Generation Interconnection

Impact Study Report

for

Queue Project AE2-172

MISSISSINEWA-GASTON 138 KV

40 MW Capacity / 40 MW Energy

June, 2020

Table of Contents

1 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, 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 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.

2 General

Invenergy Solar Project Development LLC, has proposed a Storage generating facility located in Grant County, IN. The installed facilities will have a total capability of 40 MW with 40 MW of this output being recognized by PJM as Capacity.

The proposed in-service date for this project is 12.31.2022. This study does not imply AEP's 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 AEP transmission system. These reinforcements include the Attachment Facilities, Local Upgrades, and Network Upgrades required for maintaining the reliability of the AEP transmission system.

Queue Number	**AE2-172**
Project Name	MISSISSINEWA-GASTON 138 KV
Interconnection Customer	Invenergy Solar Project Development LLC
State	Indiana
County	Grant
Transmission Owner	AEP
MFO	40
MWE	40
MWC	40
Fuel	Storage
Basecase Study Year	2022

2.1 Point of Interconnection

AE2-172 will interconnect with the AEP transmission system as a tap of the Mississinewa to Gaston 138 kV line.

To accommodate the interconnection on the Mississinewa to Gaston 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 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.

2.2 Cost Summary

This project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 250,000
Direct Connection Network Upgrade	$ 6,000,000
Non Direct Connection Network Upgrades	$ 1,500,000
Allocation for New System Upgrades	$
Contribution for Previously Identified Upgrades	$
Total Costs	$ 7,750,000

3 Transmission Owner Scope of Work

4 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	$ 250,000
Total Attachment Facility Costs	$ 250,000

5 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 Figure 1). Installation of associated protection and control equipment, 138 kV line risers and SCADA will also be required.	$ 6,000,000
Total Direct Connection Facility Costs	$ 6,000,000

6 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
Upgrade line protections & Controls at the 138kV Remote end Substation #1	$ 250,000
Upgrade line protections & Controls at the 138kV Remote end Substation #2	$ 250,000
138kV Transmission Line Cut In	$ 1,000,000
Total Non-Direct Connection Facility Costs	$ 1,500,000

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 signing Agreement execution.

9 Interconnection Customer Requirements

It is understood that Invenergy Solar Project Development LLC is responsible for all costs associated with this interconnection. The costs above are reimbursable to AEP. The cost of Invenergy Solar Project Development LLC's generating plant and the costs for the line connecting the generating plant to the AEP Transmission circuit are not included in this report; these are assumed to be Invenergy Solar Project Development LLC's responsibility.

The Generation Interconnection Agreement does not in or by itself establish a requirement for American Electric Power 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:

- 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.
- 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 AEP Requirements

The Interconnection Customer will be required to comply with all AEP Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "Requirements for Connection of New Facilities or Changes to Existing Facilities Connected to the AEP Transmission System" document located at the following link:

http://www.pjm.com/~/media/planning/plan-standards/private-aep/aep-interconnection-requirements.ashx

11 Network Impacts

The Queue Project AE2-172 was evaluated as a 40.0 MW (Capacity 40.0 MW) injection into the AE1-207 Tap 138 kV substation (which is a tap of the Mississinewa-Gaston 138 kV line) in the AEP area. Project AE2-172 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-172 was studied with a commercial probability of 1.00. Potential network impacts were as follows:

Summer Peak Load Flow

12 Generation Deliverability

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

None

13 Multiple Facility Contingency

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

None

14 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

15 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
39264218	243296	05GASTON	138.0	AEP	941700	AE2-170 TAP	138.0	AEP	1	AEP_P1-2_#5535_AE1-207B	operation	233.0	147.82	164.23	AC	40.0
39264220	243296	05GASTON	138.0	AEP	941700	AE2-170 TAP	138.0	AEP	1	Base Case	operation	167.0	125.59	136.48	AC	18.94
1577141	243343	05MISSIS	138.0	AEP	243274	05DEERCR	138.0	AEP	1	Base Case	operation	167.0	102.14	114.33	AC	21.06
39264191	243343	05MISSIS	138.0	AEP	243274	05DEERCR	138.0	AEP	1	AEP_P1-2_#5535_AE2-170A	operation	233.0	154.96	171.41	AC	40.0
1577119	939760	AE1-207 TAP	138.0	AEP	243343	05MISSIS	138.0	AEP	1	Base Case	operation	167.0	121.36	133.55	AC	21.06
39264149	939760	AE1-207 TAP	138.0	AEP	243343	05MISSIS	138.0	AEP	1	AEP_P1-2_#5535_AE2-170A	operation	233.0	168.86	185.36	AC	40.0

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
39264155	941700	AE2-170 TAP	138.0	AEP	243278	05DESOTO	138.0	AEP	1	AEP_P1-2_#5535_AE1-207B	operation	233.0	168.4	184.86	AC	40.0
39264157	941700	AE2-170 TAP	138.0	AEP	243278	05DESOTO	138.0	AEP	1	Base Case	operation	167.0	131.0	142.09	AC	18.94

16 Steady-State Voltage Requirements

(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

To be evaluated during the Facilities Study Phase

17 Stability and Reactive Power Requirements for Low Voltage Ride Through

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

To be evaluated during the Facilities Study Phase

18 Light Load Analysis

Light Load Studies (applicable to wind, coal, nuclear, and pumped storage projects).

No problems identified

19 System Reinforcements

None

Affected Systems

20 Affected Systems

20.1 LG&E

None

20.2 MISO

None

20.3 TVA

None

20.4 Duke Energy Progress

None

20.5 NYISO

None

21 Contingency Descriptions:

Contingency Name	Contingency Definition
Base Case	
AEP_P1-2_#5535_AE2-170A	CONTINGENCY 'AEP_P1-2_#5535_AE2-170A' OPEN BRANCH FROM BUS 243278 TO BUS 941700 CKT 1 / 243278 05DESOTO 138 243296 05GASTON 138 1 END
AEP_P1-2_#5535_AE1-207B	CONTINGENCY 'AEP_P1-2_#5535_AE1-207B' OPEN BRANCH FROM BUS 243274 TO BUS 243343 CKT 1 / 243274 05DEERCR 138 243343 05MISSIS 138 1 OPEN BRANCH FROM BUS 939760 TO BUS 243343 CKT 1 / 243296 05GASTON 138 243343 05MISSIS 138 1 END

Short Circuit

22 Short Circuit

The following Breakers are overduty

None.

23 Single Line Diagram