Generation Interconnection

REVISED

System Impact Study Report

for

Queue Project AF2-083

ED LOWE-KENZIE CREEK 138 KV

100 MW Capacity / 150 MW Energy

February 2022

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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.

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.

3 General

The Interconnection Customer (IC), has proposed a Solar generating facility located in Cass County, Michigan. The installed facilities will have a total capability of 150 MW with 100 MW of this output being recognized by PJM as Capacity.

The proposed in-service date for this project is October 21, 2022. This study does not imply a TO commitment to this in-service date.

Queue Number	AF2-083
Project Name	ED LOWE-KENZIE CREEK 138 KV
State	Michigan
County	Cass
Transmission Owner	AEP
MFO	150
MWE	150
MWC	100
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

AF2-083 will interconnect with the AEP transmission system via a new station cut into the Hospital Tap Switch - Stone Lake section of the Kenzie Creek - Stone Lake 69 kV circuit.

To accommodate the interconnection on the Hospital Tap Switch - Stone Lake section of the Kenzie Creek - Stone Lake 69 kV circuit, a new three (3) circuit breaker 69 kV switching station physically configured and operated as a ring-bus will be constructed (see Figure 1). Installation of associated protection and control equipment, line risers, SCADA, jumpers, switches, 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.

AEP will extend one span of 69 kV transmission line for the generation-leads going to the AF2-083 site. Unless this span extends directly from within the AEP station at the POI to the IC collector station structure, AEP will build and own the first transmission line structure outside of the proposed 69 kV station fence to which the AEP and AF2-083 transmission line conductors will attach.

5 Cost Summary

The AF2-083 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	$7,842,000
Allocation towards System Network Upgrade Costs*	$0
Total Costs	$7,842,000

*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 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.

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 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
69 kV Revenue Metering	$317,000
Generator lead first span exiting the POI station, including the first structure outside the fence	$320,000
Total Attachment Facility Costs	$637,000

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
A new three (3) circuit breaker 69 kV switching station physically configured and operated as a ring-bus will be constructed (see Figure 1). Installation of associated protection and control equipment, 69 kV line risers, and SCADA will also be required.	$6,500,000
Total Direct Connection Facility Costs	$6,500,000

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
Hospital Tap Switch - Stone Lake section of the Kenzie Creek - Stone Lake 69 kV T-Line Cut In	$615,000
Review Protection and Control Settings at the Kenzie Creek 69 kV station	$45,000
Review Protection and Control Settings at the Stone Lake 69 kV station	$45,000
Total Non-Direct Connection Facility Costs	$705,000

7 Transmission Owner Analysis

None.

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

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)

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 Analysis

The Queue Project AF2-083 was evaluated as a 150.0 MW (Capacity 100.0 MW) injection tapping the Stone Lake - Pokagon 69 kV line (specifically the Stone Lake – AF2-389 Tap line segment, part of the Stone Lake – Wolverine line segment) in the AEP area. Project AF2-083 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF2-083 was studied with a commercial probability of 100.0 %. 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)

None

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 Steady-State Voltage Requirements

None.

10.5 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
95237539	243215	05COOK	345.0	AEP	243229	05OLIVE	345.0	AEP	1	AEP_P1-2_#358	operation	1409.0	125.11	125.98	AC	14.78

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
9523747 0	24341 2	05STURG I	69.0	AEP	25533 1	17HOW E	69.0	NIPS	1	AEP_P1 - 2_#557 7	operatio n	47.0	120.42	140.09	AC	10.87

10.6 System Reinforcements

None.

