Generation Interconnection

System Impact Study Report

for

Queue Project AG1-508

INDEPENDENCE 69 KV

9.3 MW Capacity / 63.3 MW Energy

August 2021

Table of Contents

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 Wind generating facility located in Grayson County, Virginia. The installed facilities will have a total capability of 63.3 MW with 9.3 MW of this output being recognized by PJM as Capacity.

The proposed in-service date for this project is March 01, 2025. This study does not imply a TO commitment to this in-service date.

Queue Number	AG1-508
Project Name	INDEPENDENCE 69 KV
State	Virginia
County	Grayson
Transmission Owner	AEP
MFO	63.3
MWE	63.3
MWC	9.3
Fuel	Wind
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

AG1-508 will interconnect with the AEP on transmission system at the Independence 69 kV substation.

To accommodate the interconnection to the Independence 69 kV substation, one (1) new 69 kV circuit breaker will be installed (see Attachment 1). Installation of associated protection and control equipment, 69 kV line risers, SCADA, and 69 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.

It should also be noted that Supplemental Project s1851 will have a significant impact on network performance in the vicinity of Independence and Jubal Early. Supplemental projects do not carry the same certainty of timing that baseline upgrades do, and changes to scope or timing of s1851 could affect the AG1-508 project.

5 Cost Summary

The AG1-508 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	$1,091,000
Allocation towards System Network Upgrade Costs (PJM Identified - Summer Peak)*	$0
Allocation towards System Network Upgrade Costs (PJM Identified - Light Load)*	$0
Allocation towards System Network Upgrade Costs (TO Identified)*	$0
Total Costs	$1,091,000

*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.

Note 2: 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.

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
69 kV Revenue Metering	$293,000
Generator lead first span exiting the POI station, including the first structure outside the fence	$320,000
Total Attachment Facility Costs	**$613,000**

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
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
One (1) new 69 kV circuit breaker will be installed at the Independence 69 kV substation. Installation of associated protection and control equipment, 69 kV line risers, and SCADA will also be required.	$433,000
Review line protection and control settings at the Independence 69 kV substation	$478,000
Total Non-Direct Connection Facility Costs	**$478,000**

7 Schedule

Based on the scope of work for the interconnection facilities, it is expected to take a minimum of 12 to 18 months after the signing of an Interconnection Construction Service Agreement (or "Interconnection Agreement" if non-FERC) and construction kickoff call to complete the installation of the physical connection work. This assumes that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the defined interconnection work, and that all system outages will be allowed when requested.

The schedule for any required Network Impact Reinforcements will be more clearly identified in future study phases. The estimated time to complete each of the required reinforcements is identified in the "System Reinforcements" section of the report.

8 Transmission Owner Analysis

AEP conducted load flow analysis and identify the overloads below for the Sub-Transmission:

- 05FRIES – 05INDEPEND 69kV line
  - Rating: 50 MVA
  - Contingency: P1-2 OPEN BRANCH FROM BUS 244168 TO BUS 244171 CKT 1 / 244168 05INDEPEND 69.0 244171 05J.EARLY 69.0 1
  - Loading before AG1-508: 12%
  - Loading after AG1-508: 133%

A more detailed load flow and short circuit analysis will be conducted for the Sub-Transmission System in the Facilities study phase. The cost estimate for the Sub-Transmission mitigation will also be provided in the Facilities 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 wind generation facility shall provide the Transmission Provider with site-specific meteorological data including:

- Wind speed (meters/second) - (Required)
- Wind direction (decimal degrees from true north) - (Required)
- Ambient air temperature (Fahrenheit) - (Required)
- Air Pressure (Hectopascals) - (Required)
- Humidity (Percent) (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 AG1-508 was evaluated as a 63.3 MW (Capacity 9.30 MW) injection at the Independence 69 kV substation in the AEP area. Project AG1-508 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AG1-508 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)

None

11.4 Steady-State Voltage Requirements

To be determined during the Facilities Study phase.

