Generation Interconnection

System Impact Study Report

for

Queue Project AF1-268

DESOTO-JAY 138 KV

57.1 MW Capacity / 83 MW Energy

August, 2020

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1 Introduction

This System Impact Study has been prepared in accordance with the PJM Open Access Transmission Tariff, 205, as well as the System Impact 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 System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

In some instances an Interconnection Customer may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection or merchant transmission upgrade, may also contribute to the need for the same network reinforcement. 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 System Impact Study is performed.

The System Impact 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.

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.

3 General

The Interconnection Customer (IC), has proposed a Solar generating facility located in Delaware County, Indiana. The installed facilities will have a total capability of 83 MW with 57.1 MW of this output being recognized by PJM as Capacity.

The proposed in-service date for this project is January 31, 2022. This study does not imply a TO commitment to this in-service date.

The objective of this System Impact Study is to determine budgetary cost estimates and approximate construction timelines for identified transmission facilities required to connect the proposed generating facilities to the ITO transmission system. These reinforcements include the Attachment Facilities, Local Upgrades, and Network Upgrades required for maintaining the reliability of the ITO transmission system.

Queue Number	**AF1-268**
Project Name	DESOTO-JAY 138 KV
State	Indiana
County	Delaware
Transmission Owner	AEP
MFO	83
MWE	83
MWC	57.1
Fuel	Solar
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

AF1-268 will interconnect with the AEP transmission system via a new station cut into the Desoto to Jay 138 kV line.

To accommodate the interconnection on the Desoto to Jay 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 Attachment 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.

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.

5 Cost Summary

This project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$788,000
Direct Connection Network Upgrade	$8,040,000
Non Direct Connection Network Upgrades	$860,000
Allocation for New System Upgrades*	$0
Contribution to Previously Identified Upgrades*	$0
Total Costs	**$9,688,000**

*As your project progresses through the study process and other projects modify their request or withdraw, then your cost allocation could change.

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.

Note 1: PJM Open Access Transmission Tariff (OATT) section 217.3A outline cost allocation rules. The rules are further clarified in PJM Manual 14A Attachment B. The allocation of costs for a network upgrade will start

with the first Queue project to cause the need for the upgrade. Later queue projects will receive cost allocation contingent on their contribution to the violation and are allocated to the queues that have not closed less than 5 years following the execution of the first Interconnection Service Agreement which identifies the need for this upgrade.

6 Transmission Owner Scope of Work

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 three (3) circuit breaker 138 kV switching station physically configured in a breaker and half bus arrangement but operated as a ring-bus (See Attachment 1). 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
138kV Transmission Line Cut In	$770,000
Review and Revise the P&C relay settings at the Desoto 138 kV station	$45,000
Review and Revise the P&C relay settings at the Jay 138 kV station	$45,000
Total Non-Direct Connection Facility Costs	**$860,000**

7 Incremental Capacity Transfer Rights (ICTRs)

None.

8 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.

9 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 the Interconnected Transmission Owner. The cost of the Interconnection Customer's generating plant and the costs for the line connecting the generating plant to the Interconnected Transmission Owner's 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 the Interconnected 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.

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.

10 Revenue Metering and SCADA Requirements

10.1 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.

10.2 Meteorological Data Reporting Requirements

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

- Back Panel temperature (Fahrenheit)
- Irradiance (Watts/meter^2)
- Ambient air temperature (Fahrenheit) – (Accepted, not required)
- Wind speed (meters/second) – (Accepted, not required)
- Wind direction (decimal degrees from true north) – (Accepted, not required)

10.3 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/

11 Summer Peak Analysis

The Queue Project AF1-268 was evaluated as a 83.0 MW (Capacity 57.1 MW) injection tapping the Desoto to Jay 138 kV line in the AEP area. Project AF1-268 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-268 was studied with a commercial probability of 100.0 %. Potential network impacts were as follows:

11.1 Generation Deliverability

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

None

11.2 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	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
86720580	946030	AF1-268 TAP	138.0	AEP	243319	05JAY	138.0	AEP	1	AEP_P7-1_#11019	tower	393.0	99.22	103.95	AC	18.81

