Generation Interconnection

Feasibility Study Report

for

Queue Project AF1-084

EAST HARTFORD-MURCH 69 KV

54.1 MW Capacity / 85 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.

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 Solar generating facility located in Van Buren County, MI. The installed facilities will have a total capability of 85 MW with 54.1 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is 10/1/2022. This study does not imply a TO commitment to this in-service date.

Queue Number	**AF1-084**
Project Name	EAST HARTFORD-MURCH 69 KV
State	Michigan
County	Van Buren
Transmission Owner	AEP
MFO	85
MWE	85
MWC	54.1
Fuel	Solar
Basecase Study Year	2023

2.1 Point of Interconnection

AF1-084 will interconnect with the AEP transmission system tapping the East Hartford to Murch 69 kV line.

To accommodate the interconnection on the East Hartford to Murch 69kV circuit, a new three (3) circuit breaker 69 kV switching station physically configured in a breaker and half bus arrangement but operated as a ring-bus will be constructed (see Figure 1). Installation of associated protection and control equipment, 69 kV line risers, SCADA, and 69 kV revenue metering will also be required. AEP reserves the right to specify the final acceptable configuration considering design practices, future expansion, and compliance requirements.

2.2 Cost Summary

This project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$250,000
Direct Connection Network Upgrade	$4,350,000
Non Direct Connection Network Upgrades	$1,100,000
Total Costs	$5,700,000

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

Description	Total Cost
System Upgrades	$93,600

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
69 kV Revenue Metering	$250,000
Total Attachment Facility Costs	**$250,000**

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
Construct a new three (3) circuit breaker 69 kV switching station physically configured in a breaker and half bus arrangement but operated as a ring-bus (See Figure 1). Installation of associated protection and control equipment, 69 kV line risers and SCADA will also be required.	$4,350,000
Total Direct Connection Facility Costs	**$4,350,000**

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
Upgrade line protection and controls at the East Hartford 69 kV substation.	$200,000
Upgrade line protection and controls at the Murch 69 kV substation.	$200,000
East Hartford to Murch 69 kV T-Line Cut In	$700,000
Total Non-Direct Connection Facility Costs	**$1,100,000**

7 Incremental Capacity Transfer Rights (ICTRs)

Will be determined at a later study phase

8 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 signing Agreement execution.

9 Interconnection Customer Requirements

It is understood that Lightsource Renewable Energy Development is responsible for all costs associated with this interconnection. The costs above are reimbursable to AEP. The cost of Lightsource Renewable Energy Development's generating plant and the costs for the line connecting the generating plant to the Haviland – North Van Wert 69 kV line are not included in this report; these are assumed to be Lightsource Renewable Energy Development'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.

10 Revenue Metering and SCADA Requirements

10.1 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.

10.2 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

11 Network Impacts

The Queue Project AF1-084 was evaluated as a 85.0 MW (Capacity 54.1 MW) injection tapping the East Hartford to Murch 69 kV line in the AEP area. Project AF1-084 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-084 was studied with a commercial probability of 0.53. Potential network impacts were as follows:

Summer Peak Load Flow

12 Generation Deliverability

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

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
43418724	243215	05COOK	345.0	AEP	243229	05OLIVE	345.0	AEP	1	AEP_P1-3_#8684_05COOK 765_4	single	1409.0	99.87	100.39	DC	7.31

13 Multiple Facility Contingency

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

None

14 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

15 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

16 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
43418724	1	05COOK 345.0 kV - 05OLIVE 345.0 kV Ckt 1	**AEPI0020J** : A Sag Study will be required on the 23.6 miles section of ACSR ~ 954 ~ 45/7 ~ RAIL line to mitigate the overload. New ratings after the sag study : S/N: 1409 MVA , S/E: 1887 MVA. Depending on the sag study results, cost for this upgrade is expected to be between $93,600 (no remediations required just sag study) and $47.2million (complete line reconductor/rebuild required) **Project Type** : FAC **Cost** : $93,600 **Time Estimate** : 6-12 Months	$93,600
			TOTAL COST	**$93,600**

17 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.

