Generation Interconnection

Feasibility Study Report

for

Queue Project AG1-376

SORENSON-DESOTO 345 KV

12 MW Capacity / 30 MW Energy

January 2021

Table of Contents

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 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 Storage generating facility located in Blackford County, Indiana. The installed facilities will have a total capability of 30 MW with 12 MW of this output being recognized by PJM as Capacity.

The proposed in-service date for this project is October 31, 2024. This study does not imply a TO commitment to this in-service date.

Queue Number	AG1-376
Project Name	SORENSON-DESOTO 345 KV
State	Indiana
County	Blackford
Transmission Owner	AEP
MFO	30
MWE	30
MWC	12
Fuel	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

AG1-376 will interconnect with the AEP transmission system via a direct connection to the AF2-177 proposed 345 kV substation as an increase to the PJM project AG1-375.

Note: It is assumed that the existing 345 kV revenue metering system, generation lead and Protection & Control Equipment that will be installed for AG1-375 will be adequate for the increased generation of AG1-376.Depending on the timing of the completion of the AG1-375 interconnection construction relative to the AG1-376 completion, there may (or may not) be a need to review and revise the relay settings for the increased generation of AG1-376.

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

The AG1-376 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	$45,000
Total System Network Upgrade Costs	$1,000,000
Total Costs	**$1,045,000**

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
None	$0
Total Attachment Facility Costs	**$0**

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
None	$0
Total Direct Connection Facility Costs	**$0**

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
Review line protection and control settings at the AF2-177 proposed 345 kV switching station	$45,000
Total Non-Direct Connection Facility Costs	**$45,000**

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

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 AG1-376 was evaluated as a 30.0 MW (Capacity 12.0 MW) injection tapping the Sorenson to Desoto 345 kV line in the AEP area. Project AG1-376 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AG1-376 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	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
161765888	243218	05DESOTO	345.0	AEP	923880	AB2-028 TAP	345.0	AEP	1	AEP_P7-1_#11087-H	tower	1318.0	99.28	100.12	DC	11.15

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	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
168212699	243218	05DESOTO	345.0	AEP	958860	AF2-177 TAP	345.0	AEP	2	AEP_P1-2_#4817_63 41	operation	971.0	116.37	118.07	DC	16.52
168212547	944530	AF1-118 TAP	345.0	AEP	243232	05SORENS	345.0	AEP	2	AEP_P1-2_#4817_63 41	operation	971.0	161.34	162.71	DC	13.48
168212549	944530	AF1-118 TAP	345.0	AEP	243232	05SORENS	345.0	AEP	2	Base Case	operation	971.0	117.55	118.84	DC	12.46
169717182	944830	AF1-148 TAP	345.0	AEP	944530	AF1-118 TAP	345.0	AEP	2	AEP_P1-2_#4817_63 41	operation	971.0	139.54	140.91	DC	13.48
169717255	958860	AF2-177 TAP	345.0	AEP	944830	AF1-148 TAP	345.0	AEP	2	AEP_P1-2_#4817_63 41	operation	971.0	130.08	131.45	DC	13.48

10.5 System Reinforcements - Summer Peak Load Flow - Primary POI

ID	Idx	Facility	Upgrade Description	Cost
161765888	1	**05DESOTO 345.0 kV - AB2-028 TAP 345.0 kV Ckt 1**	**AEP** **AEPI0026a (177) : Replace 10 345 kV Desoto Risers (Sub Cond 22156 ACSR 84/19 STD)** **Project Type : FAC** **Cost : $1,000,000** **Time Estimate : 12-18 Months**	$1,000,000
			TOTAL COST	**$1,000,000**

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
161765888	243218	05DESOTO	AEP	923880	AB2-028 TAP	AEP	1	AEP_P7-1_#11087-H	tower	1318.0	99.28	100.12	DC	11.15

