Generation Interconnection

System Impact Study Report

for

Queue Project AF1-029

HAVILAND-N VAN WERT 69 KV

15 MW Capacity / 25 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 an uprate to a planned Solar generating facility located in Van Wert, Ohio. This project is an increase to the Interconnection Customer's AE2-298 project, which will share the same point of interconnection. The AF1-029 queue position is a 25 MW uprate (15 MW Capacity uprate) to the previous project. The total installed facilities will have a capability of 75 MW with 45 MW of this output being recognized by PJM as Capacity.

The proposed in-service date for this uprate project is December 31, 2021. 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	AF1-029
Project Name	HAVILAND-N VAN WERT 69 KV
State	Ohio
County	Van Wert
Transmission Owner	AEP
MFO	75
MWE	25
MWC	15
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

AF1-029 will interconnect with the AEP transmission system as an uprate to AE2-298 station cutting into the Cavett Switch – Haviland section of the Haviland – South Van Wert 69 kV circuit.

Note: It is assumed that the 138 kV revenue metering system, gen lead and Protection & Control Equipment that will be installed for AE2-298 will be adequate for the additional generation requested in AF1-029. Depending on the timing of the completion of the AF1-029 interconnection construction relative to the AE2-298 completion, there may (or may not) be a need to review and revise relay settings for the increased generation of AF1-029.

5 Cost Summary

This project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$0
Direct Connection Network Upgrade	$0
Non Direct Connection Network Upgrades	$45,000
Allocation for New System Upgrades	$0
Contribution to Previously Identified Upgrades	$0
Total Costs	**$45,000**

This total 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.

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

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
	$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
	$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 and revise protections and controls for the increased generation of AF1-029	$45,000
Total Non-Direct Connection Facility Costs	$45,000

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 AF1-029 was evaluated as a 25.0 MW (Capacity 15.0 MW) injection as an uprate to AE2-298 tapping the Haviland to Cavett 69 kV line in the AEP area. Project AF1-029 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-029 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)

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
43679298	246950	05TIMBSS	138.0	AEP	243383	05TILLMA	138.0	AEP	1	AEP_P4_#6533_05E LIMA 138_A	breaker	332.0	103.63	107.95	AC	14.4
43680057	246950	05TIMBSS	138.0	AEP	243383	05TILLMA	138.0	AEP	1	AEP_P7-1_#11069	tower	332.0	105.33	109.7	AC	14.56

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
43679594	243017	05HAVILN	138.0	AEP	242989	05E LIMA	138.0	AEP	1	AEP_P1-2_#7501	operation	220.0	137.65	143.17	AC	12.31
43679787	246950	05TIMBSS	138.0	AEP	243383	05TILLMA	138.0	AEP	1	AEP_P1-2_#5227	operation	332.0	103.6	107.92	AC	14.38

11.5 Steady-State Voltage Requirements

None

11.6 System Reinforcements

ID	Idx	Facility	Upgrade Description	Cost	Cost Allocated to AF1-029	Upgrade Number
43679298,43680057	1	**05TIMBSS 138.0 kV - 05TILLMA 138.0 kV Ckt 1**	Upgrade "Sub Cond 1-1233.6 KCM ACSR/TW (38/19)" riser at Timber Switch. Cost estimate $100K. Time estimate: 12-18 months. New expected SE rating to be 451 MVA. This overload is presently driven by a prior queue cycle and AF1-029 presently has no cost responsibility.	$100 K	$0	N6553
			Total Cost	**$100,000**	**$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.

12 Light Load Analysis

Light Load Studies (As applicable).

Not applicable

13 Short Circuit Analysis

The following Breakers are overdutied

None

14 Stability and Reactive Power Assessment

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

To be determined in the Facilities Study Phase.

14.1 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".

