Generation Interconnection

Feasibility Study Report

for

Queue Project AE2-171

MAKAHOY 138 KV

30 MW Capacity / 30 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.

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.

2 General

The Interconnection Customer (IC), has proposed an uprate (Storage generating facility) to an existing Solar generating facility (AD1-043) located in Madison County, Indiana. This projects requests an increase to the install capability of 30 of uprate MW with 30 of uprate MW of this output being recognized by PJM as Capacity. The installed facilities will have a total capability of 150 MW with 75.6 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is 12/31/22. This study does not imply a TO commitment to this in-service date.

Queue Number	**AE2-171**
Project Name	MAKAHOY 138 KV
State	Indiana
County	Madison
Transmission Owner	AEP
MFO	150
MWE	30
MWC	30
Fuel	Storage
Basecase Study Year	2022

2.1 Point of Interconnection

AE2-171 will interconnect with the AEP transmission system at the Makahoy 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	$TBD

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 AE2-171 was evaluated as a 31.1 MW (Capacity 30.1 MW) injection at the Makahoy 138 kV substation in the AEP area. Project AE2-171 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-171 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)

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
1574672	243311	05HOGAN	AEP	243275	05DELAWR	AEP	1	AEP_P4_#2965_05DESOTO 345_A2	breaker	231.0	110.54	113.3	DC	6.35
1574567	246763	05PIPECK	AEP	243303	05GRNTTA	AEP	1	AEP_P4_#8781_05HOGAN 138_B	breaker	205.0	113.2	119.53	DC	12.99
1574546	936560	AD2-071 TAP	AEP	246763	05PIPECK	AEP	1	AEP_P4_#8781_05HOGAN 138_B	breaker	205.0	115.2	121.53	DC	12.99

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
1575465	243311	05HOGAN	AEP	243275	05DELAWR	AEP	1	AEP_P1-2_#673-A	operation	231.0	108.98	111.79	DC	6.5
1575466	243311	05HOGAN	AEP	243275	05DELAWR	AEP	1	Base Case	operation	167.0	106.76	110.52	DC	6.28
1575413	246763	05PIPECK	AEP	243303	05GRNTTA	AEP	1	AEP_P1-2_#6957	operation	205.0	107.74	113.99	DC	12.81
1575381	936560	AD2-071 TAP	AEP	246763	05PIPECK	AEP	1	AEP_P1-2_#6957	operation	205.0	109.74	115.99	DC	12.81

15 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
1574672	1	05HOGAN 138.0 kV - 05DELAWR 138.0 kV Ckt 1	s0738 (89) : PJM Supplemental Upgrade s0738. Upgrade the Delaware - Hogan 138 kV risers. The supplemental project has an projected in-service date of 12/18/2021. Project Type : FAC Cost : $0 Time Estimate : 12-18 Months s1498.2 (90) : PJM Supplemental Upgrade s1498.2. Replace risers at Delaware station with 1200A AAC jumpers. The supplemental project has an projected in-service date of 12/18/2021. Project Type : FAC Cost : $0 Time Estimate : 12-18 Months	$0
1574546	3	AD2-071 TAP 138.0 kV - 05PIPECK 138.0 kV Ckt 1	AEP (sXXXX): Contingency is no longer valid. It is going away with the Southern Muncie project proposed by AEP (waiting for an Supplemental ID# for this project) Note: This queue project may have a cost responsibility for upgrading the overloaded element if the supplemental project is not approved. Further information will be provided during the Impact Study Phase. Project Type : CON Cost : TBD Time Estimate : TBD An AEP supplemental project may rebuild a portion or all of this line. PJM is in the process of assigning this project a Supplemental ID number. Determination of allocation of cost for the scope of SXXXX to AE2-171 (if any) or other queue positions will occur during the System Impact Study.	TBD
1574567	2	05PIPECK 138.0 kV - 05GRNTTA 138.0 kV Ckt 1		
			TOTAL COST	TBD

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
1574672	243311	05HOGAN	AEP	243275	05DELAWR	AEP	1	AEP_P4_#2965_05DESOTO 345_A2	breaker	231.0	110.54	113.3	DC	6.35

Bus #	Bus	MW Impact
246991	05WLD G1 C	0.35
247255	05WLD G2 C	0.37
247914	05WLD G1 E	19.45
247958	05WLD G2 E	20.41
247968	Z2-115 E	0.14
920501	AA2-148 C O1	2.36
920502	AA2-148 E O1	15.76
923881	AB2-028 C	1.67
923882	AB2-028 E	11.19
934161	AD1-043 C O1	9.63
934162	AD1-043 E O1	15.71
936561	AD2-071 C	12.55
936562	AD2-071 E	6.18
941692	AE2-169 BAT	7.71
941711	AE2-171	6.35
942791	AE2-297 C O1	9.84
942792	AE2-297 E O1	6.56
CARR	CARR	0.03
CBM-S1	CBM-S1	1.92
CBM-S2	CBM-S2	0.35
CBM-W1	CBM-W1	1.39
CBM-W2	CBM-W2	22.59
CIN	CIN	5.06
CPLE	CPLE	0.1
G-007	G-007	0.08
IPL	IPL	4.13
LGEE	LGEE	0.51
MEC	MEC	2.63
O-066	O-066	0.53
RENSSELAER	RENSSELAER	0.03
WEC	WEC	0.25

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
1574567	246763	05PIPECK	AEP	243303	05GRNTTA	AEP	1	AEP_P4_#8781_05HOGAN 138_B	breaker	205.0	113.2	119.53	DC	12.99

