Generation Interconnection

Feasibility Study Report

for

Queue Project AG1-380

CORWIN-ELK 138 KV

54 MW Capacity / 90 MW Energy

January 2021

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1 Introduction

This Feasibility Study has been prepared in accordance with the PJM Open Access Transmission Tariff, 36.2, as well as the Feasibility Study Agreement between the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is AEP.

2 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.

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.

3 General

The Interconnection Customer (IC), has proposed a Solar; Storage generating facility located in Jackson County, Ohio. The installed facilities will have a total capability of 90 MW with 54 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is December 31, 2023. This study does not imply a TO commitment to this in-service date.

Queue Number	AG1-380
Project Name	CORWIN-ELK 138 KV
State	Ohio
County	Jackson
Transmission Owner	AEP
MFO	90
MWE	90
MWC	54
Fuel	Solar; Storage
Basecase Study Year	2024

Any new service customers who can feasibly be commercially operable prior to June 1st of the basecase study year are required to request interim deliverability analysis.

4 Point of Interconnection

AG1-380 will interconnect with the AEP transmission system tapping the Corwin to Elk 138 kV line.

5 Cost Summary

The AG1-380 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	$9,680,000
Total System Network Upgrade Costs	$10,450,000
Total Costs	**$20,130,000**

This cost excludes a Federal Income Tax Gross Up charges. This tax may or may not be charged based on whether this project meets the eligibility requirements of IRS Notice 2016-36, 2016-25 I.R.B. (6/20/2016). If at a future date it is determined that the Federal Income Tax Gross charge is required, the Transmission Owner shall be reimbursed by the Interconnection Customer for such taxes.

Cost allocations for any System Upgrades will be provided in the System Impact Study Report.

The estimates provided in this report are preliminary in nature, as they were determined without the benefit of detailed engineering studies. Final estimates will require an on-site review and coordination to determine final construction requirements. In addition, Stability analysis will be completed during the Facilities Study stage. It is possible that a need for additional upgrades could be identified by these studies.

6 Transmission Owner Scope of Work

The total physical interconnection costs is given in the table below:

6.1 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
138 kV Revenue Metering	$380,000
Generator lead first span exiting the POI station, including the first structure outside the fence	$400,000
Total Attachment Facility Costs	**$780,000**

6.2 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
A new three (3) circuit breaker 138 kV switching station physically configured and operated as a ring-bus will be constructed. Installation of associated protection and control equipment, 138 kV line risers, and SCADA will also be required.	$8,040,000
Total Direct Connection Facility Costs	**$8,040,000**

6.3 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
Corwin - Elk 138 kV T-Line Cut In	$770,000
Review Protection and Control Settings at the Corwin 138 kV substation	$45,000
Review Protection and Control Settings at the Elk 138 kV substation	$45,000
Total Non-Direct Connection Facility Costs	**$860,000**

7 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.

8 Interconnection Customer Requirements

It is understood that the Interconnection Customer (IC) is responsible for all costs associated with this interconnection. The costs above are reimbursable to the Transmission Owner. The cost of the IC's generating plant and the costs for the line connecting the generating plant to the Point of Interconnection are not included in this report; these are assumed to be the IC's responsibility.

The Generation Interconnection Agreement does not in or by itself establish a requirement for the Transmission Owner 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.

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 Meteorological Data Reporting Requirements

The solar generation facility shall provide the Transmission Provider with site-specific meteorological data including:

- Back Panel temperature (Fahrenheit) - (Required for plants with Maximum Facility Output of 3 MW or higher)

- Irradiance (Watts/meter2) - (Required for plants with Maximum Facility Output of 3 MW or higher)
- Ambient air temperature (Fahrenheit) - (Accepted, not required)
- Wind speed (meters/second) - (Accepted, not required)
- Wind direction (decimal degrees from true north) - (Accepted, not required)

