Generation Interconnection

Impact Study Report

for

Queue Project AE1-121

AXTON 138 KV

483 MW Capacity / 529.5 MW Energy

November, 2019

Table of Contents

Contents

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

Virginia Electric & Power Co has proposed Unit# 1 and Unit#2 of Natural Gas generating facility located in Pittsylvania, Cascade, Virginia. The proposed two simple-cycle gas turbines will have a total capability of 529.5 MW with 483 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is June, 2022. This study does not imply a TO commitment to this in-service date.

Queue Number	**AE1-121**
Project Name	AXTON 138 KV
Interconnection Customer	Virginia Electric & Power Co
State	Virginia
County	Pittsylvania
Transmission Owner	AEP
MFO	529.5
MWE	529.5
MWC	483
Fuel	Natural Gas
Basecase Study Year	2022

Primary Point of Interconnection

AE1-121 will interconnect with the AEP transmission system at the Axton 138 kV substation.

To accommodate the interconnection at the Axton 138 kV substation, the substation will have to be expanded requiring the installation of two new 138 kV circuit breakers, extending the two 138kV buses, and starting a new string (See Figure 1) Installation of associated protection and control equipment, SCADA, and 138 kV revenue metering.

Cost Summary

The AE1-121 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$250,000
Direct Connection Network Upgrade	$0
Non Direct Connection Network Upgrades	$3,250,000
Allocation for New System Upgrades	$0
Contribution for Previously Identified Upgrades	$0
Total Costs	$3,500,000

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.

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

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
	$ 0
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
Expand the Axton 138 kV substation, start a new string, extend the two 138 kV buses and install two (2) 138 kV circuit breakers (see Figure 1). Installation of associated protection and control equipment, SCADA, and 138 kV revenue metering will also be required.	$ 3,250,000
Total Non-Direct Connection Facility Costs	$ 3,250,000

Incremental Capacity Transfer Rights (ICTRs)

Will be determined at a later study phase

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.

Interconnection Customer Requirements

It is understood that Virginia Electric & Power Co is responsible for all costs associated with this interconnection. The costs above are reimbursable to AEP. The cost of Virginia Electric & Power Co.'s generating plant and the costs for the line connecting the generating plant to Axton station is not included in this report; these are assumed to be Virginia Electric & Power co.'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.

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 AE1-121 was evaluated as a 484.5 MW (Capacity 483.0 MW) injection into the Axton 138 kV substation in the AEP area. Project AE1-121 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE1-121 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)

None

Multiple Facility Contingency

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

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
380397	242816	05STOCKT	AEP	242711	05MARTN1	AEP	1	AEP_P4_#10168_05AXTON 138_H	breaker	202.0	60.98	110.15	AC	99.51

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
381768	242544	05AXTON	AEP	242816	05STOCKT	AEP	1	AEP_P1-2_#5459	operation	273.0	48.53	78.03	AC	80.16
4255543	242555	05BLAINE	AEP	242773	05ROANO1	AEP	1	247499 05SMITHMTN2 - 242802 05SMITHMTN1 CKT Z1	operation	223.0	81.49	94.47	AC	34.2
381880	242620	05DANVL2	AEP	242631	05EDAN 1	AEP	1	AEP_P1-2_#1370	operation	402.0	59.35	79.63	AC	271.6

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
4255683	242620	05DANVL2	AEP	242631	05EDAN 1	AEP	1	242509 05AXTON 765 242514 05J.FERR 765 1	operation	402.0	59.35	79.63	AC	271.6
381860	242631	05EDAN 1	AEP	242632	05EDAN 2	AEP	Z1	AEP_P1-2_#1370	operation	296.0	35.96	64.6	AC	157.07
4255671	242631	05EDAN 1	AEP	242632	05EDAN 2	AEP	Z1	242509 05AXTON 765 242514 05J.FERR 765 1	operation	296.0	35.96	64.6	AC	157.07
381454	242711	05MARTN1	AEP	242744	05PATCTR	AEP	1	AEP_P1-2_#5459	operation	202.0	50.86	87.6	AC	74.74
381333	242816	05STOCKT	AEP	242711	05MARTN1	AEP	1	AEP_P1-2_#5459	operation	202.0	62.57	102.4	AC	80.16

System Reinforcements

ID	Index	Facility	Upgrade Description	Cost	Cost Allocated to AE1-121	NUN
		Stockton – Martin 138 kV line	**The SE rating is 378 MVA and is sufficient. No upgrade required.**	**$0**	$0	N/A

Flow Gate Details

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.

