Generation Interconnection

Feasibility Study Report

for

Queue Project AE1-121

AXTON 138 KV

483 MW Capacity / 529.5 MW Energy

June, 2019

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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.

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.

General

The Interconnection Customer 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.

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.

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 maintaining the reliability of the AEP transmission system. Stability analysis is not included as part of this study.

Queue Number	AE1-121
Project Name	AXTON 138 KV
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	$ 3,250,000
Direct Connection Network Upgrade	$250,000
Non Direct Connection Network Upgrades	$ 0
Total Costs	$ 3,500,000

In addition, the AE1-121 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.

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
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 Attachment Facility Costs	$ 3,250,000

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
138 kV Revenue Metering	$ 250,000
Total Direct Connection Facility Costs	$ 250,000

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

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.

Transmission Owner Analysis

None

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 Axton station is 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.

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 – Option 1

The Queue Project AE1-121 was evaluated as a 529.5 MW (Capacity 483 MW) injection at 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 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
672607	242544	05AXTON	AEP	242816	05STOCKT	AEP	1	AEP_P1-2_#5459	single	273.0	47.74	77.11	DC	80.18
672293	242711	05MARTN1	AEP	242744	05PATCTR	AEP	1	AEP_P1-2_#5459	single	202.0	50.25	87.25	DC	74.74
672295	242711	05MARTN1	AEP	242744	05PATCTR	AEP	1	AEP_P1-2_#1370	single	202.0	30.41	69.18	DC	78.31
672172	242816	05STOCKT	AEP	242711	05MARTN1	AEP	1	AEP_P1-2_#5459	single	202.0	61.9	101.58	DC	80.16
672174	242816	05STOCKT	AEP	242711	05MARTN1	AEP	1	AEP_P1-2_#1370	single	202.0	40.15	82.3	DC	85.15

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
671556	242544	05AXTON	AEP	242620	05DANVL2	AEP	1	AEP_P4_#10171_05AXTON 138_G	breaker	382.0	32.1	76.55	DC	261.94
671589	242544	05AXTON	AEP	242816	05STOCKT	AEP	1	AEP_P4_#10168_05AXTON 138_H	breaker	273.0	47.49	83.95	DC	99.52
673120	242620	05DANVL2	AEP	242631	05EDAN 1	AEP	1	AEP_P7-1_#10880	tower	402.0	23.45	60.8	DC	216.22
671851	242631	05EDAN 1	AEP	242632	05EDAN 2	AEP	Z1	AEP_P4_#2916_05J.FERR 765_A	breaker	296.0	32.98	62.42	DC	157.0
673111	242631	05EDAN 1	AEP	242632	05EDAN 2	AEP	Z1	AEP_P7-1_#10880	tower	296.0	12.15	49.73	DC	127.45
671333	242711	05MARTN1	AEP	242744	05PATCTR	AEP	1	AEP_P4_#10168_05AXTON 138_H	breaker	202.0	51.77	97.65	DC	92.68
671235	242816	05STOCKT	AEP	242711	05MARTN1	AEP	1	AEP_P4_#10168_05AXTON 138_H	breaker	202.0	63.55	112.81	DC	99.5

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
672606	242544	05AXTON	AEP	242816	05STOCKT	AEP	1	AEP_P1-2_#5459	operation	273.0	49.45	78.82	DC	80.18
672698	242631	05EDAN 1	AEP	242632	05EDAN 2	AEP	Z1	AEP_P1-2_#1370	operation	296.0	33.16	62.45	DC	157.06
672292	242711	05MARTN1	AEP	242744	05PATCTR	AEP	1	AEP_P1-2_#5459	operation	202.0	54.04	91.04	DC	74.74
672171	242816	05STOCKT	AEP	242711	05MARTN1	AEP	1	AEP_P1-2_#5459	operation	202.0	65.97	105.65	DC	80.16