9.3 Interconnected Transmission Owner Requirements

The IC will be required to comply with all Interconnected Transmission Owner's revenue metering requirements for generation interconnection customers located at the following link:

http://www.pjm.com/planning/design-engineering/to-tech-standards/

10 Summer Peak - Load Flow Analysis

The Queue Project AG1-380 was evaluated as a 90.0 MW (Capacity 54.0 MW) injection tapping the Corwin to Elk 138 kV line in the AEP area. Project AG1-380 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AG1-380 was studied with a commercial probability of 53.0 %. Potential network impacts were as follows:

10.1 Generation Deliverability

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

None

10.2 Multiple Facility Contingency

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

None

10.3 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
16177120 7	243522	05HARRISON	138.0	AEP	243593	05ZUBER	138.0	AEP	1	AEP_P7-1_#10921	tower	167.0	171.21	172.84	DC	6.04
16177128 0	243593	05ZUBER	138.0	AEP	243469	05BEATTY	138.0	AEP	1	AEP_P7-1_#10921	tower	212.0	123.07	124.36	DC	6.04

10.4 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
16821433 7	243522	05HARRISON	138.0	AEP	243593	05ZUBER	138.0	AEP	1	AEP_P2-1_243522 05HARRISON 138 243550 05OBETZ 138 1	operation	167.0	170.6	172.23	DC	6.04
16821436 8	243522	05HARRISON	138.0	AEP	243550	05OBETZ	138.0	AEP	1	AEP_P1-2_#9672_30877	operation	180.0	160.74	162.04	DC	5.18
16821439 0	243550	05OBETZ	138.0	AEP	243539	05MARION	138.0	AEP	1	AEP_P1-2_#9672_30877	operation	180.0	153.85	155.15	DC	5.18

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
168214498	243593	05ZUBER	138.0	AEP	243469	05BEATTY	138.0	AEP	1	AEP_P2-1_243522 05HARRISON 138 243550 05OBETZ 138 1	operation	212.0	122.59	123.88	DC	6.04

10.5 System Reinforcements - Summer Peak Load Flow

ID	Idx	Facility	Upgrade Description	Cost
161771207	1	**05HARRIS 138.0 kV - 05ZUBER 138.0 kV Ckt 1**	**AEP** **AEPO0015b (277) : Replace Switch 600 Amp Sw at Harrison** **Project Type : FAC** **Cost : $200,000** **Time Estimate : 12-18 Months** **AEPO0015c (278) : 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**	$8,450,000
161771280	2	**05ZUBER 138.0 kV - 05BEATTY 138.0 kV Ckt 1**	**AEP** **AEPO0046a (425) : String 3.19 miles of 336.4 ACSR or equivalent conductor on the open side of the existing double circuit structures (6-wire). Note, further engineering study will need to be performed to confirm this reinforcement can be performed on the existing lattice structures built in the 1950s.** **Project Type : FAC** **Cost : $2,000,000** **Time Estimate : 18-24 Months**	$2,000,000
			TOTAL COST	**$10,450,000**

10.6 Flow Gate Details

The following indices contain additional information about each facility presented in the body of the report. For each index, a description of the flowgate and its contingency was included for convenience. The intent of the indices is to provide more details on which projects/generators have contributions to the flowgate in question. All New Service Queue Requests, through the end of the Queue under study, that are contributors to a flowgate will be listed in the indices. Please note that there may be contributors that are subsequently queued after the queue under study that are not listed in the indices. Although this information is not used "as is" for cost allocation purposes, it can be used to gage the impact of other projects/generators. It should be noted the project/generator MW contributions presented in the body of the report are Full MW Impact contributions which are also noted in the indices column named "Full MW Impact", whereas the loading percentages reported in the body of the report, take into consideration the PJM Generator Deliverability Test rules such as commercial probability of each project as well as the ramping impact of "Adder" contributions. The MW Impact found and used in the analysis is shown in the indices column named "Gendeliv MW Impact".

