Generation Interconnection

Feasibility Study Report

for

Queue Project AG1-368

TILLMAN 138 KV

60 MW Capacity / 100 MW Energy

Solar Project

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.

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 generating facility located in Allen County, Indiana. The installed facilities will have a total capability of 100 MW with 60 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	AG1-368
Project Name	TILLMAN 138 KV
State	Indiana
County	Allen
Transmission Owner	AEP
MFO	100
MWE	100
MWC	60
Fuel	Solar
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

AG1-368 will interconnect with the AEP transmission system via a direct connection to the Tillman 138 kV substation.

To accommodate the interconnection to the Tillman 138 kV substation, three (3) new 138 kV circuit breaker(s) will be installed (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.

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 AG1-368 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	$2,543,000
Total System Network Upgrade Costs	$100,000
Total Costs	$2,643,000

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	$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
Three (3) new 138 kV circuit breaker(s) will be installed at the Tillman 138 kV substation (Figure 1). Installation of associated protection and control equipment, 138 kV line risers, and SCADA will also be required.	$1,710,000
Total Direct Connection Facility Costs	$1,710,000

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
Review line protection and control settings at the Tillman 138 kV substation	$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 Transmission Owner Analysis

No violations were identified in the Sub-Transmission load flow analysis and the short circuit analysis for the Sub-Transmission will be conducted in the System Impact Study phase.

9 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.

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) - (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)

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 - Load Flow Analysis

The Queue Project AG1-368 was evaluated as a 100.0 MW (Capacity 60.0 MW) injection at the Tillman 138 kV substation in the AEP area. Project AG1-368 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AG1-368 was studied with a commercial probability of 53.0 %. 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)

None

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)

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
16175810 9	24338 3	05TILLM A	138. 0	AEP	24324 2	05ALLE N	138. 0	AEP	1	AEP_P7-1_#1106 9	towe r	341.0	104.9	130.42	DC	87.01

11.4 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
1682094 74	24301 7	05HAVILAN D1	138. 0	AEP	24298 9	05E LIMA	138. 0	AEP	1	AEP_P2-1_243242 05ALLEN 138 243383 05TILLMA 138 1	operati on	284. 0	109.91	129.07	DC	54.41
1682094 75	24301 7	05HAVILAN D1	138. 0	AEP	24298 9	05E LIMA	138. 0	AEP	1	Base Case	operati on	205. 0	97.32	103.61	DC	12.9
1682094 76	24338 3	05TILLMA	138. 0	AEP	24324 2	05ALLEN	138. 0	AEP	1	AEP_P1-2_#5227_20 62	operati on	341. 0	103.27	128.68	DC	86.66
1682094 78	24338 3	05TILLMA	138. 0	AEP	24324 2	05ALLEN	138. 0	AEP	1	Base Case	operati on	293. 0	77.15	103.72	DC	77.85

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
168209407	246352	05HAVILAND2	138.0	AEP	243017	05HAVILAND1	138.0	AEP	Z1	AEP_P2-1_243242 05ALLEN 138 243383 05TILLMA 138 1	operation	240.0	120.01	150.57	DC	73.34
168209408	246352	05HAVILAND2	138.0	AEP	243017	05HAVILAND1	138.0	AEP	Z1	Base Case	operation	187.0	106.5	115.5	DC	16.84
168209579	246950	05TIMBSS	138.0	AEP	246352	05HAVILAND2	138.0	AEP	1	AEP_P2-1_243242 05ALLEN 138 243383 05TILLMA 138 1	operation	240.0	76.06	113.47	DC	89.79
168209580	246950	05TIMBSS	138.0	AEP	246352	05HAVILAND2	138.0	AEP	1	Base Case	operation	187.0	93.94	104.77	DC	20.26

11.5 System Reinforcements - Summer Peak Load Flow - Primary POI

ID	Idx	Facility	Upgrade Description	Cost
161758109	1	05TILLMA 138.0 kV - 05ALLEN 138.0 kV Ckt 1	AEP AEPI0040a (229) : Replace 1272 AAC Jumper at Allen station Project Type : FAC Cost : $100,000 Time Estimate : 12-18 Months	$100,000
			TOTAL COST	$100,000

11.6 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".