17.1 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
43418724	243215	05COOK	AEP	243229	05OLIVE	AEP	1	AEP_P1-3_#8684_05COOK 765_4	single	1409.0	99.87	100.39	DC	7.31

Bus #	Bus	MW Impact
238564	02BAYSG1	1.2170
238670	**02DVBSG1 (Deativation : 05/31/20)**	**4.6604**
238885	02LEMOG1	1.2556
238886	02LEMOG2	1.2556
238887	02LEMOG3	1.2556
238888	02LEMOG4	1.2556
238979	02NAPMUN	2.0846
239202	02STRYCT	0.0987
239293	02BS-PKR	0.1062
241902	Y1-069 GE	6.8410
243071	05BERRINSP G	0.0852
243440	05CKG1	42.8035
244412	05WTRV SLR C	0.0475
246397	05ELKHART HY	0.0282
246416	05TWIN BRCH1	0.0378
246422	05MAYFLWER	0.0406
246431	05BUCHANAN	0.0067
246536	05MOTTVILL	0.0219
247528	05COVRT1	6.4796
247529	05COVRT2	6.4796
247530	05COVRT3	6.4796
247531	05COVRT4	3.8889
247532	05COVRT5	3.8889
247533	05COVRT6	3.8889
247604	X1-042	0.0647
247620	Y3-023	0.0479
247643	Z2-116 C	0.0117
247651	AA2-116	184.3174
925961	AC1-072	0.6011
926581	AC1-141	16.8741
931951	AB1-107 1	15.2903
931961	AB1-107 2	34.3650
934891	AD1-118	3.9354
936141	AD2-020 C O1	7.9795
936601	AD2-075	31.2200
936631	AD2-079 C O1	0.7873
938261	AE1-039	0.1236
938911	AE1-119	30.9210
939391	AE1-170 C O1	7.9046
941781	AE2-181 C	1.6332
942661	AE2-282 C O1	2.5190

Bus #	Bus	MW Impact
942681	AE2-284	9.4102
943021	AE2-325 C	4.0413
943961	AF1-064 C O1	1.8814
944161	AF1-084 C	7.3138
944551	AF1-120 C	1.5263
944961	AF1-161 C	3.2228
945101	AF1-175 C O1	17.1374
945111	AF1-176 C O1	16.7356
945401	AF1-205 C O1	1.3522
945411	AF1-206 C O1	6.8512
950311	G934 C	4.2894
950351	J466	3.3693
950791	J201 C	0.4806
950871	J246 C	0.1935
951531	J533 C	5.5300
951571	J538 C	3.0717
951941	J602 C	3.8501
952161	J571	0.8774
952201	J589 C	4.1817
952401	J752 C	1.7782
952611	J717 C	3.9812
952761	J728 C	3.7025
952881	J758	25.6600
952971	J793	136.1792
953071	J794 C	0.2556
953271	J701 C	0.8752
953291	J796	29.9180
953321	J799	16.8569
953361	J806	18.0931
953421	J841	87.6658
953771	J832	13.6230
953781	J833	8.8380
953811	J839	10.5450
953941	J857	15.5725
954111	J875	14.6805
954381	J906 C	2.4281
954591	J937	78.3294
955021	J978 C	2.2835
955071	J984 C	4.4610
955121	J989	9.2328
955181	J996	7.0248
955261	J1005	25.0380
955341	J1013	9.2728
955351	J1014 C	5.5100
955591	J1043 C	3.0536
955621	J1046	3.8570
955721	J1056 C	2.6236
955781	J1062	15.4280
955801	J1064 C	4.8566
955811	J1065 C	4.3633
955831	J1068 C	2.8376
955861	J1071	15.3400

Bus #	Bus	MW Impact
955961	J1083	8.2509
956011	J1088	18.5460
956021	J1089	20.9423
956031	J1090	10.1520
956161	J1103	2.2900
956291	J1117	9.4200
956301	J1119	66.9180
956741	J1172	5.9370
956751	J1173	7.6424
956801	J1178	7.6616
DUCKCREEK	DUCKCREEK	5.3176
NEWTON	NEWTON	3.1569
FARMERCITY	FARMERCITY	0.2074
G-007A	G-007A	1.9660
VFT	VFT	5.3148
CBM-W1	CBM-W1	12.1597
PRAIRIE	PRAIRIE	7.5914
COFFEEN	COFFEEN	1.7853
EDWARDS	EDWARDS	1.6912
CHEOAH	CHEOAH	0.4735
TILTON	TILTON	2.1993
GIBSON	GIBSON	1.0587
CALDERWOOD	CALDERWOOD	0.4786
BLUEG	BLUEG	2.1474
TRIMBLE	TRIMBLE	0.6734
CATAWBA	CATAWBA	0.1589

Affected Systems

18 Affected Systems

18.1 LG&E

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

18.2 MISO

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

18.3 TVA

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

18.4 Duke Energy Progress

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

18.5 NYISO

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

19 Contingency Descriptions

Contingency Name	Contingency Definition
AEP_P1-3_#8684_05COOK 765_4	CONTINGENCY 'AEP_P1-3_#8684_05COOK 765_4' OPEN BRANCH FROM BUS 243205 TO BUS 243215 CKT 4 / 243205 05COOK 765 243215 05COOK 345 4 END

Short Circuit

20 Short Circuit

The following Breakers are overduty

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