Index 4

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
380397	242816	05STOCKT	AEP	242711	05MARTN1	AEP	1	AEP_P4_#10168_05AXTON 138_H	breaker	202.0	60.98	110.15	AC	99.51

Bus #	Bus	MW Impact
926461	AC1-117 C	2.43
926462	AC1-117 E	3.96
938741	AE1-100 C O1	8.61
938742	AE1-100 E O1	4.95
938931	AE1-121 O1	99.2
938932	AE1-121 E	0.31
938941	AE1-122 O1	99.2
938942	AE1-122 E	0.31
CARR	CARR	0.01
CBM-S1	CBM-S1	0.72
CBM-S2	CBM-S2	0.73
CBM-W1	CBM-W1	0.63
CBM-W2	CBM-W2	4.48
CIN	CIN	0.29
CPLE	CPLE	0.49
G-007	G-007	0.05
IPL	IPL	0.18
LGEE	LGEE	0.08
MEC	MEC	0.67
MECS	MECS	0.23
O-066	O-066	0.3
RENSSELAER	RENSSELAER	0.01
WEC	WEC	0.08

Affected Systems

Affected Systems

LG&E

None

MISO

MISO Impacts to be determined during the Facilities Study Phase

TVA

None

Duke Energy Progress

None

NYISO

None

Contingency Descriptions

Contingency Name	Contingency Definition
242509 05AXTON 765 242514 05J.FERR 765 1	CONTINGENCY '242509 05AXTON 765 242514 05J.FERR 765 1' / 8403 OPEN BRANCH FROM BUS 242509 TO BUS 242514 CKT 1 / 242509 05AXTON 765 242514 05J.FERR 765 1 END
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_P7-1_#10880	CONTINGENCY 'AEP_P7-1_#10880' OPEN BRANCH FROM BUS 242544 TO BUS 242712 CKT 1 / 242544 05AXTON 138 242712 05MARTN2 138 1 OPEN BRANCH FROM BUS 242544 TO BUS 242816 CKT 1 / 242544 05AXTON 138 242816 05STOCKT 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 242711 TO BUS 242816 CKT 1 / 242711 05MARTN1 138 242816 05STOCKT 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_#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

Contingency Name	Contingency Definition
AEP_P4_#2916_05J.FERR 765_A	CONTINGENCY 'AEP_P4_#2916_05J.FERR 765_A' OPEN BRANCH FROM BUS 242509 TO BUS 242514 CKT 1 / 242509 05AXTON 765 242514 05J.FERR 765 1 OPEN BRANCH FROM BUS 242511 TO BUS 242514 CKT 1 / 242511 05BROADF 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 OPEN BRANCH FROM BUS 242566 TO BUS 242567 CKT ZB / 242566 05BROADF 138 242567 05BROADX 138 ZB END
AEP_P4_#10171_05AXTON 138_G	CONTINGENCY 'AEP_P4_#10171_05AXTON 138_G' 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 OPEN BRANCH FROM BUS 242544 TO BUS 242619 CKT 2 / 242544 05AXTON 138 242619 05DANVL1 138 2 END
AEP_P4_#10168_05AXTON 138_H	CONTINGENCY 'AEP_P4_#10168_05AXTON 138_H' OPEN BRANCH FROM BUS 242544 TO BUS 242620 CKT 1 / 242544 05AXTON 138 242620 05DANVL2 138 1 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
247499 05SMITHMTN2 - 242802 05SMITHMTN1 CKT Z1	CONTINGENCY '247499 05SMITHMTN2 - 242802 05SMITHMTN1 CKT Z1' /MISSING SINGLE DISCONNECT BRANCH FROM BUS 247499 TO BUS 242802 CKT Z1 END