System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
671851,673111	6	05EDAN 1 138.0 kV - 05EDAN 2 138.0 kV Ckt Z1	**AEP** Description : Current AEP Ratings: S/N: 287 MVA, S/E: 337 MVA.AEP ratings are sufficient to mitigate the overload.	$0
672295,671333,672293	2	05MARTN1 138.0 kV - 05PATCTR 138.0 kV Ckt 1	**AEP** Description : Current AEP Ratings: S/N: 293 MVA, S/E: 341 MVA. AEP ratings are sufficient to mitigate the overload.	$0
671556	4	05AXTON 138.0 kV - 05DANVL2 138.0 kV Ckt 1	**AEP** Description : Current AEP Ratings: S/N: 335 MVA, S/E: 392 MVA. AEP ratings are sufficient to mitigate the overload.	$0
671235,672172,672174	3	05STOCKT 138.0 kV - 05MARTN1 138.0 kV Ckt 1	**AEP** Description : Current AEP Ratings: S/N: 296 MVA, S/E: 378 MVA. AEP ratings are sufficient to mitigate the overload.	$0
673120	5	05DANVL2 138.0 kV - 05EDAN 1 138.0 kV Ckt 1	**AEP** Description : Current AEP End Ratings: S/N: 287 MVA, S/E: 337 MVA. AEP ratings are sufficient to mitigate the overload.	$0
671589,672607	1	05AXTON 138.0 kV - 05STOCKT 138.0 kV Ckt 1	**AEP** Description : Current End Ratings: S/N: 283 MVA, S/E: 396 MVA. AEP ratings are sufficient to mitigate the overload.	$0
			TOTAL COST	**$0**

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 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
671589	242544	05AXTON	AEP	242816	05STOCKT	AEP	1	AEP_P4_#10168_05AXTON 138_H	breaker	273.0	47.49	83.95	DC	99.52

Bus #	Bus	MW Impact
938741	AE1-100 C O1	8.61
938742	AE1-100 E O1	4.95
938931	AE1-121 O1	99.52
938941	AE1-122 O1	99.52
CARR	CARR	0.01
CBM-S1	CBM-S1	0.73
CBM-S2	CBM-S2	0.74
CBM-W1	CBM-W1	0.64
CBM-W2	CBM-W2	4.6
CIN	CIN	0.3
CPLE	CPLE	0.49
G-007	G-007	0.04
IPL	IPL	0.18
LGEE	LGEE	0.09
MEC	MEC	0.68
MECS	MECS	0.24
O-066	O-066	0.15
RENSSELAER	RENSSELAER	0.01
WEC	WEC	0.08

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
671333	242711	05MARTN1	AEP	242744	05PATCTR	AEP	1	AEP_P4_#10168_05AXTON 138_H	breaker	202.0	51.77	97.65	DC	92.68

Bus #	Bus	MW Impact
926461	AC1-117 C	0.35
926462	AC1-117 E	3.69
938741	AE1-100 C O1	8.02
938742	AE1-100 E O1	4.61
938931	AE1-121 O1	92.68
938941	AE1-122 O1	92.68
CARR	CARR	0.01
CBM-S1	CBM-S1	0.68
CBM-S2	CBM-S2	0.7
CBM-W1	CBM-W1	0.58
CBM-W2	CBM-W2	4.27
CIN	CIN	0.27
CPLE	CPLE	0.47
G-007	G-007	0.05
IPL	IPL	0.17
LGEE	LGEE	0.08
MEC	MEC	0.63
MECS	MECS	0.22
O-066	O-066	0.15
RENSSELAER	RENSSELAER	0.01
WEC	WEC	0.07

Index 3

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
671235	242816	05STOCKT	AEP	242711	05MARTN1	AEP	1	AEP_P4_#10168_05AXTON 138_H	breaker	202.0	63.55	112.81	DC	99.5

Bus #	Bus	MW Impact
926461	AC1-117 C	0.37
926462	AC1-117 E	3.96
938741	AE1-100 C O1	8.61
938742	AE1-100 E O1	4.95
938931	AE1-121 O1	99.5
938941	AE1-122 O1	99.5
CARR	CARR	0.02
CBM-S1	CBM-S1	0.72
CBM-S2	CBM-S2	0.73
CBM-W1	CBM-W1	0.62
CBM-W2	CBM-W2	4.5
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	0.16
RENSSELAER	RENSSELAER	0.01
WEC	WEC	0.08

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
671556	242544	05AXTON	AEP	242620	05DANVL2	AEP	1	AEP_P4_#10171_05AXTON 138_G	breaker	382.0	32.1	76.55	DC	261.94

