Generation Interconnection

Feasibility Study Report

for

Queue Project AE1-178

WOLF HILLS 138 KV

19 MW Capacity / 19 MW Energy

June, 2019

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.

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.

General

The Interconnection Customer has proposed to increase its existing Natural Gas generating facility, PJM project # N11, located in Washington County, Bristol, Virginia by 19MW with 19MW of this output being recognized by PJM as capacity. Note that this project does not involve a modification to any equipment. The installed facilities will have a total capability of 294 MW with 262.9 MW of this output being recognized by PJM as Capacity. The Point of Interconnection will be the Wolf Hills 138 kV substation.

The proposed in-service date for this project is August 31, 2019. This study does not imply AEP's commitment to this in-service date.

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 for maintaining the reliability of the AEP transmission system.

The Feasibility Study includes Short Circuit and Peak Load steady state power flow analyses. The conduct of power flow studies at other load levels, stability analysis, and coordination with non-PJM Transmission Planners, as required under the PJM planning process, is not performed during the Generation Interconnection Feasibility Study phase of the PJM study process. Additional reinforcement requirements for this Interconnection Request may be defined during the conduct of these additional analyses which shall be performed following execution of the System Impact Study agreement.

Queue Number	AE1-178
Project Name	WOLF HILLS 138 KV
State	Virginia
County	Washington
Transmission Owner	AEP
MFO	294
MWE	19
MWC	19
Fuel	Natural Gas
Basecase Study Year	2022

Point of Interconnection

AE1-178 is an uprate to the existing Natural Gas generating facility (PJM project # N11) at Wolf Hills station.

Cost Summary

The AE1-178 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$0
Direct Connection Network Upgrade	$0
Non Direct Connection Network Upgrades	$0
Total Costs	$0

In addition, the AE1-178 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	$3,096,000

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

Transmission Owner Scope of Work

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
	$
	$
	$
Total Attachment Facility Costs	$0

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
	$
	$
	$
Total Direct Connection Facility Costs	$0

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

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 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.

Requirement from the PJM Open Access Transmission Tariff:

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.

Revenue Metering and SCADA Requirements

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.

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

Network Impacts

The Queue Project AE1-178 was evaluated as a 19 MW (Capacity 19 MW) uprate to the Interconnection Customers facility in the AEP area. Project AE1-178 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE1-178 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Load Flow

Generation Deliverability

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

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
792035	242850	05WOLFH1	AEP	242738	05ORBNK1	AEP	1	AEP_P1-2_#5698	single	151.0	94.82	101.77	DC	10.49

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)

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
791103	242861	05ABINGDON	AEP	244241	05HILLMAN	AEP	1	AEP_P4_#9173_05BROADF 765_P	breaker	50.0	104.47	104.94	DC	0.52
791997	242861	05ABINGDON	AEP	244241	05HILLMAN	AEP	1	AEP_P1-2_#1375	single	50.0	104.72	105.77	DC	0.52

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	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING	POST PROJECT LOADING	AC|DC	MW IMPACT

											%	%		
792034	242850	05WOLFH1	AEP	242738	05ORBNK1	AEP	1	AEP_P1-2_#5698	operation	151.0	94.82	101.77	DC	10.49
791998	242861	05ABINGDON	AEP	244241	05HILLMAN	AEP	1	AEP_P1-2_#1375	operation	50.0	102.99	103.46	DC	0.52

System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
792035	1	05WOLFH1 138.0 kV - 05ORBNK1 138.0 kV Ckt 1	**AEP** Description: No Violation. Current AEP Rating: S/N: 167 MVA, S/E: 167 MVA.	$0
791997,791103	2	05ABINGDON 69.0 kV - 05HILLMAN 69.0 kV Ckt 1	**AEP** Description: Current End Ratings: S/N: 50 MVA, S/E: 50 MVA. 1) Rebuild/reconductor the 2.58 miles of ACSR ~ 211.6 ~ 6/1 ~ PENGUIN (4/0) @ 320 deg, Conductor Section 1 to mitigate the overload. Estimated cost: 3.096 million. Time Estimate : 18-24 Months Cost : $3,096,000	$3,096,000
			TOTAL COST	**$3,096,000**

Flow Gate Details

The following appendices contain additional information about each flow gate presented in the body of the report. For each appendix, a description of the flow gate 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 flow gate 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.