14.1.1 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
43680057	246950	05TIMBSS	AEP	243383	05TILLMA	AEP	1	AEP_P7-1_#11069	tower	332.0	105.33	109.16	AC	12.71

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
246953	05TIMB G C	4.3576	50/50	4.3576
247607	V1-011 C	1.6456	50/50	1.6456
247911	05TIMB G E	99.0693	50/50	99.0693
247959	V1-011 E	62.1815	50/50	62.1815
926811	AC1-167 C O1	8.4941	50/50	8.4941
926812	AC1-167 E O1	4.1206	50/50	4.1206
926901	AC1-176 C	6.2328	50/50	6.2328
926902	AC1-176 E	41.9076	50/50	41.9076
934741	AD1-101 C O1	2.7422	50/50	2.7422
934742	AD1-101 E O1	4.4749	50/50	4.4749
934901	AD1-119 C O1	6.6553	50/50	6.6553
934902	AD1-119 E O1	10.8606	50/50	10.8606
940031	AE1-245 C O1	13.9339	50/50	13.9339
940032	AE1-245 E O1	93.2501	50/50	93.2501
942801	AE2-298 C O1	17.4684	50/50	17.4684
942802	AE2-298 E O1	11.6456	50/50	11.6456
943181	AE2-322 C	10.1878	50/50	10.1878
943182	AE2-322 E	4.9802	50/50	4.9802
943581	AF1-029 C O1	8.73	50/50	8.73
943582	AF1-029 E O1	5.82	50/50	5.82
943791	AF1-047 C	5.2785	50/50	5.2785
943792	AF1-047 E	3.5190	50/50	3.5190
NEWTON	NEWTON	0.1515	Confirmed LTF	0.1515
FARMERCITY	FARMERCITY	0.0079	Confirmed LTF	0.0079
G-007A	G-007A	0.0456	Confirmed LTF	0.0456
VFT	VFT	0.1226	Confirmed LTF	0.1226
PRAIRIE	PRAIRIE	0.3410	Confirmed LTF	0.3410
COFFEEN	COFFEEN	0.0291	Confirmed LTF	0.0291
CHEOAH	CHEOAH	0.0325	Confirmed LTF	0.0325
EDWARDS	EDWARDS	0.0577	Confirmed LTF	0.0577
TILTON	TILTON	0.1002	Confirmed LTF	0.1002
GIBSON	GIBSON	0.0759	Confirmed LTF	0.0759
CALDERWOOD	CALDERWOOD	0.0328	Confirmed LTF	0.0328
BLUEG	BLUEG	0.1805	Confirmed LTF	0.1805
TRIMBLE	TRIMBLE	0.0568	Confirmed LTF	0.0568
CATAWBA	CATAWBA	0.0150	Confirmed LTF	0.0150

14.2 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
AC1-176	Timber Switch 138kV	Active
AD1-101	Continental 69 kV	Active
AD1-119	Payne 69 kV	Active
AE1-245	Haviland 138 kV	Active
AE2-298	Haviland-N. Van Wert 69 kV	Active
AE2-322	Mark Center 69 kV	Active
AF1-029	Haviland-N Van Wert 69 kV	Active
AF1-047	Mark Center 69 kV	Active
V1-011	Haviland 138kV	In Service

