



**Generation Interconnection
Feasibility Study Report
for
Queue Project AF2-204
VAN BUREN 138 KV
72 MW Capacity / 110 MW Energy**

July 2020

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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.

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.

3 General

The Interconnection Customer (IC), has proposed a Solar; Storage generating facility located in Grant County, Indiana. The installed facilities will have a total capability of 110 MW with 72 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is June 01, 2023. This study does not imply a TO commitment to this in-service date.

Queue Number	AF2-204
Project Name	VAN BUREN 138 KV
State	Indiana
County	Grant
Transmission Owner	AEP
MFO	110
MWE	110
MWC	72
Fuel	Solar; Storage
Basecase Study Year	2023

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

AF2-204 will interconnect with the AEP transmission system along one of the following Points of Interconnection:

Primary POI: Van Buren 138 kV

To accommodate the interconnection at the Van Buren 138 kV substation, the substation will have to be expanded requiring the rebuild of the 138 kV bus, installation of four (4) 138 kV circuit breaker (see Attachment 1). Installation of associated protection and control equipment, 138 kV line risers, SCADA, and 138 kV revenue metering will also be required. Note that the configuration shown in Attachment 1 represents several changes from previous studies.

Installation of the generator lead first span exiting the POI station, including the first structure outside the AEP fence, will also be included in AEP's scope. In the case where the generator lead is a single span, the structure in the customer station will be the customer's responsibility.

Secondary POI: Tap - Van Buren to Delaware 138 kV line

To accommodate the interconnection at the Van Buren – Delaware 138 kV Circuit, a new 138 kV switching station will be built, requiring the installation of three (3) 138 kV circuit breaker (see Attachment 2). Installation of associated protection and control equipment, 138 kV line risers, SCADA, and 138 kV revenue metering will also be required. Note that the configuration shown in Attachment 2 represents several changes from previous studies.

5 Cost Summary

The AF2-204 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	\$10,578,000
Total System Network Upgrade Costs	\$33,200
Total Costs	\$10,611,200

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.

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 88-129. 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.

6 Transmission Owner Scope of Work

The total physical interconnection costs is given in the tables 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
138kV Revenue Metering	\$ 388,000
Generator lead first span exiting the POI station, including the first structure outside the fence	\$ 400,000
Total Attachment Facility Costs	\$ 788,000

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
Construct a new four (4) circuit breaker 138 kV switching station physically configured in a ring bus arrangement and operated as a ring-bus (see Single Line Diagram). Installation of associated protection and control equipment, 138 kV line risers and SCADA will also be required.	\$8,930,000
Total Direct Connection Facility Costs	\$8,930,000

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
Upgrade Line Protections & Controls at the Sorenson 138 kV Substation	\$45,000
Upgrade Line Protections & Controls at the Delaware 138 kV Substation	\$45,000
Sorenson – Delaware 138 kV Circuit Cut into Van Buren station	\$770,000
Total Non-Direct Connection Facility Costs	\$860,000

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 (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

Solar generation facilities shall provide the Transmission Provider with site-specific meteorological data including:

- Back Panel temperature (Fahrenheit)
- Irradiance (Watts/meter²)

- 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 – Primary POI

The Queue Project AF2-204 was evaluated as a 110.0 MW (Capacity 72.0 MW) injection at the Van Buren 138 kV substation in the AEP area. Project AF2-204 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF2-204 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)

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CK T ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADIN G %	POST PROJECT LOADIN G %	AC D C	MW IMPACT
95781982	939770	AE1-208 TAP	138.0	AEP	243275	05DELAWR	138.0	AEP	1	AEP_P7-1_#11031-B-B	tower	167.0	80.06	132.5	DC	87.56

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)

None

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	CK T ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADIN G %	POST PROJECT LOADIN G %	AC D C	MW IMPACT
95781522	243387	05VANBUR	138.0	AEP	243377	05SORENS	138.0	AEP	1	AEP_P1-2_#5595-A	operation	167.0	74.5	130.37	DC	93.31
95781613	939770	AE1-208 TAP	138.0	AEP	243275	05DELAWR	138.0	AEP	1	Base Case	operation	136.0	79.68	111.43	DC	43.18
95781614	939770	AE1-208 TAP	138.0	AEP	243275	05DELAWR	138.0	AEP	1	AEP_SUBT_P1-2_#763-B	operation	167.0	76.51	105.0	DC	47.58