Bus #	Bus	MW Impact
246991	05WLD G1 C	0.79
247255	05WLD G2 C	0.83
247914	05WLD G1 E	43.28
247958	05WLD G2 E	45.41
920501	AA2-148 C O1	1.49
920502	AA2-148 E O1	9.95
934161	AD1-043 C O1	19.67
934162	AD1-043 E O1	32.1
936561	AD2-071 C	39.86
936562	AD2-071 E	19.63
941702	AE2-170 BAT	1.67
941711	AE2-171	12.99
941722	AE2-172 BAT	1.81
942791	AE2-297 C O1	6.14
942792	AE2-297 E O1	4.1
CBM-N	CBM-N	0.02
CBM-S1	CBM-S1	0.68
CBM-S2	CBM-S2	0.15
CBM-W2	CBM-W2	4.86
CIN	CIN	1.62
CPLE	CPLE	0.05
DUCKCREEK	DUCKCREEK	0.23
EDWARDS	EDWARDS	0.13
FARMERCITY	FARMERCITY	0.03
G-007A	G-007A	0.06
IPL	IPL	1.62
LGEE	LGEE	0.3
NYISO	NYISO	0.07
TATANKA	TATANKA	0.1
VFT	VFT	0.16

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
1574546	936560	AD2-071 TAP	AEP	246763	05PIPECK	AEP	1	AEP_P4_#8781_05HOGAN 138_B	breaker	205.0	115.2	121.53	DC	12.99

Bus #	Bus	MW Impact
246991	05WLD G1 C	0.79
247255	05WLD G2 C	0.83
247914	05WLD G1 E	43.28
247958	05WLD G2 E	45.41
920501	AA2-148 C O1	1.49
920502	AA2-148 E O1	9.95
934161	AD1-043 C O1	19.67
934162	AD1-043 E O1	32.1
936561	AD2-071 C	39.86
936562	AD2-071 E	19.63
941702	AE2-170 BAT	1.67
941711	AE2-171	12.99
941722	AE2-172 BAT	1.81
942791	AE2-297 C O1	6.14
942792	AE2-297 E O1	4.1
CBM-N	CBM-N	0.02
CBM-S1	CBM-S1	0.68
CBM-S2	CBM-S2	0.15
CBM-W2	CBM-W2	4.86
CIN	CIN	1.62
CPLE	CPLE	0.05
DUCKCREEK	DUCKCREEK	0.23
EDWARDS	EDWARDS	0.13
FARMERCITY	FARMERCITY	0.03
G-007A	G-007A	0.06
IPL	IPL	1.62
LGEE	LGEE	0.3
NYISO	NYISO	0.07
TATANKA	TATANKA	0.1
VFT	VFT	0.16

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_#673-A	CONTINGENCY 'AEP_P1-2_#673-A' OPEN BRANCH FROM BUS 243218 TO BUS 923880 CKT 1 / 243218 05DESOTO 345 923880 AB2-028 TAP 345 1 END
Base Case	
AEP_P1-2_#6957	CONTINGENCY 'AEP_P1-2_#6957' OPEN BRANCH FROM BUS 247116 TO BUS 246913 CKT 1 / 247116 05ALADDIN 138 246913 05JONES 138 1 OPEN BRANCH FROM BUS 247116 TO BUS 246988 CKT 1 / 247116 05ALADDIN 138 246988 05STRWTN 138 1 OPEN BRANCH FROM BUS 243311 TO BUS 246913 CKT 1 / 243311 05HOGAN 138 246913 05JONES 138 1 END
AEP_P4_#2965_05DESOTO 345_A2	CONTINGENCY 'AEP_P4_#2965_05DESOTO 345_A2' OPEN BRANCH FROM BUS 243218 TO BUS 923880 CKT 1 / 243218 05DESOTO 345 923880 AB2-028 TAP 345 1 /* CONTINGENCY LINE ADDED FOR AE1 BUILD OPEN BRANCH FROM BUS 243218 TO BUS 243278 CKT 1 / 243218 05DESOTO 345 243278 05DESOTO 138 1 END
AEP_P4_#8781_05HOGAN 138_B	CONTINGENCY 'AEP_P4_#8781_05HOGAN 138_B' OPEN BRANCH FROM BUS 247116 TO BUS 246913 CKT 1 / 247116 05ALADDIN 138 246913 05JONES 138 1 OPEN BRANCH FROM BUS 247116 TO BUS 246988 CKT 1 / 247116 05ALADDIN 138 246988 05STRWTN 138 1 OPEN BRANCH FROM BUS 247420 TO BUS 243311 CKT 1 / 247420 05CROSS ST Z 138 243311 05HOGAN 138 1 OPEN BRANCH FROM BUS 243275 TO BUS 243311 CKT 1 / 243275 05DELAWR 138 243311 05HOGAN 138 1 OPEN BRANCH FROM BUS 243311 TO BUS 246913 CKT 1 / 243311 05HOGAN 138 246913 05JONES 138 1 OPEN BRANCH FROM BUS 243311 TO BUS 246046 CKT 1 / 243311 05HOGAN 138 246046 05HOGAN 34.5 1 OPEN BRANCH FROM BUS 243311 TO BUS 246047 CKT 1 / 243311 05HOGAN 138 246047 05HOGAN L 12.0 1 END

Short Circuit

19 Short Circuit

The following Breakers are overduty

None.