Index 1

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
792035	242850	05WOLFH1	AEP	242738	05ORBNK1	AEP	1	AEP_P1-2_#5698	single	151.0	94.82	101.77	DC	10.49

Bus #	Bus	MW Impact
247347	05WLF1G3	7.48
247348	05WLF1G4	7.48
247349	05WLF1G5	7.48
939471	AE1-178 3	2.7
939481	AE1-178 4	3.6
939491	AE1-178 5	4.2
BAYOU	BAYOU	0.08
BIG_CAJUN1	BIG_CAJUN1	0.13
BIG_CAJUN2	BIG_CAJUN2	0.26
BLUEG	BLUEG	0.4
CALDERWOOD	CALDERWOOD	0.04
CANNELTON	CANNELTON	0.02
CARR	CARR	0.03
CATAWBA	CATAWBA	0.03
CHEOAH	CHEOAH	0.04
CHILHOWEE	CHILHOWEE	0.01
CHOCTAW	CHOCTAW	0.09
COFFEEN	COFFEEN	0.04
COTTONWOOD	COTTONWOOD	0.33
DEARBORN	DEARBORN	0.07
DUCKCREEK	DUCKCREEK	0.09
EDWARDS	EDWARDS	0.04
ELMERSMITH	ELMERSMITH	0.04
FARMERCITY	FARMERCITY	0.03
GIBSON	GIBSON	0.02
HAMLET	HAMLET	0.09
NEWTON	NEWTON	0.11
PRAIRIE	PRAIRIE	0.2
RENSSELAER	RENSSELAER	0.02
SANTEETLA	SANTEETLA	0.01
SMITHLAND	SMITHLAND	0.02
TATANKA	TATANKA	0.05
TILTON	TILTON	0.05
TRIMBLE	TRIMBLE	0.04
TVA	TVA	0.14
UNIONPOWER	UNIONPOWER	0.06

Index 2

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
791997	242861	05ABINGDON	AEP	244241	05HILLMAN	AEP	1	AEP_P1-2_#1375	single	50.0	104.72	105.77	DC	0.52

Bus #	Bus	MW Impact
247351	05WLF2G1	0.47
247352	05WLF2G2	0.47
939451	AE1-178 1	0.26
939461	AE1-178 2	0.26
CARR	CARR	0.02
CBM-S1	CBM-S1	1.65
CBM-S2	CBM-S2	0.34
CBM-W1	CBM-W1	0.77
CBM-W2	CBM-W2	8.06
CIN	CIN	0.39
CPLE	CPLE	0.07
IPL	IPL	0.23
LGEE	LGEE	0.14
MEC	MEC	1.04
MECS	MECS	0.14
RENSSELAER	RENSSELAER	0.01
WEC	WEC	0.1

Affected Systems

LG&E

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

MISO

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

TVA

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

Duke Energy Progress

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

NYISO

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

Contingency Name	Contingency Definition
AEP_P1-2_#1375	CONTINGENCY 'AEP_P1-2_#1375' OPEN BRANCH FROM BUS 242511 TO BUS 242518 CKT 4 / 242511 05BROADF 765 242518 05BROADF 500 4 OPEN BRANCH FROM BUS 242518 TO BUS 360106 CKT 1 / 242518 05BROADF 500 360106 8SULLIVAN TN 500 1 END
AEP_P4_#9173_05BROADF 765_P	CONTINGENCY 'AEP_P4_#9173_05BROADF 765_P' OPEN BRANCH FROM BUS 242510 TO BUS 242511 CKT 1 / 242510 05BAKER 765 242511 05BROADF 765 1 OPEN BRANCH FROM BUS 242511 TO BUS 242518 CKT 4 / 242511 05BROADF 765 242518 05BROADF 500 4 OPEN BRANCH FROM BUS 242518 TO BUS 360106 CKT 1 / 242518 05BROADF 500 360106 8SULLIVAN TN 500 1 END
AEP_P1-2_#5698	CONTINGENCY 'AEP_P1-2_#5698' OPEN BRANCH FROM BUS 242566 TO BUS 242693 CKT 1 / 242566 05BROADF 138 242693 05KEYWSS 138 1 OPEN BRANCH FROM BUS 242692 TO BUS 242693 CKT 1 / 242692 05KEYWOD 138 242693 05KEYWSS 138 1 OPEN BRANCH FROM BUS 242693 TO BUS 242850 CKT 1 / 242693 05KEYWSS 138 242850 05WOLFH1 138 1 END

Short Circuit

Short Circuit

The following Breakers are overduty

Bus Number	Bus Name	BREAKER	Type	Capacity (Amps)	Duty Percentage Post Queue	Duty Percentage Pre Queue

None