Short Circuit

Short Circuit

The following Breakers are over duty:

None

Figure 1: AE1-121 (Axton 138kV) One Line Diagram

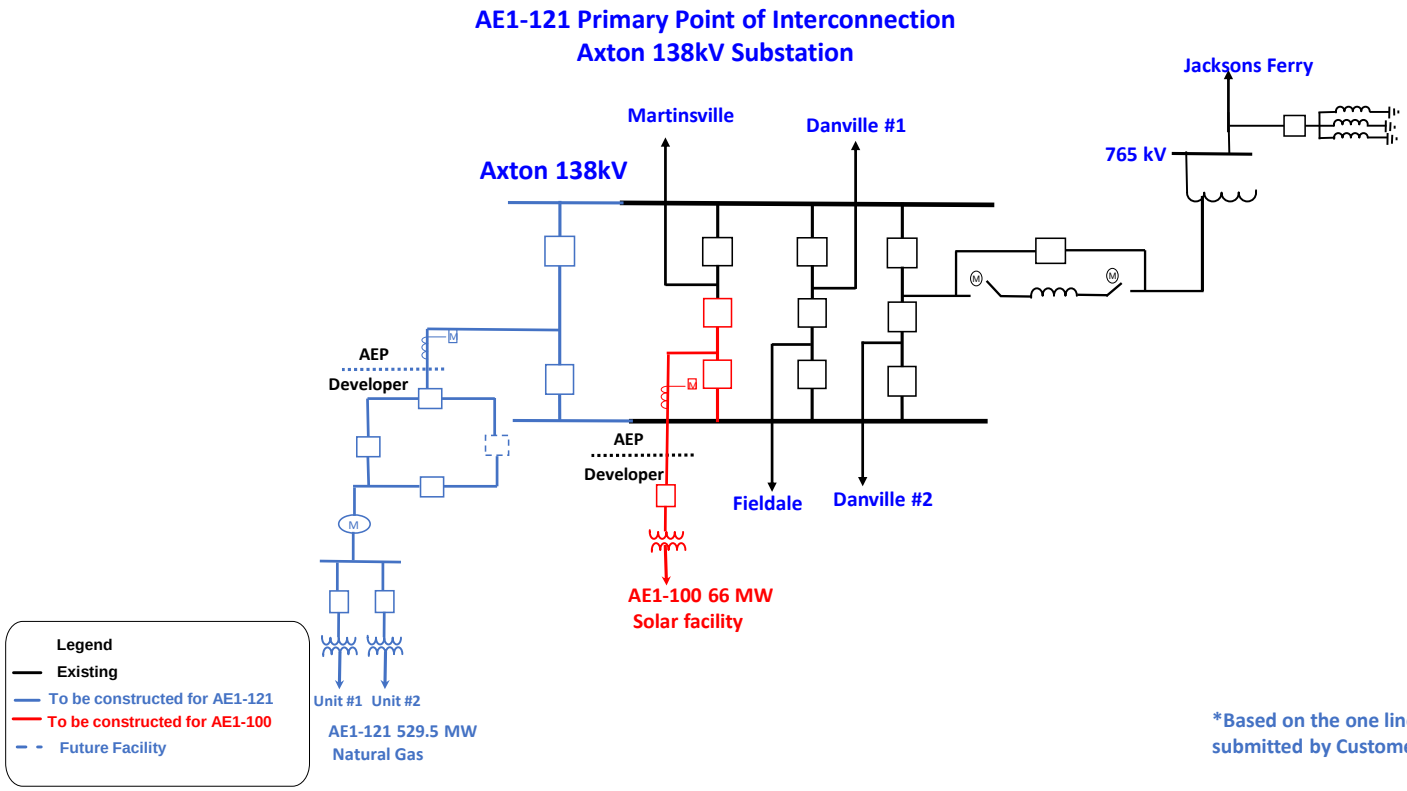

Figure 2: Point of Interconnection (Axton 138kV)