10.5 System Reinforcements - Summer Peak Load Flow - Primary POI

ID	Idx	Facility	Upgrade Description	Cost
95781982	1	AE1-208 TAP 138.0 kV - 05DELAWR 138.0 kV Ckt 1	<p>AEPI0028a (316) : A Sag Study will be required on the 8.3 mile section of ACSR ~ 397.5 ~ 30/7 ~ LARK line to mitigate the overload . New Rating after the Sag Study: S/N: 167 MVA S/E: 245 MVA. Depending on the sag study results, cost for this upgrade is expected to be between \$33,200 (No remediations required just sag study) and \$24.9 million (complete line reconductor/rebuild required). Time Estimate: a) Sag Study: 6-12 months b) Rebuild: The standard time required for construction differs from state to state. An approximate construction time would be 24 to 36 months after signing an interconnection agreement.</p> <p>Project Type : FAC Cost : \$33,200 Time Estimate : 6-12 Months</p>	\$33,200
			TOTAL COST	\$33,200

10.6 Flow Gate Details – Primary POI

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
95781982	939770	AE1-208 TAP	AEP	243275	05DELAWR	AEP	1	AEP_P7-1_#11031-B-B	tower	167.0	80.06	132.5	DC	87.56

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
939771	AE1-208 C	49.9340	50/50	49.9340
939772	AE1-208 E	68.0918	50/50	68.0918
941691	AE2-169	29.9604	50/50	29.9604
942221	AE2-234 C O1	8.6844	50/50	8.6844
942222	AE2-234 E O1	3.9278	50/50	3.9278
959131	AF2-204 C O1	57.3142	50/50	57.3142
959132	AF2-204 E O1	30.2491	50/50	30.2491
WEC	WEC	0.0013	Confirmed LTF	0.0013
NEWTON	NEWTON	0.0666	Confirmed LTF	0.0666
FARMERCITY	FARMERCITY	0.0013	Confirmed LTF	0.0013
G-007A	G-007A	0.0072	Confirmed LTF	0.0072
VFT	VFT	0.0193	Confirmed LTF	0.0193
CALDERWOOD	CALDERWOOD	0.0169	Confirmed LTF	0.0169
CBM-W1	CBM-W1	0.1626	Confirmed LTF	0.1626
PRAIRIE	PRAIRIE	0.1214	Confirmed LTF	0.1214
CHEOAH	CHEOAH	0.0170	Confirmed LTF	0.0170
EDWARDS	EDWARDS	0.0021	Confirmed LTF	0.0021
TILTON	TILTON	0.0410	Confirmed LTF	0.0410
MADISON	MADISON	0.0887	Confirmed LTF	0.0887
GIBSON	GIBSON	0.0666	Confirmed LTF	0.0666
BLUEG	BLUEG	0.1441	Confirmed LTF	0.1441
TRIMBLE	TRIMBLE	0.0451	Confirmed LTF	0.0451
CATAWBA	CATAWBA	0.0073	Confirmed LTF	0.0073

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
AE1-208	Delaware-Van Buren 138 kV	Active
AE2-169	Delaware-Van Buren 138 kV	Active
AE2-234	Liberty Center-Buckeye Tap 69 kV	Active
AF2-204	Van Buren 138 kV	Active

10.8 Contingency Descriptions – Primary POI

Contingency Name	Contingency Definition
Base Case	
AEP_P7-1_#11031-B-B	CONTINGENCY 'AEP_P7-1_#11031-B-B' OPEN BRANCH FROM BUS 243278 TO BUS 243369 CKT 1 / 243278 05DESOTO 138 243369 05ROYERT 138 1 OPEN BRANCH FROM BUS 243369 TO BUS 946490 CKT 1 / 243369 05ROYERT 138 946490 AF1-313 TAP 138 1 OPEN BRANCH FROM BUS 243377 TO BUS 243387 CKT 1 / 243377 05SORENS 138 243387 05VANBUR 138 1 END
AEP_P1-2_#5595-A	CONTINGENCY 'AEP_P1-2_#5595-A' OPEN BRANCH FROM BUS 243275 TO BUS 939770 CKT 1 / 243275 05DELAWR 138 939770 AE1-208 TAP 138 1 END
AEP_SUBT_P1-2_#763-B	CONTINGENCY 'AEP_SUBT_P1-2_#763-B' OPEN BRANCH FROM BUS 942220 TO BUS 246249 CKT 1 / 942220 AE2-234 TAP 69.0 246249 05LIBRTY C 69.0 1 END

11 Light Load Analysis

Light Load Studies (As applicable)

To be determined during later study phases.

12 Short Circuit Analysis – Primary POI

The following Breakers are overdutied:

To be determined during later study phases.

