Generation Interconnection

Feasibility Study Report

for

Queue Project AE2-325

VALLEY 138 KV

31.32 MW Capacity / 52.2 MW Energy

December, 2019

Table of Contents

© PJM Interconnection 2019. All rights reserved

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.

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

© PJM Interconnection 2019. All rights reserved

way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

© PJM Interconnection 2019. All rights reserved

2 General

The Interconnection Customer (IC), has proposed an uprate (Storage generating facility) to an existing Solar generating facility (AD2-020) located in Van Buren County, Michigan. This projects requests an increase to the install capability of 52.2 of uprate MW with 31.32 of uprate MW of this output being recognized by PJM as Capacity. The installed facilities will have a total capability of 152.2 MW with 93.22 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is 12/1/2022. This study does not imply a TO commitment to this in-service date.

Queue Number	**AE2-325**
Project Name	VALLEY 138 KV
State	Michigan
County	Van Buren
Transmission Owner	AEP
MFO	152.2
MWE	52.2
MWC	31.32
Fuel	Storage
Basecase Study Year	2022

© PJM Interconnection 2019. All rights reserved

2.1 Point of Interconnection

AE2-325 will interconnect with the AEP transmission system as an uprate to AD2-020 at the Valley 138kV 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	$6,000,000

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

© PJM Interconnection 2019. All rights reserved

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

© PJM Interconnection 2019. All rights reserved

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:

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.

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

© PJM Interconnection 2019. All rights reserved

10 Network Impacts

The Queue Project AE2-325 was evaluated as a 53.3 MW (Capacity 31.4 MW) uprate to AD2-020 at the Valley 138kV substation in the AEP area. Project AE2-325 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-325 was studied with a commercial probability of 0.53. Potential network impacts were as follows:

© PJM Interconnection 2019. All rights reserved

Summer Peak Load Flow

© PJM Interconnection 2019. All rights reserved

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)

None

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
7441968	243212	05BENTON	AEP	243250	05BENTON	AEP	1	AEP_P4_#7027_05COOK 345_N	breaker	564.0	195.35	197.38	DC	11.48
7443673	243212	05BENTON	AEP	243250	05BENTON	AEP	1	AEP_P7-1_#10998	tower	564.0	195.35	197.38	DC	11.48

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.

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
7443517	243212	05BENTON	AEP	243250	05BENTON	AEP	1	AEP_P1-2_#1242	operation	564.0	105.15	107.33	DC	12.3

© PJM Interconnection 2019. All rights reserved

15 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
7441968,7443673	1	05BENTON 345.0 kV - 05BENTON 138.0 kV Ckt 1	AEPI0003a (100) : Add another 345/138kV transformer with associated equipment Project Type : Con Cost : $6,000,000 Time Estimate : 18-24 Months	$6,000,000
			TOTAL COST	$6,000,000

© PJM Interconnection 2019. All rights reserved

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.

© PJM Interconnection 2019. All rights reserved

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
7443673	243212	05BENTON	AEP	243250	05BENTON	AEP	1	AEP_P7-1_#10998	tower	564.0	195.35	197.38	DC	11.48

Bus #	Bus	MW Impact
247528	05COVRT1	5.56
247529	05COVRT2	5.56
247530	05COVRT3	5.56
247531	05COVRT4	3.34
247532	05COVRT5	3.34
247533	05COVRT6	3.34
925961	AC1-072	0.52
936601	AD2-075	30.71
942682	AE2-284 BAT	9.17
943023	AE2-325 BAT	11.48
950031	J301 C	1.65
950032	J301 E	6.62
950041	J308 C	4.73
950042	J308 E	18.91
950121	J392	43.04
950241	J419	6.05
950311	G934 C	3.46
950312	G934 E	13.85
950351	J466	2.53
950361	J469	0.18
950791	J201 C	0.37
950792	J201 E	1.47
950871	J246 C	0.14
950872	J246 E	0.54
950942	J325 E	0.33
950951	J327 C	2.46
950952	J327 E	7.37
951011	J340 C	1.64
951012	J340 E	4.91
951051	J354 C	0.85
951052	J354 E	2.56
951531	J533 C	4.42
951532	J533 E	17.69
951571	J538 C	2.04
951572	J538 E	8.17
951581	J540	5.63
951941	J602 C	2.97
951942	J602 E	16.07
952161	J571	0.65
952201	J589 C	3.27
952202	J589 E	17.68
952312	J646 E	0.12