14.3 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 05HAVILN 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
AEP_P1-2_#7501	CONTINGENCY 'AEP_P1-2_#7501' OPEN BRANCH FROM BUS 243242 TO BUS 243383 CKT 1 / 243242 05ALLEN 138 243383 05TILLMA 138 1 OPEN BRANCH FROM BUS 243383 TO BUS 246950 CKT 1 / 243383 05TILLMA 138 246950 05TIMBSS 138 1 OPEN BRANCH FROM BUS 243383 TO BUS 246265 CKT 1 / 243383 05TILLMA 138 246265 05TILLMAN 34.5 1 OPEN BRANCH FROM BUS 246264 TO BUS 247877 CKT 1 / 246264 05ST R14 8 34.5 247877 05ST.RD14 SS34.5 1 END
AEP_P4_#6533_05E LIMA 138_A	CONTINGENCY 'AEP_P4_#6533_05E LIMA 138_A' OPEN BRANCH FROM BUS 245775 TO BUS 243067 CKT 1 / 245775 05NWOODCEQ 999 243067 05NWOODC 138 1 OPEN BRANCH FROM BUS 245775 TO BUS 245766 CKT 1 / 245775 05NWOODCEQ 999 245766 05N WOODCK 69.0 1 OPEN BRANCH FROM BUS 245775 TO BUS 245765 CKT 1 / 245775 05NWOODCEQ 999 245765 05N WOODCK 34.5 1 OPEN BRANCH FROM BUS 242989 TO BUS 243017 CKT 1 / 242989 05E LIMA 138 243017 05HAVILN 138 1 OPEN BRANCH FROM BUS 242989 TO BUS 243067 CKT 1 / 242989 05E LIMA 138 243067 05NWOODC 138 1 OPEN BRANCH FROM BUS 243059 TO BUS 243067 CKT 1 / 243059 05NFINDL 138 243067 05NWOODC 138 1 OPEN BRANCH FROM BUS 245763 TO BUS 245766 CKT 1 / 245763 05N BLUFFT 69.0 245766 05N WOODCK 69.0 1 END
AEP_P1-2_#5227	CONTINGENCY 'AEP_P1-2_#5227' OPEN BRANCH FROM BUS 242989 TO BUS 243017 CKT 1 / 242989 05E LIMA 138 243017 05HAVILN 138 1 END

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).

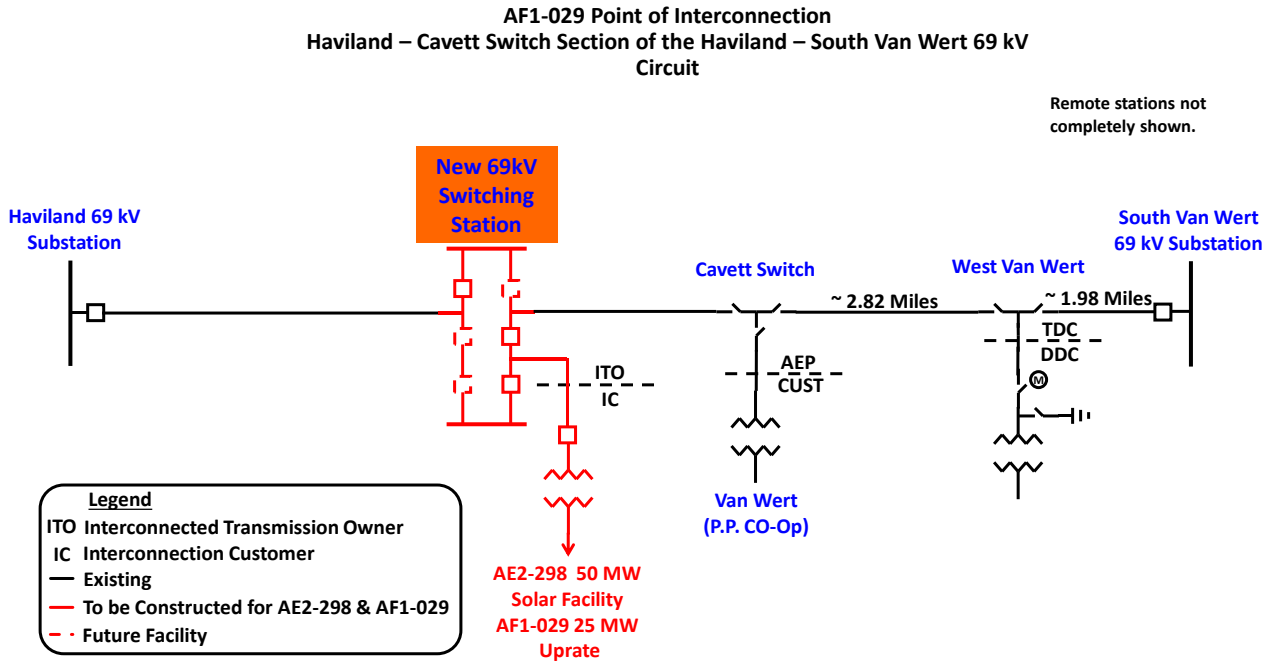
15.3 MISO

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



17 Attachment 2: Point of Interconnection Map