13 Stability and Reactive Power Assessment

(Summary of the VAR requirements based upon the results of the dynamic studies)

To be determined during later study phases.

14 Affected Systems

14.1 TVA

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

14.2 Duke Energy Progress

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

14.3 MISO

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

14.4 LG&E

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

15 Summer Peak – Load Flow Analysis – Secondary POI

The Queue Project AF2-204 was evaluated as a 110.0 MW (Capacity 72.0 MW) injection tapping the Van Buren to Delaware 138 kV line in the AEP area. Project AF2-204 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF2-204 was studied with a commercial probability of 53.0 %. Potential network impacts were as follows:

15.1 Generation Deliverability

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

None

15.2 Multiple Facility Contingency

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

None

15.3 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)

None

15.4 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	FRO M BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CK T ID	CONT NAME	Type	Ratin g MVA	PRE PROJEC T LOADIN G %	POST PROJEC T LOADIN G %	AC D C	MW IMPAC T
144882372	243387	05VANBUR	138.0	AEP	243377	05SORENS	138.0	AEP	1	AEP_P1-2_#5595-C	operatio n	167.0	74.5	130.37	DC	93.31
95781613	939770	AE1-208 TAP	138.0	AEP	243275	05DELAWR	138.0	AEP	1	Base Case	operatio n	136.0	79.68	112.53	DC	44.68
95781895	939770	AE1-208 TAP	138.0	AEP	243275	05DELAWR	138.0	AEP	1	AEP_P1-2_#5595-B	operatio n	167.0	97.49	163.35	DC	110.0
144882299	939770	AE1-208 TAP	138.0	AEP	243275	05DELAWR	138.0	AEP	1	24338705VANBUR 138 959130 AF2-204 TAP 138 1	operatio n	167.0	97.49	163.35	DC	110.0
144882306	959130	AF2-204 TAP	138.0	AEP	243387	05VANBUR	138.0	AEP	1	AEP_P1-2_#5595-C	operatio n	167.0	97.49	163.35	DC	110.0
144882309	959130	AF2-204 TAP	138.0	AEP	243387	05VANBUR	138.0	AEP	1	Base Case	operatio n	136.0	54.2	102.23	DC	65.32

15.5 Flow Gate Details – Secondary POI

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".

15.6 Contingency Descriptions – Secondary POI

Contingency Name	Contingency Definition
Base Case	
243387 05VANBUR 138 959130 AF2-204 TAP 138 1	CONTINGENCY '243387 05VANBUR 138 959130 AF2-204 TAP 138 1' OPEN BRANCH FROM BUS 243387 TO BUS 959130 CKT 1 END
AEP_P1-2_#5595-B	CONTINGENCY 'AEP_P1-2_#5595-B' OPEN BRANCH FROM BUS 246000 TO BUS 243387 CKT 1 / 246000 05VANBUREQ 999 243387 05VANBUR 138 1 OPEN BRANCH FROM BUS 246000 TO BUS 245999 CKT Z1 / 246000 05VANBUREQ 999 245999 05VAN BURE 69.0 Z1 OPEN BRANCH FROM BUS 246000 TO BUS 245998 CKT Z1 / 246000 05VANBUREQ 999 245998 05VAN BURE 12.0 Z1 OPEN BRANCH FROM BUS 959130 TO BUS 243387 CKT 1 / 959130 AF2-204 TAP 138 243387 05VANBUR 138 1 OPEN BRANCH FROM BUS 243377 TO BUS 243387 CKT 1 / 243377 05SORENS 138 243387 05VANBUR 138 1 OPEN BRANCH FROM BUS 245987 TO BUS 245999 CKT 1 / 245987 05MTETNA T 69.0 245999 05VAN BURE 69.0 1 END
AEP_P1-2_#5595-C	CONTINGENCY 'AEP_P1-2_#5595-C' OPEN BRANCH FROM BUS 243275 TO BUS 939770 CKT 1 / 243275 05DELAWR 138 939770 AE1-208 TAP 138 1 END

16 Light Load Analysis – Secondary POI

Light Load Studies (As applicable).

To be determined during later study phases.

17 Short Circuit Analysis – Secondary POI

The following Breakers are overdutied

To be determined during later study phases.

18 Stability and Reactive Power Assessment – Secondary POI

(Summary of the VAR requirements based upon the results of the dynamic studies)

To be determined during later study phases.

19 Affected Systems – Secondary POI

19.1 TVA

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

19.2 Duke Energy Progress

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

19.3 MISO

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

19.4 LG&E

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