Generation Interconnection

Feasibility Study Report

for

Queue Project AE2-245

STOCKTON-AXTON 34.5 KV

5.3 MW Capacity / 0 MW Energy

December, 2019

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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.

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 Capacity Only uprate to an existing Solar generating facility (AC1-117) located in Henry County, Virginia. This projects requests an increase to the install capability of 0 of uprate MW (energy) with 5.3 of uprate MW of this output being recognized by PJM as Capacity. The installed facilities will have a total capability of 20 MW with 12.9 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is 12/30/2020. This study does not imply a TO commitment to this in-service date.

Queue Number	**AE2-245**
Project Name	STOCKTON-AXTON 34.5 KV
State	Virginia
County	Henry
Transmission Owner	AEP
MFO	20
MWE	0
MWC	5.3
Fuel	Solar
Basecase Study Year	2022

2.1 Point of Interconnection

AE2-245 is an uprate to AC1-117 will interconnect with the AEP transmission system at the Stockton 138 kV substation.

2.2 Cost Summary

This 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

Note: These cost estimates assume that no relaying upgrades are required to accommodate this project. During later study phases, AEP/PJM may determine that relaying upgrades may be required depending on final project schedules for the existing project and this uprate project.

In addition, this project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	$32,000

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
	$0
Total Attachment Facility Costs	$0

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
	$0
Total Direct Connection Facility Costs	$0

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 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 AEP Transmission circuit 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.

Requirement from the PJM Open Access Transmission Tariff:

- 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.
- 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.

9 Revenue Metering and SCADA Requirements

9.1 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.

9.2 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

10 Network Impacts

The Queue Project AE2-245 was evaluated as a 6.9 MW (Capacity 6.9 MW) uprate to the AC1-117 which is an injection at the Stockton 138 kV substation in the AEP area. Project AE2-245 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-245 was studied with a commercial probability of 0.53. Potential network impacts were as follows:

Summer Peak Load Flow

11 Generation Deliverability

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

None

12 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
7265855	242744	05PATCTR	AEP	243799	05FIELDALE 2	AEP	1	AEP_P4_#10171_05AXTON 138_G	breaker	296.0	99.58	100.34	DC	2.25
7265856	242744	05PATCTR	AEP	243799	05FIELDALE 2	AEP	1	AEP_P4_#10168_05AXTON 138_H	breaker	296.0	99.47	100.16	DC	2.05
7265859	243799	05FIELDALE 2	AEP	242736	05OAKLEV	AEP	1	AEP_P4_#10171_05AXTON 138_G	breaker	223.0	99.6	100.07	DC	1.05

13 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
7265216	242711	05MARTN 1	AEP	242744	05PATCTR	AEP	1	AEP_P4_#10171_05AXTON 138_G	breaker	202.0	153.75	154.86	DC	2.25
7265217	242711	05MARTN 1	AEP	242744	05PATCTR	AEP	1	AEP_P4_#10168_05AXTON 138_H	breaker	202.0	153.58	154.6	DC	2.05
7266129	242711	05MARTN 1	AEP	242744	05PATCTR	AEP	1	242509 05AXTON 765 242514 05J.FERR 765 1	single	202.0	122.98	124.0	DC	2.07
7266130	242711	05MARTN 1	AEP	242744	05PATCTR	AEP	1	AEP_P1-2_#1370	single	202.0	122.98	124.0	DC	2.07
7265146	242816	05STOCKT	AEP	242711	05MARTN 1	AEP	1	AEP_P4_#10171_05AXTON 138_G	breaker	202.0	174.74	175.98	DC	2.5
7265147	242816	05STOCKT	AEP	242711	05MARTN 1	AEP	1	AEP_P4_#10168_05AXTON 138_H	breaker	202.0	172.8	173.9	DC	2.21
7266073	242816	05STOCKT	AEP	242711	05MARTN 1	AEP	1	AEP_P1-2_#1370	single	202.0	141.01	142.15	DC	2.3
7266074	242816	05STOCKT	AEP	242711	05MARTN 1	AEP	1	242509 05AXTON 765 242514 05J.FERR 765 1	single	202.0	141.01	142.15	DC	2.3

14 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

15 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
7265146,7265147,7266074,7266073	4	05STOCKT 138.0 kV - 05MARTN1 138.0 kV Ckt 1	AEP Current AEP Ratings are S/N: 283 MVA S/E: 378 MVA. Current AEP ratings are sufficient to mitigate the overloads.	$0
7265859	2	05FIELDALE2 138.0 kV - 05OAKLEV 138.0 kV Ckt 1	AEP AEPA0005a (276) : Perform Sag Study on Fieldale-Roanoke 138 kV circuit between Fieldale and Oak Level (~8 miles of ACSR ~ 636 ~ 26/7 ~ GROSBEAK) Project Type : FAC Cost : $32,000 Time Estimate : 6 - 12months	$32,000
7265216,7265217,7266130,7266129	3	05MARTN1 138.0 kV - 05PATCTR 138.0 kV Ckt 1	AEP No Violation. Current AEP End Ratings: S/N: 293, S/E: 341.	$0
7265855,7265856	1	05PATCTR 138.0 kV - 05FIELDALE2 138.0 kV Ckt 1	AEP Current AEP Ratings are S/N: 293 MVA S/E: 341 MVA. Current AEP ratings are sufficient to mitigate the overloads.	$0
			TOTAL COST	$32,000

16 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.