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
243795	05HDWTR1G C	1.3162	50/50	1.3162
247536	05BLUFF P WF	0.5712	50/50	0.5712
247543	V3-007 C	1.3162	50/50	1.3162
247621	Y3-024	0.0509	50/50	0.0509
247929	S-071 E	14.4826	50/50	14.4826
247935	V3-007 E	55.8314	50/50	55.8314
247963	05HDWTR1G E	55.8314	50/50	55.8314
926881	AC1-175 C	24.3861	50/50	24.3861
926882	AC1-175 E	39.7879	50/50	39.7879
932681	AC2-090 C	12.1931	50/50	12.1931
932682	AC2-090 E	19.8939	50/50	19.8939
932841	AC2-111 C O1	2.4964	Adder	2.94
932842	AC2-111 E O1	4.0731	Adder	4.79
933594	AC2-176 C	0.4304	50/50	0.4304
933596	AC2-176 E	18.2555	50/50	18.2555
934961	AD1-128 C	12.1131	50/50	12.1131
934962	AD1-128 E	19.7634	50/50	19.7634
939761	AE1-207 C	8.6150	50/50	8.6150
939762	AE1-207 E	11.8970	50/50	11.8970
939771	AE1-208 C	6.8277	50/50	6.8277
939772	AE1-208 E	9.3105	50/50	9.3105
939781	AE1-209 C O1	4.8308	50/50	4.8308
939782	AE1-209 E O1	32.3292	50/50	32.3292
939791	AE1-210 C O1	4.8308	50/50	4.8308
939792	AE1-210 E O1	32.3292	50/50	32.3292
940981	AE2-089 C O1	11.2948	50/50	11.2948
940982	AE2-089 E O1	7.5299	50/50	7.5299
941691	AE2-169	4.0966	50/50	4.0966
941721	AE2-172	5.1280	50/50	5.1280
942071	AE2-219 C	6.1349	50/50	6.1349
942072	AE2-219 E	8.4721	50/50	8.4721
942081	AE2-220 C	16.8457	50/50	16.8457
942082	AE2-220 E	23.2631	50/50	23.2631
942221	AE2-234 C O1	1.8389	Adder	2.16
942222	AE2-234 E O1	0.8317	Adder	0.98
944031	AF1-071 C	0.6241	Adder	0.73
944032	AF1-071 E	1.0183	Adder	1.2
944531	AF1-118 C O1	99.9205	50/50	99.9205
944532	AF1-118 E O1	30.1359	50/50	30.1359
944541	AF1-119 C O1	52.0226	50/50	52.0226
944542	AF1-119 E O1	22.2954	50/50	22.2954

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
944831	AF1-148 C O1	35.4497	50/50	35.4497
944832	AF1-148 E O1	23.6331	50/50	23.6331
945371	AF1-202 C O1	12.6341	50/50	12.6341
945372	AF1-202 E O1	61.6839	50/50	61.6839
945561	AF1-221 C O1	10.0053	Adder	11.77
945562	AF1-221 E O1	3.0074	Adder	3.54
945581	AF1-223 C O1	33.4431	50/50	33.4431
945582	AF1-223 E O1	22.2954	50/50	22.2954
946031	AF1-268 C O1	13.8056	50/50	13.8056
946032	AF1-268 E O1	6.2621	50/50	6.2621
957741	AF2-068 C O1	14.5269	50/50	14.5269
957742	AF2-068 E O1	9.6846	50/50	9.6846
958711	AF2-162 C	11.1477	50/50	11.1477
958712	AF2-162 E	5.5739	50/50	5.5739
958821	AF2-173 C	31.2144	50/50	31.2144
958822	AF2-173 E	43.1056	50/50	43.1056
958861	AF2-177 C O1	9.6613	50/50	9.6613
958862	AF2-177 E O1	64.6567	50/50	64.6567
959131	AF2-204 C	4.5827	Adder	5.39
959132	AF2-204 E	2.4186	Adder	2.85
959201	AF2-211 C	4.9271	Adder	5.8
959202	AF2-211 E	3.2847	Adder	3.86
960441	AF2-335 C	10.9086	50/50	10.9086
960442	AF2-335 E	3.6362	50/50	3.6362
960791	AF2-370	3.6362	50/50	3.6362
960971	AF2-388 C	13.0800	50/50	13.0800
960972	AF2-388 E	61.2380	50/50	61.2380
961162	AF2-407 BAT	92.0370	50/50	92.0370
961172	AF2-408 BAT	13.2544	50/50	13.2544
961761	AG1-017 C	0.4729	50/50	0.4729
961762	AG1-017 E	2.2129	50/50	2.2129
962031	AG1-047 C	9.6846	50/50	9.6846
962032	AG1-047 E	6.4564	50/50	6.4564
962051	AG1-049	0.7660	Adder	1.7
963731	AG1-225 C	8.9178	Adder	19.8
963732	AG1-225 E	5.9883	Adder	13.29
964353	AG1-297 BAT	21.5127	Merchant Transmission	21.5127
964611	AG1-324 C O1	5.6070	50/50	5.6070
964612	AG1-324 E O1	2.4030	50/50	2.4030
965031	AG1-367 C	22.2960	50/50	22.2960
965032	AG1-367 E	14.8640	50/50	14.8640
965101	AG1-375 C	22.2954	50/50	22.2954
965102	AG1-375 E	14.8636	50/50	14.8636
965111	AG1-376 C	4.4591	50/50	4.4591
965112	AG1-376 E	6.6886	50/50	6.6886
965461	AG1-414 C O1	1.8132	Adder	4.02
965462	AG1-414 E O1	1.2088	Adder	2.68
965651	AG1-433 C	6.5400	50/50	6.5400
965652	AG1-433 E	30.6190	50/50	30.6190
G-007A	G-007A	0.5874	Confirmed LTF	0.5874
VFT	VFT	1.5867	Confirmed LTF	1.5867
CALDERWOOD	CALDERWOOD	0.5994	Confirmed LTF	0.5994

