date.

Queue Number	**AF1-049**
Project Name	BERRY HILL 138 KV
State	Virginia
County	Pittsylvania
Transmission Owner	AEP
MFO	125
MWE	125
MWC	75
Fuel	Solar
Basecase Study Year	2023

2.1 Primary Point of Interconnection

AF1-049 will interconnect with the AEP transmission system via a direct connection to the proposed Berry Hill 138 kV station. The Berry Hill station does not presently exist, but is part of a supplemental project presently under development by AEP for other purposes. Supplemental projects are driven by other factors and the in-service date is not finalized yet for the Berry Hill station. See https://www.aeptransmission.com/virginia/BerryHill/ and Figure 2.

To accommodate the interconnection at the Berry Hill 138 kV substation, the substation will have to be expanded requiring the installation of two 138 kV circuit breakers (see Figure 1.) Installation of associated protection and control equipment, 138 kV line risers, SCADA and 138 kV revenue metering will also be required.

An Alternate Point of Interconnection was also studied, which would interconnect via a new station to be cut into the Berry Hill-Danville #2 138 kV circuit (see Figures 3 and 4.)

2.2 Cost Summary:

The AF1-049 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$250,000
Direct Connection Network Upgrade	$4,000,000
Non Direct Connection Network Upgrades	$0
Total Costs	$4,250,000

In addition, the AF1-049 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	$0

Cost allocations for these upgrades will be provided in the System Impact Study Report.

3 Transmission Owner Scope of Work

4 Attachment Facilities

The total preliminary cost estimate for the Attachment work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
138kV Revenue Metering	$250,000
Total Attachment Facility Costs	$250,000

5 Direct Connection Cost Estimate

The total preliminary cost estimate for the Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
Adding a new string and install two (2) additional 138 kV circuit breakers. Installation of associated protection and control equipment, 138 kV line risers and SCADA will also be required.	$4,000,000
Total Direct Connection Facility Costs	$4,000,000

6 Non-Direct Connection Cost Estimate

The total preliminary cost estimate for the Non-Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
	$0
Total Non-Direct Connection Facility Costs	$0

7 Incremental Capacity Transfer Rights (ICTRs)

Will be determined at a later study phase

8 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 generally be between 24 to 36 months after Agreement execution.

9 Interconnection Customer Requirements

It is understood that the Interconnection Customer is responsible for all costs associated with this interconnection. The costs above are reimbursable to AEP. The cost of the Interconnection Customer's generating plant and the costs for the line connecting the generating plant to the Proposed Berry Hill 138 kV station are not included in this report; these are assumed to be the Interconnection Customer '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.

In addition, if the Interconnection Customer considers use of the Option to Build, they should consult the guidance AEP has posted at:

https://www.aep.com/assets/docs/requiredpostings/TransmissionStudies/docs/2019/MerchantGenerationGuidelinesPJMoptiontoBuild.pdf

10 Revenue Metering and SCADA Requirements

10.1 PJM Requirements

The Interconnection Customer will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Section 8 of Attachment O.

10.2 AEP Requirements

The Interconnection Customer will be required to comply with all AEP Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "Requirements for Connection of New Facilities or Changes to Existing Facilities Connected to the AEP Transmission System" document located at the following link:

http://www.pjm.com/~/media/planning/plan-standards/private-aep/aep-interconnection-requirements.ashx

11 Network Impacts

The Queue Project AF1-049 was evaluated as a 125.0 MW (Capacity 75.0 MW) injection at the Berry Hill 138 kV substation in the AEP area. Project AF1-049 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-049 was studied with a commercial probability of 0.53. Potential network impacts were as follows:

Summer Peak Load Flow

12 Generation Deliverability

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

None

13 Multiple Facility Contingency

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

None

14 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

15 Potential Congestion due to Local Energy Deliverability

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.

Note: Only the most severely overloaded conditions are listed below. 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 shall study all overload conditions associated with the overloaded element(s) identified.

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
43703810	242555	05BLAINE	138.0	AEP	242773	05ROANO1	138.0	AEP	1	AEP_P1-2_#PMS_73	operation	223.0	102.64	104.42	DC	8.73
43703807	242620	05DANVL2	138.0	AEP	242631	05EDAN1	138.0	AEP	1	AEP_P1-2_#1370	operation	402.0	87.18	107.26	DC	80.7
43703808	242620	05DANVL2	138.0	AEP	242631	05EDAN1	138.0	AEP	1	Base Case	operation	275.0	82.52	104.3	DC	59.89
43703790	242631	05EDAN1	138.0	AEP	242632	05EDAN2	138.0	AEP	Z1	AEP_P1-3_#8675_05EDANV1 230_5-B	operation	296.0	97.59	116.38	DC	55.6
43703726	242711	05MARTN1	138.0	AEP	242744	05PATCTR	138.0	AEP	1	AEP_P1-2_#5459	operation	202.0	108.98	115.89	DC	13.95
43703600	242816	05STOCKT	138.0	AEP	242711	05MARTN1	138.0	AEP	1	AEP_P1-2_#5459	operation	202.0	127.31	134.7	DC	14.93

16 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
			TOTAL COST	$0

17 Flow Gate Details

The following indices contain additional information about each flowgate presented in the body of the report. For each index, 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.

Affected Systems

18 Affected Systems

18.1 LG&E

LG&E Impacts to be determined during later study phases (as applicable).

18.2 MISO

MISO Impacts to be determined during later study phases (as applicable).

18.3 TVA

TVA Impacts to be determined during later study phases (as applicable).

18.4 Duke Energy Progress

Duke Energy Progress Impacts to be determined during later study phases (as applicable).

18.5 NYISO

NYISO Impacts to be determined during later study phases (as applicable).

19 Contingency Descriptions

Contingency Name	Contingency Definition
Base Case	
AEP_P1-2_#5459	CONTINGENCY 'AEP_P1-2_#5459' 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 Z1 / 243977 05MART 115 34.5 243979 05MART2-30 34.5 Z1 OPEN BRANCH FROM BUS 243977 TO BUS 243980 CKT 1 / 243977 05MART 115 34.5 243980 05MORRIS-N 34.5 1 END
AEP_P1-2_#PMS_73	CONTINGENCY 'AEP_P1-2_#PMS_73' OPEN BRANCH FROM BUS 247499 TO BUS 242802 CKT Z1 / 247499 05SMITHMTN2 242802 05SMITHMTN1 Z1 END
AEP_P1-2_#1370	CONTINGENCY 'AEP_P1-2_#1370' OPEN BRANCH FROM BUS 242509 TO BUS 242514 CKT 1 / 242509 05AXTON 765 242514 05J.FERR 765 1 OPEN BRANCH FROM BUS 242509 TO BUS 242545 CKT 1 / 242509 05AXTON 765 242545 05AXTONX 138 1 OPEN BRANCH FROM BUS 242544 TO BUS 242545 CKT SR / 242544 05AXTON 138 242545 05AXTONX 138 SR OPEN BRANCH FROM BUS 242544 TO BUS 242545 CKT ZB / 242544 05AXTON 138 242545 05AXTONX 138 ZB END
AEP_P1-3_#8675_05EDANV1 230_5-B	CONTINGENCY 'AEP_P1-3_#8675_05EDANV1 230_5-B' OPEN BRANCH FROM BUS 936160 TO BUS 304024 CKT 1 / 936160 AD2-022 TAP 230 304024 6ROXSEP230 T 230 1 END

Short Circuit

20 Short Circuit

The following Breakers are overduty

None