Generation Interconnection

Feasibility Study Report

for

Queue Project AE2-327

BIERS RUN-CIRCLEVILLE 138 KV

31.32 MW Capacity / 52.2 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.

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 (AD2-162) located in Pickaway County, Ohio. 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 162.2 MW with 105.13 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is 12.01.2021. This study does not imply a TO commitment to this in-service date.

Queue Number	AE2-327
Project Name	BIERS RUN-CIRCLEVILLE 138 KV
State	Ohio
County	Pickaway
Transmission Owner	AEP
MFO	162.2
MWE	52.2
MWC	31.32
Fuel	Storage
Basecase Study Year	2022

2.1 Point of Interconnection

AE2-327 is an uprate to AD2-162 which will interconnect with the AEP transmission system as a tap of the Biers Run to Circleville 138 kV line.

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	$9,150,000

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 AE2-327 was evaluated as a 53.3 MW (Capacity 31.4 MW) uprate to AD2-162 which is an injection tapping the Biers Run to Circleville 138 kV line in the AEP area. Project AE2-327 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-327 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
7447703	243593	05ZUBER	AEP	243469	05BEATTY	AEP	1	AEP_P4_#9679_05HARRISON 138_2E	breaker	212.0	92.83	100.04	DC	15.29

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
7447200	243522	05HARRIS	AEP	243593	05ZUBER	AEP	1	AEP_P4_#9679_05HARRISON 138_2E	breaker	167.0	128.98	138.13	DC	15.29
7448772	243522	05HARRIS	AEP	243593	05ZUBER	AEP	1	AEP_P7-1_#10921	tower	167.0	121.43	130.58	DC	15.27

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
7448132	243522	05HARRIS	AEP	243550	05OBETZ	AEP	1	AEP_P1-2_#5806	operation	167.0	123.86	131.73	DC	13.14
7448135	243522	05HARRIS	AEP	243550	05OBETZ	AEP	1	Base Case	operation	136.0	104.58	109.97	DC	7.33
7448165	243522	05HARRIS	AEP	243593	05ZUBER	AEP	1	AEP_P1-2_#5764	operation	167.0	120.12	129.27	DC	15.29

15 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
7448772,7447200	2	05HARRIS 138.0 kV - 05ZUBER 138.0 kV Ckt 1	AEP AEPO0015a (214) : Replace six 300 Cu jumpers at Harrison Project Type : FAC Cost : $600,000 Time Estimate : 12-18 Months AEPO0015b (215) : Replace 600 Amp Sw at Harrison Project Type : FAC Cost : $200,000 Time Estimate : 12-18 Months AEPO0015c (216) : Reconductor 5.5 miles of ACSR ~ 336.4 ~ 30/7 ~ ORIOLE Harrison - Zuber conductor with 795 ACSR or equivalent Project Type : FAC Cost : $8,250,000 Time Estimate : 24-36 Months AEPO0015d (217) : Replace 800 Amp wavetrap at Harrison Project Type : FAC Cost : $100,000 Time Estimate : 12.18 Months	$9,150,000
7447703	1	05ZUBER 138.0 kV - 05BEATTY 138.0 kV Ckt 1	AEP No mitigation required. AEP current rating is S/N: 150 MVA S/E:219 MVA	$0
			TOTAL COST	$9,150,000

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
7447703	243593	05ZUBER	AEP	243469	05BEATTY	AEP	1	AEP_P4_#9679_05HARRISON 138_2E	breaker	212.0	92.83	100.04	DC	15.29

Bus #	Bus	MW Impact
924351	AB2-083 C O1	4.84
924352	AB2-083 E O1	2.28
925341	AC1-001 C O1	9.67
925342	AC1-001 E O1	4.55
927061	AC1-194 C O1	3.53
927062	AC1-194 E O1	5.76
932201	AC2-029 C	10.46
932202	AC2-029 E	17.07
932251	AC2-038 C O1	1.04
932252	AC2-038 E O1	0.69
932311	AC2-045 C	0.33
932312	AC2-045 E	0.53
932411	AC2-059 C	15.46
932412	AC2-059 E	15.96
934481	AD1-072 C	3.4
934482	AD1-072 E	1.55
936111	AD2-016 C	15.46
936112	AD2-016 E	15.96
937231	AD2-162 C	21.57
937232	AD2-162 E	10.58
938711	AE1-093	1.65
943041	AE2-327 C	9.16
943042	AE2-327 E	6.12
CARR	CARR	0.0
CBM-S1	CBM-S1	0.4
CBM-S2	CBM-S2	0.37
CBM-W2	CBM-W2	0.75
COFFEEN	COFFEEN	0.03
CPLE	CPLE	0.14
DUCKCREEK	DUCKCREEK	0.14
EDWARDS	EDWARDS	0.07
FARMERCITY	FARMERCITY	0.02
G-007A	G-007A	0.02
GIBSON	GIBSON	0.0
LGEE	LGEE	0.04
NEWTON	NEWTON	0.04
PRAIRIE	PRAIRIE	0.03
RENSSELAER	RENSSELAER	0.0
TATANKA	TATANKA	0.06
TILTON	TILTON	0.05
VFT	VFT	0.06

