Generation Interconnection

Feasibility Study Report

for

Queue Project AF1-047

MARK CENTER 69 KV

20.88 MW Capacity / 34.8 MW Energy

January, 2020

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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.

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 an uprate (Storage generating facility) to an existing Solar generating facility (AE2-322) located in Defiance County, Indiana. This projects requests an increase to the install capability of 34.8 uprate MW with 20.88 of uprate MW of this output being recognized by PJM as Capacity. The installed facilities will have a total capability of 94.8 MW with 54.22 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is 12/1/23. This study does not imply a TO commitment to this in-service date.

Queue Number	**AF1-047**
Project Name	MARK CENTER 69 KV
State	Ohio
County	Defiance
Transmission Owner	AEP
MFO	34.8
MWE	34.8
MWC	20.88
Fuel	Storage
Basecase Study Year	2023

2.1 Point of Interconnection

AF1-047 will interconnect with the AEP transmission system as an uprate to AE2-322 at the Mark Center 69kV 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	$100,000

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:

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

10 Network Impacts

The Queue Project AF1-047 was evaluated as a 34.9 MW (Capacity 20.9 MW) injection as an uprate to AE2-322 at the Mark Center 69kV substation in the AEP area. Project AF1-047 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-047 was studied with a commercial probability of 1.00. 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)

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	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
43700266	246950	05TIMBSS	138.0	AEP	243383	05TILLMA	138.0	AEP	1	AEP_P2-2_#10084_05HAVILN 138_1	bus	332.0	114.3	116.68	DC	7.91
43700593	246950	05TIMBSS	138.0	AEP	243383	05TILLMA	138.0	AEP	1	AEP_P4_#10084_05HAVILN 138_I	breaker	332.0	114.3	116.68	DC	7.91

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	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
43700890	243017	05HAVILN	138.0	AEP	242989	05E LIMA	138.0	AEP	1	AEP_P1-2_#7501	operation	220.0	142.3	145.69	DC	7.45
43701082	246950	05TIMBSS	138.0	AEP	243383	05TILLMA	138.0	AEP	1	AEP_P1-1_#7096	operation	332.0	111.96	114.13	DC	7.2

15 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
43700266,43700593	1	05TIMBSS 138.0 kV - 05TILLMA 138.0 kV Ckt 1	AEPO0011a : Upgrade "Sub Cond 1-1233.6 KCM ACSR/TW (38/19)" riser at Timber Switch Project Type : FAC Cost : $100,000 Time Estimate : 12-18 Months	$100,000
			TOTAL COST	$100,000

16 Flow Gate Details

The following indices contain additional information about each flowgate presented in the body of the report. For each index, 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
4370059 3	24695 0	05TIMBS S	AEP	243383	05TILLM A	AEP	1	AEP_P4_#10084_05HAVIL N 138_I	breaker	332.0	114.3	116.68	DC	7.91

Bus #	Bus	MW Impact
246953	05TIMB G C	3.6342
247607	V1-011 C	10.2922
247911	05TIMB G E	104.8375
247959	V1-011 E	68.8788
926811	AC1-167 C O1	7.6403
926812	AC1-167 E O1	3.7065
926901	AC1-176 C	6.5957
926902	AC1-176 E	44.3476
934741	AD1-101 C O1	2.0435
934742	AD1-101 E O1	3.3347
934901	AD1-119 C O1	3.7364
934902	AD1-119 E O1	6.0973
940031	AE1-245 C O1	15.4383
940032	AE1-245 E O1	103.3182
942801	AE2-298 C O1	7.9284
942802	AE2-298 E O1	5.2856
943181	AE2-322 C	9.1638
943182	AE2-322 E	4.4796
943581	AF1-029 C O1	3.9642
943582	AF1-029 E O1	2.6428
943791	AF1-047 C	4.7479
943792	AF1-047 E	3.1653
DUCKCREEK	DUCKCREEK	0.1670
NEWTON	NEWTON	0.1332
FARMERCITY	FARMERCITY	0.0071
G-007A	G-007A	0.0503
VFT	VFT	0.1354
PRAIRIE	PRAIRIE	0.2996
COFFEEN	COFFEEN	0.0682
EDWARDS	EDWARDS	0.0518
CHEOAH	CHEOAH	0.0265
TILTON	TILTON	0.0888
GIBSON	GIBSON	0.0655
CALDERWOOD	CALDERWOOD	0.0268
BLUEG	BLUEG	0.1510
TRIMBLE	TRIMBLE	0.0479
CATAWBA	CATAWBA	0.0116

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_#7501	CONTINGENCY 'AEP_P1-2_#7501' OPEN BRANCH FROM BUS 243242 TO BUS 243383 CKT 1 / 243242 05ALLEN 138 243383 05TILLMA 138 1 OPEN BRANCH FROM BUS 243383 TO BUS 246950 CKT 1 / 243383 05TILLMA 138 246950 05TIMBSS 138 1 OPEN BRANCH FROM BUS 243383 TO BUS 246265 CKT 1 / 243383 05TILLMA 138 246265 05TILLMAN 34.5 1 OPEN BRANCH FROM BUS 246264 TO BUS 247877 CKT 1 / 246264 05ST R14 8 34.5 247877 05ST.RD14 SS34.5 1 END
AEP_P4_#10084_05HAVILN 138_I	CONTINGENCY 'AEP_P4_#10084_05HAVILN 138_I' OPEN BRANCH FROM BUS 242989 TO BUS 243017 CKT 1 / 242989 05E LIMA 138 243017 05HAVILN 138 1 OPEN BRANCH FROM BUS 243017 TO BUS 243168 CKT 1 / 243017 05HAVILN 138 243168 05HAVILND1 69.0 1 END
AEP_P2-2_#10084_05HAVILN 138_1	CONTINGENCY 'AEP_P2-2_#10084_05HAVILN 138_1' OPEN BRANCH FROM BUS 242989 TO BUS 243017 CKT 1 / 242989 05E LIMA 138 243017 05HAVILN 138 1 OPEN BRANCH FROM BUS 243017 TO BUS 243168 CKT 1 / 243017 05HAVILN 138 243168 05HAVILND1 69.0 1 END
AEP_P1-1_#7096	CONTINGENCY 'AEP_P1-1_#7096' OPEN BRANCH FROM BUS 243017 TO BUS 246352 CKT 1 / 243017 05HAVILAND2 138 247564 V1-012 138 1 END

Short Circuit

19 Short Circuit

The following Breakers are overduty

Bus Number	Bus Name	BREAKER	Type	Capacity (Amps)	Duty Percentage Post Queue	Duty Percentage Pre Queue