11.3 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

11.4 Steady-State Voltage Requirements

None

11.5 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
4358479 7	243218	05DESOTO	345.0	AEP	944830	AF1-148 TAP	345.0	AEP	2	AEP_P1-2_#4817	operation	971.0	107.95	109.41	AC	14.44
4358482 3	243218	05DESOTO	345.0	AEP	945370	AF1-202 TAP	345.0	AEP	1	AEP_P1-2_#8702-C	operation	897.0	100.8	102.37	AC	14.36
4358487 7	243225	05KEYSTN	345.0	AEP	243232	05SORENS	345.0	AEP	1	AEP_P1-2_#8702-C	operation	1301.0	101.74	102.83	AC	14.26
4358487 8	243225	05KEYSTN	345.0	AEP	243232	05SORENS	345.0	AEP	1	Base Case	operation	897.0	103.9	105.06	AC	10.43
4527522 4	940980	AE2-089 TAP	138.0	AEP	243237	05ADAM	138.0	AEP	1	AEP_P1-2_#5598-A	operation	205.0	87.17	100.56	AC	27.72
4358467 4	944530	AF1-118 TAP	345.0	AEP	243232	05SORENS	345.0	AEP	2	AEP_P1-2_#4817	operation	971.0	138.38	139.84	AC	14.44
4358467 9	944530	AF1-118 TAP	345.0	AEP	243232	05SORENS	345.0	AEP	2	Base Case	operation	971.0	100.42	101.5	AC	10.66
4358471 0	944540	AF1-119 TAP	345.0	AEP	243225	05KEYSTN	345.0	AEP	1	AEP_P1-2_#8702-C	operation	897.0	125.64	127.2	AC	14.36
4358474 8	944830	AF1-148 TAP	345.0	AEP	944530	AF1-118 TAP	345.0	AEP	2	AEP_P1-2_#4817	operation	971.0	116.77	118.23	AC	14.44
4358476 9	945370	AF1-202 TAP	345.0	AEP	944540	AF1-119 TAP	345.0	AEP	1	AEP_P1-2_#8702-C	operation	897.0	115.99	117.55	AC	14.36

11.6 System Reinforcements

ID	Idx	Facility	Upgrade Description	Cost	Cost Allocated to AF1-268	Upgrade Number
86720580,86720581	1	**AF1-268 TAP 138.0 kV - 05JAY 138.0 kV Ckt 1**	1) Replace 2 risers at Jay 138 kV substation. Time estimate 24-36 months. Cost estimate: $70K. Note: There is a supplemental project, S2015.3, which may increase the SE rating to 409 MVA which may inlcude this work scope. AEP will need to confirm this during the Facilities Study. 2) A Sag Study will be required on the 12.53 miles of ACSR ~ 556.5 ~ 26/7 ~ DOVE - Conductor section 1 to mitigate the overload. The new ratings after sag study will be: S/N: 409 MVA, S/E: 620 MVA, Depending on the sag study results, the cost for this upgrade is expected to be between $50,120(no remediation required, just sag study) and $18.8 million (complete line Reconductor/rebuild). 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. This line is first overloaded in a prior queue cycle.	$70 K + $50.12 K	$0	N6279.1 N6279.2
			Total Cost:	**$120,120**	**$0**	

Note: For customers with System Reinforcements listed: If your present cost allocation to a System Reinforcement indicates $0, then please be aware that as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, reducing in size, etc, the cost responsibilities can change and a cost allocation may be assigned to your project. In addition, although your present cost allocation to a System Reinforcement is presently $0, your project may need this system reinforcement completed to be deliverable to the PJM system. If your project comes into service prior to completion of the system reinforcement, an interim deliverability study for your project will be required.

11.7 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".

11.7.1 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
86720580	946030	AF1-268 TAP	AEP	243319	05JAY	AEP	1	AEP_P7-1_#11019	tower	393.0	99.22	103.95	AC	18.81

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
247935	V3-007 E	10.0128	Adder	11.78
247963	05HDWTR1G E	10.0128	Adder	11.78
923881	AB2-028 C	1.2800	Adder	1.51
923882	AB2-028 E	8.5664	Adder	10.08
926881	AC1-175 C	4.3734	Adder	5.15
926882	AC1-175 E	7.1356	Adder	8.39
927181	AC1-212 C	-0.1224	Adder	-0.14
927183	AC1-212 BAT	1.5088	Merchant Transmission	1.5088
932681	AC2-090 C	2.1867	Adder	2.57
932682	AC2-090 E	3.5678	Adder	4.2
933592	AC2-176 E O1	-53.8481	Adder	-63.35
933601	AC2-177 C O1	1.4962	Adder	1.76
933602	AC2-177 E O1	10.0128	Adder	11.78
934961	AD1-128 C	3.3891	Adder	3.99
934962	AD1-128 E	5.5295	Adder	6.51
939761	AE1-207 C	3.0188	Adder	3.55
939762	AE1-207 E	4.1688	Adder	4.9
939771	AE1-208 C	2.4698	Adder	2.91
939772	AE1-208 E	3.3679	Adder	3.96
939781	AE1-209 C O1	0.8571	Adder	1.01
939782	AE1-209 E O1	5.7363	Adder	6.75
939791	AE1-210 C O1	0.8571	Adder	1.01
939792	AE1-210 E O1	5.7363	Adder	6.75
941691	AE2-169	1.4819	Adder	1.74
941721	AE2-172	1.7969	Adder	2.11
942081	AE2-220 C	3.0211	Adder	3.55
942082	AE2-220 E	4.1720	Adder	4.91
944531	AF1-118 C O1	17.7229	Adder	20.85
944532	AF1-118 E O1	5.3452	Adder	6.29
944541	AF1-119 C O1	9.2285	Adder	10.86
944542	AF1-119 E O1	3.9551	Adder	4.65
944831	AF1-148 C O1	6.2877	Adder	7.4
944832	AF1-148 E O1	4.1918	Adder	4.93
945371	AF1-202 C O1	2.2412	Adder	2.64
945372	AF1-202 E O1	10.9423	Adder	12.87
945581	AF1-223 C O1	5.9326	Adder	6.98
945582	AF1-223 E O1	3.9551	Adder	4.65
946031	AF1-268 C O1	12.9400	50/50	12.9400
946032	AF1-268 E O1	5.8695	50/50	5.8695
946491	AF1-313 C O1	1.7446	Adder	2.05
946492	AF1-313 E O1	1.1631	Adder	1.37
WEC	WEC	0.0151	Confirmed LTF	0.0151