© PJM Interconnection 2019. All rights reserved

Bus #	Bus	MW Impact
952401	J752 C	1.34
952402	J752 E	7.26
952611	J717 C	3.1
952612	J717 E	16.77
952761	J728 C	2.89
952762	J728 E	15.61
952881	J758	18.73
952941	J921 C	3.03
952942	J921 E	16.41
952971	J793	99.3
953071	J794 C	0.2
953072	J794 E	1.08
953271	J701 C	0.67
953272	J701 E	3.6
953291	J796	23.23
953321	J799	11.6
953361	J806	13.13
953421	J841	67.92
953771	J832	10.81
953781	J833	6.05
953811	J839	7.77
953941	J857	11.32
954111	J875	10.21
954381	J906 C	1.99
954382	J906 E	10.76
954541	J931 C	3.02
954542	J931 E	16.32
954591	J937	59.29
BLUEG	BLUEG	4.13
CALDERWOOD	CALDERWOOD	0.31
CANNELTON	CANNELTON	0.29
CATAWBA	CATAWBA	0.11
CBM-N	CBM-N	0.39
CBM-W1	CBM-W1	10.58
CHEOAH	CHEOAH	0.28
CHILHOWEE	CHILHOWEE	0.1
COFFEEN	COFFEEN	0.83
COTTONWOOD	COTTONWOOD	2.09
DUCKCREEK	DUCKCREEK	2.36
EDWARDS	EDWARDS	1.12
ELMERSMITH	ELMERSMITH	0.5
FARMERCITY	FARMERCITY	0.59
G-007A	G-007A	1.03
GIBSON	GIBSON	0.23
HAMLET	HAMLET	0.14
MECS	MECS	35.23
NEWTON	NEWTON	1.95
NYISO	NYISO	1.7
PRAIRIE	PRAIRIE	3.62
SANTEETLA	SANTEETLA	0.08
SMITHLAND	SMITHLAND	0.22
TATANKA	TATANKA	1.19

© PJM Interconnection 2019. All rights reserved

Bus #	Bus	MW Impact
TILTON	TILTON	1.01
TRIMBLE	TRIMBLE	0.45
TVA	TVA	1.4
UNIONPOWER	UNIONPOWER	0.69
VFT	VFT	2.78

© PJM Interconnection 2019. All rights reserved

Affected Systems

© PJM Interconnection 2019. All rights reserved

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).

© PJM Interconnection 2019. All rights reserved

18 Contingency Descriptions:

Contingency Name	Contingency Definition
AEP_P1-2_#1242	CONTINGENCY 'AEP_P1-2_#1242' OPEN BRANCH FROM BUS 243212 TO BUS 243215 CKT 1 / 243212 05BENTON 345 243215 05COOK 345 1 END
AEP_P7-1_#10998	CONTINGENCY 'AEP_P7-1_#10998' OPEN BRANCH FROM BUS 243212 TO BUS 243215 CKT 1 / 243212 05BENTON 345 243215 05COOK 345 1 OPEN BRANCH FROM BUS 243215 TO BUS 247803 CKT 1 / 243215 05COOK 345 247803 05SEGRETO 345 1 END
AEP_P4_#7027_05COOK 345_N	CONTINGENCY 'AEP_P4_#7027_05COOK 345_N' OPEN BRANCH FROM BUS 243212 TO BUS 243215 CKT 1 / 243212 05BENTON 345 243215 05COOK 345 1 OPEN BRANCH FROM BUS 243215 TO BUS 247803 CKT 1 / 243215 05COOK 345 247803 05SEGRETO 345 1 END

© PJM Interconnection 2019. All rights reserved

Short Circuit

© PJM Interconnection 2019. All rights reserved

19 Short Circuit

The following Breakers are overduty

None

© PJM Interconnection 2019. All rights reserved