11.6.1 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
161758109	243383	05TILLMA	AEP	243242	05ALLEN	AEP	1	AEP_P7-1_#11069	tower	341.0	104.9	130.42	DC	87.01

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
246953	05TIMB G C	2.8868	50/50	2.8868
247607	V1-011 C	1.4278	50/50	1.4278
247911	05TIMB G E	96.5228	50/50	96.5228
247959	V1-011 E	60.5633	50/50	60.5633
926811	AC1-167 C O1	8.0744	50/50	8.0744
926812	AC1-167 E O1	3.9171	50/50	3.9171
934741	AD1-101 C O1	2.5623	50/50	2.5623
934742	AD1-101 E O1	4.1812	50/50	4.1812
934901	AD1-119 C O1	6.4646	50/50	6.4646
934902	AD1-119 E O1	10.5493	50/50	10.5493
940031	AE1-245 C	13.5714	50/50	13.5714
940032	AE1-245 E	90.8241	50/50	90.8241
942801	AE2-298 C	16.9704	50/50	16.9704
942802	AE2-298 E	11.3136	50/50	11.3136
943181	AE2-322 C	9.6845	50/50	9.6845
943182	AE2-322 E	4.7341	50/50	4.7341
943581	AF1-029 C O1	8.4852	50/50	8.4852
943582	AF1-029 E O1	5.6568	50/50	5.6568
943791	AF1-047 C	5.0177	50/50	5.0177
943792	AF1-047 E	3.3451	50/50	3.3451
958091	AF2-103 C	0.9189	50/50	0.9189
958092	AF2-103 E	1.2739	50/50	1.2739
958951	AF2-186 C O1	6.7108	50/50	6.7108
958952	AF2-186 E O1	9.2673	50/50	9.2673
960851	AF2-376 C	15.9806	50/50	15.9806
960852	AF2-376 E	23.9709	50/50	23.9709
965041	AG1-368 C	52.2072	50/50	52.2072
965042	AG1-368 E	34.8048	50/50	34.8048
G-007A	G-007A	0.0503	Confirmed LTF	0.0503
VFT	VFT	0.1419	Confirmed LTF	0.1419
CALDERWOOD	CALDERWOOD	0.0313	Confirmed LTF	0.0313
PRAIRIE	PRAIRIE	0.3332	Confirmed LTF	0.3332
CHEOAH	CHEOAH	0.0315	Confirmed LTF	0.0315
CBM-N	CBM-N	0.0264	Confirmed LTF	0.0264
COTTONWOOD	COTTONWOOD	0.2016	Confirmed LTF	0.2016
HAMLET	HAMLET	0.0196	Confirmed LTF	0.0196
GIBSON	GIBSON	0.0748	Confirmed LTF	0.0748
BLUEG	BLUEG	0.1719	Confirmed LTF	0.1719
TRIMBLE	TRIMBLE	0.0540	Confirmed LTF	0.0540
CATAWBA	CATAWBA	0.0140	Confirmed LTF	0.0140

11.7 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
AC1-167	Mark Center 69kV	Active
AD1-101	Continental 69 kV	Active
AD1-119	Payne 69 kV	Active
AE1-245	Haviland 138 kV	Active
AE2-298	Haviland-Cavett Switch 69 kV	Active
AE2-322	Mark Center 69 kV	Active
AF1-029	Haviland-Cavett Switch 69 kV	Active
AF1-047	Mark Center 69 kV	Active
AF2-103	Haviland 138 kV	Active
AF2-186	South Cecil 69 kV	Active
AF2-376	Timber Switch 138 kV	Active
AG1-368	Tillman 138 kV	Active
V1-011	Haviland 138kV	In Service

11.8 Contingency Descriptions

Contingency Name	Contingency Definition
AEP_P7-1_#11069	CONTINGENCY 'AEP_P7-1_#11069' OPEN BRANCH FROM BUS 242989 TO BUS 243017 CKT 1 / 242989 05E LIMA 138 243017 05HAVILAND1 138 1 OPEN BRANCH FROM BUS 242991 TO BUS 243051 CKT 1 / 242991 05E SIDE 138 243051 05NDELPH 138 1 OPEN BRANCH FROM BUS 242991 TO BUS 243108 CKT 1 / 242991 05E SIDE 138 243108 05STRLN1 138 1 END
Base Case	
AEP_P2-1_243242 05ALLEN 138 243383 05TILLMA 138 1	CONTINGENCY 'AEP_P2-1_243242 05ALLEN 138 243383 05TILLMA 138 1' OPEN BRANCH FROM BUS 243242 TO BUS 243383 CKT 1 END
AEP_P1-2_#5227_2062	CONTINGENCY 'AEP_P1-2_#5227_2062' OPEN BRANCH FROM BUS 242989 TO BUS 243017 CKT 1 / 242989 05E LIMA 138 243017 05HAVILAND1 138 1 END

12 Short Circuit Analysis

The following Breakers are overdutied:

None.

13 Affected Systems

13.1 TVA

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

13.2 Duke Energy Progress

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

13.3 MISO

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

13.4 LG&E

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