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
LGEE	LGEE	0.6566	Confirmed LTF	0.6566
CPLE	CPLE	0.1435	Confirmed LTF	0.1435
CBM-W2	CBM-W2	6.5520	Confirmed LTF	6.5520
NY	NY	0.0465	Confirmed LTF	0.0465
TVA	TVA	0.8134	Confirmed LTF	0.8134
O-066	O-066	0.4906	Confirmed LTF	0.4906
CBM-S2	CBM-S2	1.6242	Confirmed LTF	1.6242
CBM-S1	CBM-S1	5.8532	Confirmed LTF	5.8532
G-007	G-007	0.0749	Confirmed LTF	0.0749
MEC	MEC	0.4942	Confirmed LTF	0.4942

11.8 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
AB2-028	Fall Creek-Desoto 345kV	Active
AC1-175	Losantville 345kV	Active
AC1-212	Minster 69kV	Engineering and Procurement
AC2-090	Losantville 345kV	Active
AC2-176	Jay 138 kV	Under Construction
AC2-177	Desoto-Tanners Creek 345kV	Active
AD1-128	Modoc 138 kV	Active
AE1-207	Mississinewa-Gaston 138 kV	Active
AE1-208	Delaware-Van Buren 138 kV	Active
AE1-209	Desoto 345 kV	Active
AE1-210	Desoto 345 kV	Active
AE2-169	Delaware-Van Buren 138 kV	Active
AE2-172	Mississinewa-Gaston 138 kV	Active
AE2-220	Losantville 345 kV	Active
AF1-118	Sorenson-Desoto 345 kV	Active
AF1-119	Keystone-Desoto 345 kV	Active
AF1-148	Sorenson-Desoto 345 kV	Active
AF1-202	Keystone-Desoto 345 kV	Active
AF1-223	Jay-Desoto 138 kV	Active
AF1-268	Desoto-Jay 138 kV	Active
AF1-313	Wes Del-Royerton 138 kV	Active
V3-007	Desoto-Tanners Creek #1 345kV	Under Construction

11.9 Contingency Descriptions

Contingency Name	Contingency Definition
AEP_P1-2_#4817	CONTINGENCY 'AEP_P1-2_#4817' OPEN BRANCH FROM BUS 243225 TO BUS 243232 CKT 1 / 243225 05KEYSTN 345 243232 05SORENS 345 1 END
AEP_P1-2_#8702-C	CONTINGENCY 'AEP_P1-2_#8702-C' OPEN BRANCH FROM BUS 944530 TO BUS 243232 CKT 2 / 944530 AF1-118 TAP 345 243232 05SORENS 345 2 END
AEP_P7-1_#11087-C	CONTINGENCY 'AEP_P7-1_#11087-C' OPEN BRANCH FROM BUS 944540 TO BUS 243225 CKT 1 / 944540 AF1-119 TAP 345 243225 05KEYSTN 345 1 OPEN BRANCH FROM BUS 944530 TO BUS 243232 CKT 2 / 944530 AF1-118 TAP 345 243232 05SORENS 345 2 END
Base Case	
AEP_P7-1_#11019	CONTINGENCY 'AEP_P7-1_#11019' OPEN BRANCH FROM BUS 944530 TO BUS 243232 CKT 2 / 243218 05DESOTO 345 243232 05SORENS 345 2 OPEN BRANCH FROM BUS 243225 TO BUS 243232 CKT 1 / 243225 05KEYSTN 345 243232 05SORENS 345 1 END
AEP_P1-2_#5598-A	CONTINGENCY 'AEP_P1-2_#5598-A' OPEN BRANCH FROM BUS 243278 TO BUS 946030 CKT 1 / 243278 05DESOTO 138 946030 AF1-268 TAP 138 1 END

12 Light Load Analysis

Not Required.

13 Short Circuit Analysis

The following Breakers are overdutied

None.

14 Stability and Reactive Power

To be determined in the Facilities Study Phase.

15 Affected Systems

15.1 TVA

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

15.2 Duke Energy Progress

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

15.3 MISO

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

15.4 LG&E

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

16 Attachment 1: One-Line Diagram and Site Location