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
PRAIRIE	PRAIRIE	8.5007	Confirmed LTF	8.5007
CHEOAH	CHEOAH	0.5936	Confirmed LTF	0.5936
CBM-N	CBM-N	0.2964	Confirmed LTF	0.2964
COTTONWOOD	COTTONWOOD	4.4415	Confirmed LTF	4.4415
HAMLET	HAMLET	0.2836	Confirmed LTF	0.2836
GIBSON	GIBSON	3.8553	Confirmed LTF	3.8553
BLUEG	BLUEG	3.1595	Confirmed LTF	3.1595
TRIMBLE	TRIMBLE	0.8570	Confirmed LTF	0.8570
CATAWBA	CATAWBA	0.2062	Confirmed LTF	0.2062

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
AC1-175	Losantville 345kV	Active
AC2-090	Losantville 345kV	Active
AC2-111	College Corner 138kV	Active
AC2-176	Jay 138 kV	In Service
AD1-128	Modoc-Delaware 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
AE2-089	Pennville-Adams 138 kV	Active
AE2-169	Delaware-Van Buren 138 kV	Active
AE2-172	Mississinewa-Gaston 138 kV	Active
AE2-219	Bluff Point-Randolph 138 kV	Active
AE2-220	Losantville 345 kV	Active
AE2-234	Liberty Center-Buckeye Tap 69 kV	Active
AF1-071	College Corner 138 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
AF1-221	College Corner-Drewersburg 138 kV	Active
AF1-223	Jay-Desoto 138 kV	Active
AF1-268	Desoto-Jay 138 kV	Active
AF2-068	Jay 138 kV	Active
AF2-162	Keystone-Desoto 345 kV	Active
AF2-173	Desoto 345 kV	Active
AF2-177	Sorenson-DeSoto #2 345 kV	Active
AF2-204	Van Buren 138 kV	Active
AF2-211	College Corner 138 kV	Active
AF2-335	West Del-Royerton 138 kV	Active
AF2-370	West Del-Royerton 138 kV	Active
AF2-388	Desoto-Sorenson 345 kV	Active
AF2-407	Fall Creek 345 kV	Active
AF2-408	Fall Creek 138 kV	Active
AG1-017	Jay 138 kV	Active
AG1-047	Jay 138 kV	Active
AG1-049	College Corner 138 kV	Active
AG1-225	Adams 138 kV	Active
AG1-297	Hanna-Tanners Creek 345 kV	Active

Queue Number	Project Name	Status
AG1-324	Jay-Desoto 138 kV	Active
AG1-367	DeSoto 345 kV	Active
AG1-375	Sorenson-Desoto 345 kV	Active
AG1-376	Sorenson-DeSoto 345 kV	Active
AG1-414	Mississinewa 138 kV	Active
AG1-433	DeSoto-Keystone 345 kV	Active
V3-007	Desoto-Tanners Creek #1 345kV	Under Construction
Y3-024	Bluff Point 12kV	In Service

10.8 Contingency Descriptions

Contingency Name	Contingency Definition
Base Case	
AEP_P1-2_#4817_6341	CONTINGENCY 'AEP_P1-2_#4817_6341' OPEN BRANCH FROM BUS 243225 TO BUS 243232 CKT 1 / 243225 05KEYSTN 345 243232 05SORENS 345 1 END
AEP_P7-1_#11087-H	CONTINGENCY 'AEP_P7-1_#11087-H' OPEN BRANCH FROM BUS 960970 TO BUS 243225 CKT 1 / 960970 AF2-388 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

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).