16.1 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
7265856	242744	05PATCTR	AEP	243799	05FIELDALE 2	AEP	1	AEP_P4_#10168_05AXTON 138_H	breaker	296.0	99.47	100.16	DC	2.05

Bus #	Bus	MW Impact
926461	AC1-117 C	2.26
926462	AC1-117 E	3.69
938741	AE1-100 C O1	8.02
938742	AE1-100 E O1	4.61
938931	AE1-121 O1	92.69
938941	AE1-122 O1	92.69
941671	AE2-166 C	16.06
941672	AE2-166 E	10.71
942321	AE2-245	2.05
CARR	CARR	0.01
CBM-S1	CBM-S1	0.69
CBM-S2	CBM-S2	0.7
CBM-W1	CBM-W1	0.59
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	0.28
RENSSELAER	RENSSELAER	0.01
WEC	WEC	0.07

16.2 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
7265859	243799	05FIELDALE 2	AEP	242736	05OAKLEV	AEP	1	AEP_P4_#10171_05AXTON 138_G	breaker	223.0	99.6	100.07	DC	1.05

Bus #	Bus	MW Impact
244012	05PINNACLE	0.63
247723	05PHILPOTT	0.32
926461	AC1-117 C	1.16
926462	AC1-117 E	1.89
938741	AE1-100 C O1	5.8
938742	AE1-100 E O1	3.33
938931	AE1-121 O1	67.04
938941	AE1-122 O1	67.04
940601	AE2-047 C O1	4.16
940602	AE2-047 E O1	2.78
941431	AE2-140 C O1	15.48
941432	AE2-140 E O1	10.32
941671	AE2-166 C	8.24
941672	AE2-166 E	5.5
942321	AE2-245	1.05
BLUEG	BLUEG	0.47
CANNELTON	CANNELTON	0.01
CARR	CARR	0.01
CBM-S1	CBM-S1	0.56
CBM-S2	CBM-S2	1.94
CBM-W2	CBM-W2	2.88
COFFEEN	COFFEEN	0.01
CPLE	CPLE	1.06
DUCKCREEK	DUCKCREEK	0.05
EDWARDS	EDWARDS	0.03
ELMERSMITH	ELMERSMITH	0.01
G-007	G-007	0.01
GIBSON	GIBSON	0.01
MEC	MEC	0.05
NEWTON	NEWTON	0.04
O-066	O-066	0.06
RENSSELAER	RENSSELAER	0.01
TILTON	TILTON	0.04
TRIMBLE	TRIMBLE	0.06

16.3 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
7265217	247271	05MARTN 1	AEP	247274	05PATCTR	AEP	1	AEP_P4_#10168_05AXTON 138_H	breaker	202.0	153.58	154.6	DC	2.05

Bus #	Bus	MW Impact
926461	AC1-117 C	2.26
926462	AC1-117 E	3.69
938741	AE1-100 C O1	8.02
938742	AE1-100 E O1	4.61
938931	AE1-121 O1	92.69
938941	AE1-122 O1	92.69
941671	AE2-166 C	16.06
941672	AE2-166 E	10.71
942321	AE2-245	2.05
CARR	CARR	0.01
CBM-S1	CBM-S1	0.69
CBM-S2	CBM-S2	0.7
CBM-W1	CBM-W1	0.59
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	0.28
RENSSELAER	RENSSELAER	0.01
WEC	WEC	0.07

16.4 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
7265146	242816	05STOCKT	AEP	242711	05MARTN1	AEP	1	AEP_P4_#10171_05AXTON 138_G	breaker	202.0	174.74	175.98	DC	2.5

Bus #	Bus	MW Impact
244012	05PINNACLE	0.75
926461	AC1-117 C	2.75
926462	AC1-117 E	4.49
938741	AE1-100 C O1	8.72
938742	AE1-100 E O1	5.02
938931	AE1-121 O1	100.87
938941	AE1-122 O1	100.87
941431	AE2-140 C O1	23.01
941432	AE2-140 E O1	15.34
941671	AE2-166 C	19.57
941672	AE2-166 E	13.04
942321	AE2-245	2.5
BLUEG	BLUEG	0.89
CANNELTON	CANNELTON	0.04
CBM-N	CBM-N	0.01
CBM-S1	CBM-S1	0.12
CBM-S2	CBM-S2	1.49
CBM-W2	CBM-W2	0.05
COFFEEN	COFFEEN	0.06
CPLE	CPLE	1.02
DUCKCREEK	DUCKCREEK	0.15
EDWARDS	EDWARDS	0.07
ELMERSMITH	ELMERSMITH	0.06
FARMERCITY	FARMERCITY	0.02
G-007A	G-007A	0.09
GIBSON	GIBSON	0.03
NEWTON	NEWTON	0.16
NYISO	NYISO	0.04
PRAIRIE	PRAIRIE	0.16
SMITHLAND	SMITHLAND	0.0
TATANKA	TATANKA	0.06
TILTON	TILTON	0.1
TRIMBLE	TRIMBLE	0.1
VFT	VFT	0.24

Affected Systems

17 Affected Systems

17.1 LG&E

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

17.2 MISO

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

17.3 TVA

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

17.4 Duke Energy Progress

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

17.5 NYISO

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

18 Contingency Descriptions:

Contingency Name	Contingency Definition
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
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_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 941430 CKT 1 / 242544 05AXTON 138 941430 AE2-140 TAP 138 1 /* CONTINGENCY LINE ADDED FOR AE2 BUILD 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

19 Short Circuit

The following Breakers are overduty

None