Generation Interconnection

Feasibility Study Report

for

Queue Project AE1-208

DELAWARE-VAN BUREN 138 KV

55 MW Capacity / 130 MW Energy

June, 2019

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 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.

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.

General

The Interconnection Customer has proposed a Solar generating facility located Delaware County, Indiana. The installed facilities will have a total capability of 130 MW with 55 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is December 2022. This study does not imply a TO commitment to this in-service date.

The Feasibility Study includes Short Circuit and Peak Load steady state power flow analyses. The conduct of power flow studies at other load levels, stability analysis, and coordination with non-PJM Transmission Planners, as required under the PJM planning process, is not performed during the Generation Interconnection Feasibility Study phase of the PJM study process. Additional reinforcement requirements for this Interconnection Request may be defined during the conduct of these additional analyses which shall be performed following execution of the System Impact Study agreement.

The objective of this Feasibility Study is to determine budgetary cost estimates and approximate construction timelines for identified transmission facilities required to connect the proposed generating facilities to the AEP transmission system. These reinforcements include the Attachment Facilities, Local Upgrades, and Network Upgrades required maintaining the reliability of the AEP transmission system. Stability analysis is not included as part of this study.

Queue Number	AE1-208
Project Name	DELAWARE-VAN BUREN 138 KV
State	Indiana
County	Delaware
Transmission Owner	AEP
MFO	130
MWE	130
MWC	55
Fuel	Solar
Basecase Study Year	2022

Point of Interconnection

AE1-208 will interconnect with the AEP transmission system via a new station cut into the Delaware to Van Buren 138 kV section of the Delaware – Sorenson 138kV Circuit.

To accommodate the interconnection on the Delaware – Van Buren 138kV section of the Delaware – Sorenson 138kV Circuit, a new three (3) circuit breaker 138kV 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, 138 kV line risers, SCADA, and 138 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.

Cost Summary

The AE1-208 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 6,000,000
Direct Connection Network Upgrade	$ 1,250,000
Non Direct Connection Network Upgrades	$ 500,000
Total Costs	$ 7,750,000

In addition, the AE1-208 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	$ 135,000

Cost allocations for these upgrades will be provided in the System Impact Study Report.

Transmission Owner Scope of Work

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
▪ Construct a new three (3) circuit breaker 138 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, 138 kV line risers and SCADA will also be required.	$ 6,000,000
Total Attachment Facility Costs	$ 6,000,000

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
Delaware – Van Buren 138kV T- Line Cut In	$ 1,000,000
138kV Revenue Metering	$ 250,000
Total Direct Connection Facility Costs	$1,250,000

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 protections & Controls at the Sorenson 138kV Substation	$ 250,000
Upgrade line protections & Controls at the Delaware 138kV Substation	$ 250,000
Total Non-Direct Connection Facility Costs	$ 500,000

Incremental Capacity Transfer Rights (ICTRs)

Will be determined at a later study phase

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 Agreement execution.

Transmission Owner Analysis

None

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 Delaware – Van Buren section of the Delaware – Sorenson 138kV 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.

Revenue Metering and SCADA Requirements

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.

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

Network Impacts

The Queue Project AE1-208 was evaluated as a 130 MW (Capacity 55 MW) injection via a new station cut into Delaware to Van Buren 138 kV section of Delaware – Sorenson 138kV Circuit in the AEP area. Project AE1-208 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE1-208 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Load Flow

Generation Deliverability

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

None

Multiple Facility Contingency

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

None

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
240896	248001	06DEARB1	OVEC	248013	06PIERCE	OVEC	1	.345.DEO&K-AEP.C5 4504MFTANNERS4512EBTANNERS	tower	972.0	107.52	108.1	DC	12.41

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
240374	243262	05COLLCO	AEP	250001	08COLINV	DEO&K	1	AEP_P1-2_#6372A	operation	167.0	111.57	113.35	DC	6.62
240375	243262	05COLLCO	AEP	250001	08COLINV	DEO&K	1	.138.DEO&K-AEP-DAY.B2 TODHUNTER JCT 138	operation	167.0	111.57	113.35	DC	6.62
850256	243262	05COLLCO	AEP	250001	08COLINV	DEO&K	1	.138.DEO&K-AEP-DAY.B2 TODHUNTER JCT 138	operation	167.0	111.57	113.35	DC	6.62

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
850257	243262	05COLLCO	AEP	250001	08COLINV	DEO&K	1	AEP_P1-2_#6372A	operation	167.0	111.57	113.35	DC	6.62
850539	936560	AD2-071 TAP	AEP	246763	05PIPECK	AEP	1	AEP_P1-2_#362	operation	205.0	98.1	99.68	DC	7.18

System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
240896	1	**06DEARB1 345.0 kV - 06PIERCE 345.0 kV Ckt 1**	**OVEC** A Sag Study will be required on the 33.5 miles of 1414 ~ 62/19 ACSR/PE Conductor, to mitigate the overload. The new ratings after sag study and any required mitigation will be: S/N: 971 MVA, S/E: 1419 MVA. The estimated study cost is $135,000. The cost of any mitigation will depend on the outcome of the sag study.	$135,000
			TOTAL COST	**$135,000**

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.