10.6.1 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
161771207	243522	05HARRISON	AEP	243593	05ZUBER	AEP	1	AEP_P7-1_#10921	tower	167.0	171.21	172.84	DC	6.04

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
924351	AB2-083 C O1	4.6447	50/50	4.6447
924352	AB2-083 E O1	2.1857	50/50	2.1857
925345	AC1-001 C	9.2893	50/50	9.2893
925346	AC1-001 E	4.3715	50/50	4.3715
927061	AC1-194 C O1	3.0108	Adder	3.54
927062	AC1-194 E O1	4.9123	Adder	5.78
932201	AC2-029 C	10.2144	50/50	10.2144
932202	AC2-029 E	16.6656	50/50	16.6656
932411	AC2-059 C	15.0725	50/50	15.0725
932412	AC2-059 E	15.5548	50/50	15.5548
934481	AD1-072 C	3.3111	50/50	3.3111
934482	AD1-072 E	1.5121	50/50	1.5121
936111	AD2-016 C	15.0725	50/50	15.0725
936112	AD2-016 E	15.5548	50/50	15.5548
937231	AD2-162 C	21.0440	50/50	21.0440
937232	AD2-162 E	10.3181	50/50	10.3181
938711	AE1-093	2.6621	Adder	3.13
960801	AF2-371 C	22.5016	50/50	22.5016
960802	AF2-371 E	15.0011	50/50	15.0011
964631	AG1-326 C	9.0214	50/50	9.0214
964632	AG1-326 E	6.7503	50/50	6.7503
964871	AG1-351 C	15.5368	50/50	15.5368
964872	AG1-351 E	47.8605	50/50	47.8605
965151	AG1-380 C	1.6336	Adder	3.63
965152	AG1-380 E	1.0890	Adder	2.42
LGEE	LGEE	0.0421	Confirmed LTF	0.0421
CPLE	CPLE	0.1508	Confirmed LTF	0.1508
G-007A	G-007A	0.0336	Confirmed LTF	0.0336
VFT	VFT	0.0839	Confirmed LTF	0.0839
CBM-W2	CBM-W2	0.4032	Confirmed LTF	0.4032
NY	NY	0.0022	Confirmed LTF	0.0022
TVA	TVA	0.1918	Confirmed LTF	0.1918
SIGE	SIGE	0.0001	Confirmed LTF	0.0001
CBM-S2	CBM-S2	2.4012	Confirmed LTF	2.4012
CBM-S1	CBM-S1	0.0471	Confirmed LTF	0.0471
CBM-N	CBM-N	0.0144	Confirmed LTF	0.0144
GIBSON	GIBSON	0.0071	Confirmed LTF	0.0071
LAGN	LAGN	0.1697	Confirmed LTF	0.1697

10.6.2 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
161771280	243593	05ZUBER	AEP	243469	05BEATTY	AEP	1	AEP_P7-1_#10921	tower	212.0	123.07	124.36	DC	6.04