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
7447200	243522	05HARRIS	AEP	243593	05ZUBER	AEP	1	AEP_P4_#9679_05HARRISON 138_2E	breaker	167.0	128.98	138.13	DC	15.29

Bus #	Bus	MW Impact
924351	AB2-083 C O1	4.84
924352	AB2-083 E O1	2.28
925341	AC1-001 C O1	9.67
925342	AC1-001 E O1	4.55
927061	AC1-194 C O1	3.53
927062	AC1-194 E O1	5.76
932201	AC2-029 C	10.46
932202	AC2-029 E	17.07
932251	AC2-038 C O1	1.04
932252	AC2-038 E O1	0.69
932311	AC2-045 C	0.33
932312	AC2-045 E	0.53
932411	AC2-059 C	15.46
932412	AC2-059 E	15.96
934481	AD1-072 C	3.4
934482	AD1-072 E	1.55
936111	AD2-016 C	15.46
936112	AD2-016 E	15.96
937231	AD2-162 C	21.57
937232	AD2-162 E	10.58
938711	AE1-093	1.65
943041	AE2-327 C	9.16
943042	AE2-327 E	6.12
CARR	CARR	0.0
CBM-S1	CBM-S1	0.4
CBM-S2	CBM-S2	0.37
CBM-W2	CBM-W2	0.75
COFFEEN	COFFEEN	0.03
CPLE	CPLE	0.14
DUCKCREEK	DUCKCREEK	0.14
EDWARDS	EDWARDS	0.07
FARMERCITY	FARMERCITY	0.02
G-007A	G-007A	0.02
GIBSON	GIBSON	0.0
LGEE	LGEE	0.04
NEWTON	NEWTON	0.04
PRAIRIE	PRAIRIE	0.03
RENSSELAER	RENSSELAER	0.0
TATANKA	TATANKA	0.06
TILTON	TILTON	0.05
VFT	VFT	0.06

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_P4_#9679_05HARRISON 138_2E	CONTINGENCY 'AEP_P4_#9679_05HARRISON 138_2E' OPEN BRANCH FROM BUS 243522 TO BUS 243550 CKT 1 / 243522 05HARRIS 138 243550 05OBETZ 138 1 OPEN BRANCH FROM BUS 243539 TO BUS 243550 CKT 1 / 243539 05MARION 138 243550 05OBETZ 138 1 OPEN BRANCH FROM BUS 243522 TO BUS 246706 CKT 1 / 243522 05HARRIS 138 246706 05HARRISON 69.0 1 END
Base Case	
AEP_P1-2_#5806	CONTINGENCY 'AEP_P1-2_#5806' OPEN BRANCH FROM BUS 243469 TO BUS 243593 CKT 1 / 243469 05BEATTY 138 243593 05ZUBER 138 1 OPEN BRANCH FROM BUS 243522 TO BUS 243593 CKT 1 / 243522 05HARRIS 138 243593 05ZUBER 138 1 OPEN BRANCH FROM BUS 243593 TO BUS 246686 CKT 1 / 243593 05ZUBER 138 246686 05ZUBER-L 13.8 1 END
AEP_P7-1_#10921	CONTINGENCY 'AEP_P7-1_#10921' OPEN BRANCH FROM BUS 243522 TO BUS 243550 CKT 1 / 243522 05HARRIS 138 243550 05OBETZ 138 1 OPEN BRANCH FROM BUS 243536 TO BUS 243539 CKT 1 / 243536 05LS-II 138 243539 05MARION 138 1 OPEN BRANCH FROM BUS 243539 TO BUS 243550 CKT 1 / 243539 05MARION 138 243550 05OBETZ 138 1 END
AEP_P1-2_#5764	CONTINGENCY 'AEP_P1-2_#5764' OPEN BRANCH FROM BUS 243522 TO BUS 243550 CKT 1 / 243522 05HARRIS 138 243550 05OBETZ 138 1 OPEN BRANCH FROM BUS 243539 TO BUS 243550 CKT 1 / 243539 05MARION 138 243550 05OBETZ 138 1 END

Short Circuit

19 Short Circuit

The following Breakers are overduty

None