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
240896	248001	06DEARB1	OVEC	248013	06PIERCE	OVEC	1	.345.DEO&K-AEP.C5 4504MFTANNERS4512EBTANNERS	tower	972.0	107.52	108.1	DC	12.41

Bus #	Bus	MW Impact
243795	05HDWTR1G C	0.62
247264	05LAWG1A	7.65
247265	05LAWG1B	7.65
247266	05LAWG1S	12.21
247267	05LAWG2A	7.65
247268	05LAWG2B	7.65
247269	05LAWG2S	12.21
247543	V3-007 C	0.62
247914	05WLD G1 E	8.02
247929	S-071 E	8.58
247935	V3-007 E	26.87
247958	05WLD G2 E	8.41
247963	05HDWTR1G E	9.67
247968	Z2-115 E	0.16
915662	Y3-099 E	0.2
915672	Y3-100 E	0.2
916182	Z1-065 E	0.38
920501	AA2-148 C O1	3.54
920502	AA2-148 E O1	23.7
923881	AB2-028 C	2.91
923882	AB2-028 E	19.49
925242	AB2-178 E	1.98
926691	AC1-152	15.73
926851	AC1-172	15.73
926881	AC1-175 C	11.74
926882	AC1-175 E	19.15
932681	AC2-090 C	5.87
932682	AC2-090 E	9.57
932841	AC2-111 C O1	2.77
932842	AC2-111 E O1	4.52
933591	AC2-176 C O1	1.52
933592	AC2-176 E O1	10.16
933601	AC2-177 C O1	4.01
933602	AC2-177 E O1	26.87
934161	AD1-043 C O1	4.47
934162	AD1-043 E O1	7.3
934961	AD1-128 C O1	5.63
934962	AD1-128 E O1	9.19
936561	AD2-071 C	5.95
936562	AD2-071 E	2.93

Bus #	Bus	MW Impact
936681	AD2-087 C O1	3.17
936682	AD2-087 E O1	14.86
938061	AE1-008 C	0.69
938062	AE1-008 E	1.13
939761	AE1-207 C	5.97
939762	AE1-207 E	8.24
939771	AE1-208 C	5.25
939772	AE1-208 E	7.16
939781	AE1-209 C O1	1.28
939782	AE1-209 E O1	8.59
939791	AE1-210 C O1	1.61
939792	AE1-210 E O1	10.78
939811	AE1-217 C O1	7.96
939812	AE1-217 E O1	11.0
950161	J401	1.31
954711	J851 C	0.49
954712	J851 E	2.64
AB2-013	AB2-013	5.62
AE1-033	AE1-033	5.7
CARR	CARR	0.32
CATAWBA	CATAWBA	0.08
CBM-S1	CBM-S1	4.35
CBM-W1	CBM-W1	17.14
CBM-W2	CBM-W2	71.42
CIN	CIN	13.7
G-007	G-007	0.92
HAMLET	HAMLET	0.37
IPL	IPL	12.58
LGEE	LGEE	1.1
MEC	MEC	15.46
MECS	MECS	7.27
O-066	O-066	3.1
RENSSELAER	RENSSELAER	0.25
WEC	WEC	2.44
Z1-043	Z1-043	9.8

Affected Systems

LG&E

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

MISO

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

TVA

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

Duke Energy Progress

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

NYISO

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

Contingency Name	Contingency Definition
AEP_P1-2_#6372A	CONTINGENCY 'AEP_P1-2_#6372A' OPEN BRANCH FROM BUS 243262 TO BUS 250106 CKT 1 / 243262 05COLLCO 138 250106 08TODHJT 138 1 END
.345.DEO&K-AEP.C5 4504MFTANNERS4512EBTANNERS	CONTINGENCY '.345.DEO&K-AEP.C5 4504MFTANNERS4512EBTANNERS' OPEN BRANCH FROM BUS 243233 TO BUS 249567 CKT 1 OPEN BRANCH FROM BUS 243233 TO BUS 249565 CKT 1 END
.138.DEO&K-AEP-DAY.B2 TODHUNTER JCT 138	CONTINGENCY '.138.DEO&K-AEP-DAY.B2 TODHUNTER JCT 138' OPEN BUS 250106 END
AEP_P1-2_#362	CONTINGENCY 'AEP_P1-2_#362' OPEN BRANCH FROM BUS 243207 TO BUS 243208 CKT 1 / 243207 05GRNTWN 765 243208 05JEFRSO 765 1 END