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
16979183 3	934750	AD1-102 TAP	138.0	AEP	242609	05CLYTR 2	138.0	AEP	1	AEP_P1-2_#311_5	operation	251.0	140.13	141.32	AC	3.55

11.6 System Reinforcements

ID	Idx	Facility	Upgrade Description	Cost	Cost Allocated to AG1-508	Upgrade Number
			TOTAL COST	**$0**	**$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 Contingency Descriptions

Contingency Name	Contingency Definition
AEP_P1-2_#311_5	CONTINGENCY 'AEP_P1-2_#311_5' OPEN BRANCH FROM BUS 242512 TO BUS 242514 CKT 1 / 242512 05CLOVRD 765 242514 05J.FERR 765 1 END

12 Light Load Analysis

The Queue Project AG1-508 was evaluated as a 63.3 MW injection at the Independence 69 kV substation in the AEP area. Project AG1-508 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AG1-508 was studied with a commercial probability of 100.0 %. Potential network impacts were as follows:

12.1 Light Load Deliverability

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

None.

12.2 Multiple Facility Contingency

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

None.

12.3 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
17870692	934750	AD1-102 TAP	138.0	AEP	242609	05CLYTR 2	138.0	AEP	1	AEP_P1-2_#311_5	single	251.0	120.94	123.32	AC	2.81

12.4 Steady-State Voltage Requirements

To be determined during the Facilities Study phase.

12.5 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
169791833	934750	AD1-102 TAP	138.0	AEP	242609	05CLYTR2	138.0	AEP	1	AEP_P1-2_#311_5	operation	251.0	121.03	123.15	DC	2.81

12.6 System Reinforcements

ID	Idx	Facility	Upgrade Description	Cost	Cost Allocated to AG1-508	Upgrade Number
178706926	1	**AD1-102 TAP 138.0 kV - 05CLYTR2 138.0 kV Ckt 1**	To resolve the AD1-102 Tap – Claytor 138 kV line overload: The existing conductor is ACSR~795~45/7~TERN. This line is sag limited so a sag study may be necessary during the Facilities Study. If the sag study determines a complete reconductor/rebuild is required, the cost estimate to reconductor/rebuild the 4.69 mile section of line is $7,035,000. An approximate construction time would be 24 to 36 months after signing an interconnection agreement. Per the Z2-042 Facilities Study: a sag study has been previously completed on the Wurno – Claytor 138 kV line which includes this line section. The results of the sag study indicated the need to replace 17 structures on the Wurno – Claytor 138 kV line. Cost estimate is $2.739M. PJM Network Upgrade N4505.1. Fewer structures may need to be replaced for just this line section. This information will need to be confirmed during the AG1-508 Facilities Study as well as confirming the new expected SE rating is sufficient for the AG1-508 flow. Note: This overload is presently driven by a prior queue cycle (AD1-102) and therefore AG1-508 presently does not receive a cost allocation to this upgrade assuming the upgrade cost is less than $5M per PJM cost allocation rules.	$2.739 M	$0	N4505.1
			Total Cost	**$2,739,000**	**$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.

12.7 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".

12.7.1 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
178706926	934750	AD1-102 TAP	AEP	242609	05CLYTR2	AEP	1	AEP_P1-2_#311_5	single	251.0	120.94	123.32	DC	2.81

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
934756	AD1-102 C	12.4928	80/20	12.4928
934757	AD1-102 E	83.6109	80/20	83.6109
943031	AE2-326 C	2.3869	80/20	2.3869
943032	AE2-326 E	1.5913	80/20	1.5913
945351	AF1-200 FTIR	14.8555	Merchant Transmission	14.8555
962433	AG1-092 BAT	5.7384	80/20	5.7384
966391	AG1-508 C O1	0.4127	80/20	0.4127
966392	AG1-508 E O1	2.3963	80/20	2.3963
966401	AG1-509 C	0.6878	80/20	0.6878
966402	AG1-509 E	3.9894	80/20	3.9894

12.8 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
AD1-102	Wurno-Claytor Lake 138 KV	Active
AE2-326	Jacksons Ferry 138 kV	Active
AF1-200	Plano 345 kV	Active
AG1-092	Hickman-River Bend 69 kV	Active
AG1-508	Independence 69 kV	Active
AG1-509	Independence 69 kV	Active

12.9 Contingency Descriptions

Contingency Name	Contingency Definition
AEP_P1-2_#311_5	CONTINGENCY 'AEP_P1-2_#311_5' OPEN BRANCH FROM BUS 242512 TO BUS 242514 CKT 1 / 242512 05CLOVRD 765 242514 05J.FERR 765 1 END

13 Short Circuit Analysis

The following Breakers are overdutied:

None.

14 Stability and Reactive Power

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

To be determined in the Facilities Study Phase.

15 Affected Systems

15.1 TVA

None

15.2 Duke Energy Progress

None

15.3 MISO

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

15.4 LG&E

None

16 Attachment 1: One Line Diagram and Project Site Location