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
924351	AB2-083 C O1	4.6447	50/50	4.6447
924352	AB2-083 E O1	2.1857	50/50	2.1857
925345	AC1-001 C	9.2893	50/50	9.2893
925346	AC1-001 E	4.3715	50/50	4.3715
927061	AC1-194 C O1	3.0108	Adder	3.54
927062	AC1-194 E O1	4.9123	Adder	5.78
932201	AC2-029 C	10.2144	50/50	10.2144
932202	AC2-029 E	16.6656	50/50	16.6656
932411	AC2-059 C	15.0725	50/50	15.0725
932412	AC2-059 E	15.5548	50/50	15.5548
934481	AD1-072 C	3.3111	50/50	3.3111
934482	AD1-072 E	1.5121	50/50	1.5121
936111	AD2-016 C	15.0725	50/50	15.0725
936112	AD2-016 E	15.5548	50/50	15.5548
937231	AD2-162 C	21.0440	50/50	21.0440
937232	AD2-162 E	10.3181	50/50	10.3181
938711	AE1-093	2.6621	Adder	3.13
960801	AF2-371 C	22.5016	50/50	22.5016
960802	AF2-371 E	15.0011	50/50	15.0011
964631	AG1-326 C	9.0214	50/50	9.0214
964632	AG1-326 E	6.7503	50/50	6.7503
964871	AG1-351 C	15.5368	50/50	15.5368
964872	AG1-351 E	47.8605	50/50	47.8605
965151	AG1-380 C	1.6336	Adder	3.63
965152	AG1-380 E	1.0890	Adder	2.42
LGEE	LGEE	0.0421	Confirmed LTF	0.0421
CPLE	CPLE	0.1508	Confirmed LTF	0.1508
G-007A	G-007A	0.0336	Confirmed LTF	0.0336
VFT	VFT	0.0839	Confirmed LTF	0.0839
CBM-W2	CBM-W2	0.4032	Confirmed LTF	0.4032
NY	NY	0.0022	Confirmed LTF	0.0022
TVA	TVA	0.1918	Confirmed LTF	0.1918
SIGE	SIGE	0.0001	Confirmed LTF	0.0001
CBM-S2	CBM-S2	2.4012	Confirmed LTF	2.4012
CBM-S1	CBM-S1	0.0471	Confirmed LTF	0.0471
CBM-N	CBM-N	0.0144	Confirmed LTF	0.0144
GIBSON	GIBSON	0.0071	Confirmed LTF	0.0071
LAGN	LAGN	0.1697	Confirmed LTF	0.1697

10.7 Queue Dependencies

The Queue Projects below are listed in one or more indices for the overloads identified in your report. These projects contribute to the loading of the overloaded facilities identified in your report. The percent overload of a facility and cost allocation you may have towards a particular reinforcement could vary depending on the action of these earlier projects. The status of each project at the time of the analysis is presented in the table. This list may change as earlier projects withdraw or modify their requests.

Queue Number	Project Name	Status
AB2-083	Delano 138kV	Active
AC1-001	Delano 138kV	Active
AC1-194	Elk 138kV	Active
AC2-029	Circleville 138kV	Active
AC2-059	Biers Run-Circleville 138kV	Active
AD1-072	Biers Run-Circleville 138 kV	Active
AD2-016	Biers Run-Circleville 138 kV	Active
AD2-162	Biers Run-Circleville 138kV	Active
AE1-093	Elk 138 kV	Active
AF2-371	Harrison-Good Hope 138 kV	Active
AG1-326	Circleville-Biers Run 138 kV	Active
AG1-351	Harrison-Good Hope 138 kV	Active
AG1-380	Corwin-Elk 138 kV	Active

10.8 Contingency Descriptions

Contingency Name	Contingency Definition
AEP_P1-2_#9672_30877	CONTINGENCY 'AEP_P1-2_#9672_30877' 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 05HARRISON 138 243593 05ZUBER 138 1 OPEN BRANCH FROM BUS 243522 TO BUS 244419 CKT 1 / 243522 05HARRISON 138 244419 05HARRISON 39.4 1 END
AEP_P2-1_243522 05HARRISON 138 243550 05OBETZ 138 1	CONTINGENCY 'AEP_P2-1_243522 05HARRISON 138 243550 05OBETZ 138 1' OPEN BRANCH FROM BUS 243522 TO BUS 243550 CKT 1 END
AEP_P7-1_#10921	CONTINGENCY 'AEP_P7-1_#10921' OPEN BRANCH FROM BUS 243522 TO BUS 243550 CKT 1 / 243522 05HARRISON 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

11 Short Circuit Analysis

The following Breakers are overdutied

None

12 Affected Systems

12.1 TVA

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

12.2 Duke Energy Progress

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

12.3 MISO

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

12.4 LG&E

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