Revised Generation Interconnection

Impact Study Report

for

Queue Project AE1-178

WOLF HILLS 138 KV

19 MW Capacity / 19 MW Energy

December, 2019

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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: 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 an Interconnection Customer 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.

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.

General

Wolf Hills Energy, LLC 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.

Queue Number	**AE1-178**
Project Name	WOLF HILLS 138 KV
Interconnection Customer	Wolf Hills Energy, LLC
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
Allocation for New System Upgrades	$0
Contribution for Previously Identified Upgrades	$0
Total Costs	$0

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.

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

Incremental Capacity Transfer Rights (ICTRs)

Will be determined at a later study phase

Interconnection Customer Requirements

It is understood that Wolf Hills Energy 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) injection into the Wolf Hills 138 kV substation 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 1.00. 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
501197	242850	05WOLFH1	AEP	242738	05ORBNK1	AEP	1	AEP_P1-2_#5698	single	151.0	96.84	103.65	AC	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)

None

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
501196	242850	05WOLFH1	AEP	242738	05ORBNK1	AEP	1	AEP_P1-2_#5698	operation	151.0	96.85	103.66	AC	10.49

Stability & Reactive Assessment

To be determined during later study phases (as applicable).

System Reinforcements

ID	Index	Facility	Upgrade Description	Cost	Cost Allocated to AE1-178	NUN
		Wolf Hill – Orbank 138 kV line	The SE rating is 167 MVA, no upgrade is required.	**$0**	$0	N/A

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
501197	242850	05WOLFH1	AEP	242738	05ORBNK1	AEP	1	AEP_P1-2_#5698	single	151.0	96.84	103.65	AC	10.49

Bus #	Bus	MW Impact
247347	05WLF1G3	6.86
247348	05WLF1G4	6.86
247349	05WLF1G5	6.86
939471	AE1-178 3	2.7
939481	AE1-178 4	3.6
939491	AE1-178 5	4.2
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
COFFEEN	COFFEEN	0.04
COTTONWOOD	COTTONWOOD	0.17
DUCKCREEK	DUCKCREEK	0.09
EDWARDS	EDWARDS	0.04
FARMERCITY	FARMERCITY	0.03
GIBSON	GIBSON	0.02
HAMLET	HAMLET	0.05
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

Affected Systems

Affected Systems

LG&E

A LG&E Affected System Study will be required for AE1-178. The AE1-178 customer will need to sign onto a LG&E Affected System Study Agreement.

MISO

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

TVA

A TVA Affected System Study will be required for AE1-178. The AE1-178 customer will need to sign onto a TVA Affected System Study Agreement.

Duke Energy Progress

None

NYISO

None

Contingency Descriptions

Contingency Name	Contingency Definition
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

Figure 1: AE1-178 Single-Line Diagram (Wolf Hills 138 kV)

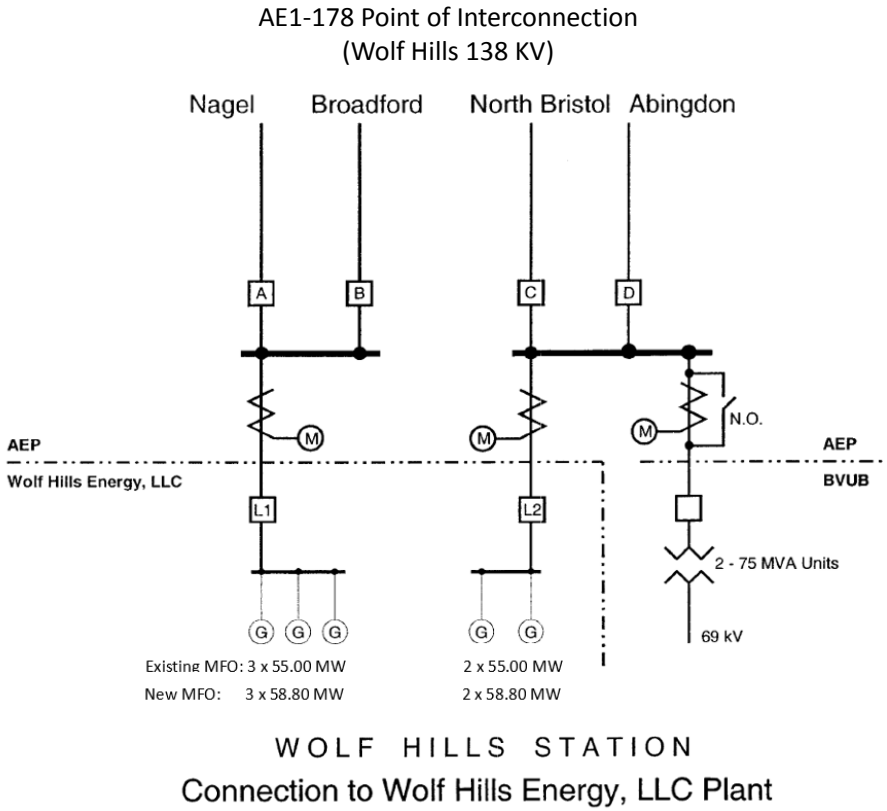

Figure 1: AE1-178 Point of Interconnection (Wolf Hills 138 kV)