Short Circuit

Short Circuit

The following Breakers are over duty:

None

Figure 1: AE1-208 Delaware – Van Buren One Line Diagram

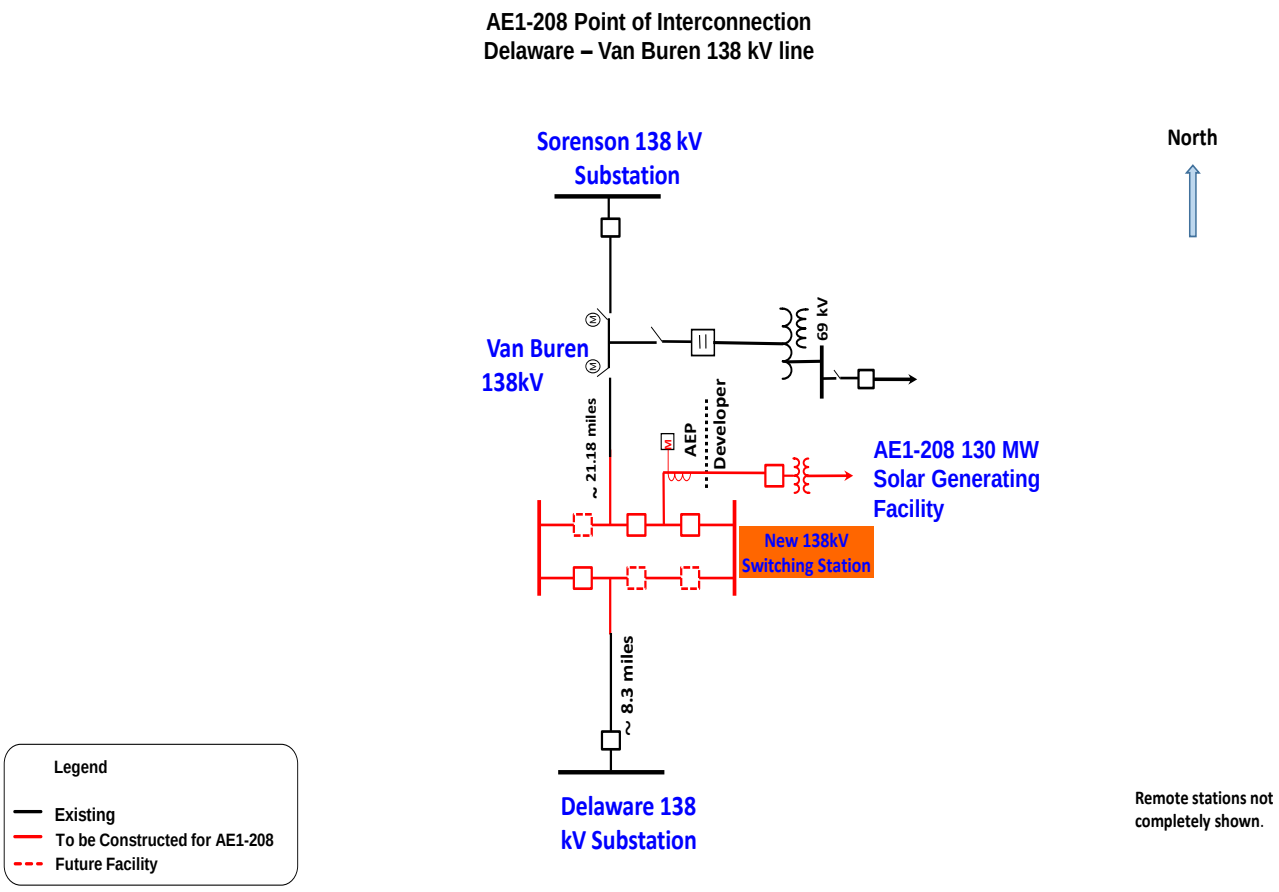

Figure 2: AE1-208 Point of Interconnection (Delaware – Van Buren 138kV)