Bus #	Bus	MW Impact
247723	05PHILPOTT	0.61
926461	AC1-117 C	0.57
926462	AC1-117 E	6.03
934751	AD1-102 C	1.21
934752	AD1-102 E	8.09
937471	AD2-201AC O1	1.75
937472	AD2-201AE O1	1.07
938741	AE1-100 C O1	22.65
938742	AE1-100 E O1	13.03
938931	AE1-121 O1	261.94
938941	AE1-122 O1	261.94
939441	AE1-176	0.14
940083	AE1-250 EBAT	6.02
BAYOU	BAYOU	0.27
BIG_CAJUN1	BIG_CAJUN1	0.49
BIG_CAJUN2	BIG_CAJUN2	0.97
CALDERWOOD	CALDERWOOD	0.23
CARR	CARR	0.01
CATAWBA	CATAWBA	0.57
CBM-W1	CBM-W1	1.73
CHEOAH	CHEOAH	0.23
CHILHOWEE	CHILHOWEE	0.07
CHOCTAW	CHOCTAW	0.35
CIN	CIN	0.83
COTTONWOOD	COTTONWOOD	1.0
G-007	G-007	0.09
HAMLET	HAMLET	2.77
IPL	IPL	0.56
LGEE	LGEE	0.26
MEC	MEC	0.87
MECS	MECS	1.34
O-066	O-066	0.3
RENSSELAER	RENSSELAER	0.01
SANTEETLA	SANTEETLA	0.07
TVA	TVA	0.36
UNIONPOWER	UNIONPOWER	0.36
WEC	WEC	0.2

Index 5

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
673120	242620	05DANVL2	AEP	242631	05EDAN 1	AEP	1	AEP_P7-1_#10880	tower	402.0	23.45	60.8	DC	216.22

Bus #	Bus	MW Impact
244012	05PINNACLE	2.62
934233	AD1-050 BAT	2.26
938741	AE1-100 C O1	18.7
938742	AE1-100 E O1	10.76
938931	AE1-121 O1	216.22
938941	AE1-122 O1	216.22
940083	AE1-250 EBAT	21.12
AC1-133	AC1-133	16.49
BAYOU	BAYOU	0.03
BIG_CAJUN1	BIG_CAJUN1	0.16
BIG_CAJUN2	BIG_CAJUN2	0.31
CALDERWOOD	CALDERWOOD	0.13
CARR	CARR	0.05
CATAWBA	CATAWBA	0.88
CBM-S1	CBM-S1	0.94
CBM-W1	CBM-W1	4.94
CBM-W2	CBM-W2	8.87
CHEOAH	CHEOAH	0.16
CHILHOWEE	CHILHOWEE	0.04
CHOCTAW	CHOCTAW	0.14
CIN	CIN	2.34
G-007	G-007	0.29
HAMLET	HAMLET	4.49
IPL	IPL	1.55
LGEE	LGEE	0.73
MEC	MEC	3.24
MECS	MECS	3.3
O-066	O-066	0.94
RENSSELAER	RENSSELAER	0.04
SANTEETLA	SANTEETLA	0.05
UNIONPOWER	UNIONPOWER	0.31
WEC	WEC	0.59

Index 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
671851	242631	05EDAN 1	AEP	242632	05EDAN 2	AEP	Z1	AEP_P4_#2916_05J.FERR 765_A	breaker	296.0	32.98	62.42	DC	157.0

Bus #	Bus	MW Impact
244012	05PINNACLE	2.39
247723	05PHILPOTT	0.36
926461	AC1-117 C	0.34
926462	AC1-117 E	3.61
936161	AD2-022 C O1	12.51
936162	AD2-022 E O1	7.51
938741	AE1-100 C O1	13.58
938742	AE1-100 E O1	7.81
938931	AE1-121 O1	157.0
938941	AE1-122 O1	157.0
939943	AE1-230 E2	0.27
940083	AE1-250 EBAT	49.74
CBM-N	CBM-N	0.01
CBM-S1	CBM-S1	0.54
CBM-S2	CBM-S2	0.34
CBM-W1	CBM-W1	0.79
CBM-W2	CBM-W2	3.75
CIN	CIN	0.36
CPLE	CPLE	0.05
G-007A	G-007A	0.01
IPL	IPL	0.23
LGEE	LGEE	0.1
MEC	MEC	0.68
MECS	MECS	0.43
NYISO	NYISO	0.05
O-066A	O-066A	0.0
VFT	VFT	0.03
WEC	WEC	0.09

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_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_#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_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_#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_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_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

Short Circuit

Short Circuit

The following Breakers are over duty:

None

Secondary Point of Interconnection (Axton 765 kV):

To accommodate the interconnection at the Axton 765kV substation, installation of three (3) additional 765 kV circuit breaker will be required (see Figure 3). Installation of associated protection and control equipment, 765 kV line risers, SCADA, and 765 kV revenue metering will also be required.

Option -2 : Network Impacts

The Queue Project AE1-121 was evaluated as a 529.5 MW (Capacity 483 MW) injection at the Axton 765 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 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)

None

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.

None

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.

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

None

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
242684	J.Ferry 138kV	P2	S	50050	100.83	98.97

Supplemental project s1832 will mitigate the above Jackson ferry breaker P2 overduty with the projected ISD of 12/1/2020.