10.7 Contingency Descriptions

Contingency Name	Contingency Definition
AEP_P1-2_#6388	CONTINGENCY 'AEP_P1-2_#6388' OPEN BRANCH FROM BUS 243220 TO BUS 255105 CKT 1 / 243220 05E.ELKHART 345 255105 17HIPLE 345 1 END
AEP_SUBT_P2-2_#1279_05POKAGON 69.0_1	CONTINGENCY 'AEP_SUBT_P2-2_#1279_05POKAGON 69.0_1' OPEN BRANCH FROM BUS 243360 TO BUS 246480 CKT 1 / 243360 05POKAGO 138 246480 05POKAGON 69.0 1 OPEN BRANCH FROM BUS 246506 TO BUS 246480 CKT 1 / 246506 05BARRETTZ 69.0 246480 05POKAGON 69.0 1 OPEN BRANCH FROM BUS 246516 TO BUS 246480 CKT 1 / 246516 05DAILEY 8 69.0 246480 05POKAGON 69.0 1 OPEN BRANCH FROM BUS 246464 TO BUS 246480 CKT 1 / 246464 05LAKE ST 69.0 246480 05POKAGON 69.0 1 REMOVE SWSHUNT FROM BUS 246480 / 246480 05POKAGON 69.0 END
AEP_SUBT_P4_#1281_05POKAGON 69.0_H	CONTINGENCY 'AEP_SUBT_P4_#1281_05POKAGON 69.0_H' OPEN BRANCH FROM BUS 243360 TO BUS 246480 CKT 1 / 243360 05POKAGO 138 246480 05POKAGON 69.0 1 OPEN BRANCH FROM BUS 246505 TO BUS 246506 CKT 1 / 246505 05BARRETT8 69.0 246506 05BARRETTZ 69.0 1 OPEN BRANCH FROM BUS 246506 TO BUS 246511 CKT 1 / 246506 05BARRETTZ 69.0 246511 05COLBY 69.0 1 OPEN BRANCH FROM BUS 246506 TO BUS 246480 CKT 1 / 246506 05BARRETTZ 69.0 246480 05POKAGON 69.0 1 OPEN BRANCH FROM BUS 246516 TO BUS 246480 CKT 1 / 246516 05DAILEY 8 69.0 246480 05POKAGON 69.0 1 OPEN BRANCH FROM BUS 246464 TO BUS 246480 CKT 1 / 246464 05LAKE ST 69.0 246480 05POKAGON 69.0 1 OPEN BRANCH FROM BUS 246511 TO BUS 243420 CKT 1 / 246511 05COLBY 69.0 243420 05COLBY 34.5 1 REMOVE SWSHUNT FROM BUS 246480 / 246480 05POKAGON 69.0 END

Contingency Name	Contingency Definition
AEP_P1-2_#358	CONTINGENCY 'AEP_P1-2_#358' OPEN BRANCH FROM BUS 243205 TO BUS 243206 CKT 1 / 243205 05COOK 765 243206 05DUMONT 765 1 END
AEP_P1-2_#5577	CONTINGENCY 'AEP_P1-2_#5577' OPEN BRANCH FROM BUS 243287 TO BUS 243346 CKT 1 / 243287 05E.ELKHART 138 243346 05MOTTV 138 1 END
AEP_SUBT_P4_#1282_05POKAGON 69.0_E	CONTINGENCY 'AEP_SUBT_P4_#1282_05POKAGON 69.0_E' OPEN BRANCH FROM BUS 243360 TO BUS 246480 CKT 1 / 243360 05POKAGO 138 246480 05POKAGON 69.0 1 OPEN BRANCH FROM BUS 246506 TO BUS 246480 CKT 1 / 246506 05BARRETTZ 69.0 246480 05POKAGON 69.0 1 OPEN BRANCH FROM BUS 246516 TO BUS 246480 CKT 1 / 246516 05DAILEY 8 69.0 246480 05POKAGON 69.0 1 OPEN BRANCH FROM BUS 246464 TO BUS 246480 CKT 1 / 246464 05LAKE ST 69.0 246480 05POKAGON 69.0 1 REMOVE SWSHUNT FROM BUS 246480 / 246480 05POKAGON 69.0 END
AEP_SUBT_P2-2_#1012_05VALLEY 69.0_1	CONTINGENCY 'AEP_SUBT_P2-2_#1012_05VALLEY 69.0_1' OPEN BRANCH FROM BUS 243204 TO BUS 243386 CKT 1 / 243204 05VALLEYEQ 999 243386 05VALLY 138 1 OPEN BRANCH FROM BUS 243204 TO BUS 246551 CKT 1 / 243204 05VALLEYEQ 999 246551 05VALLEY 69.0 1 OPEN BRANCH FROM BUS 243204 TO BUS 246550 CKT 1 / 243204 05VALLEYEQ 999 246550 05VALLEY 34.5 1 OPEN BRANCH FROM BUS 243261 TO BUS 243386 CKT 1 / 243261 05COLBYTAPSS 138 243386 05VALLY 138 1 OPEN BRANCH FROM BUS 243307 TO BUS 243386 CKT 1 / 243307 05HARTFO 138 243386 05VALLY 138 1 OPEN BRANCH FROM BUS 247329 TO BUS 243386 CKT 1 / 247329 05STINGER 138 243386 05VALLY 138 1 REMOVE SWSHUNT FROM BUS 243386 / 243386 05VALLY 138 OPEN BRANCH FROM BUS 246509 TO BUS 246551 CKT 1 / 246509 05CAMERON 69.0 246551 05VALLEY 69.0 1 OPEN BRANCH FROM BUS 247174 TO BUS 246550 CKT 1 / 247174 05ROTHDEW 34.5 246550 05VALLEY 34.5 1 END
AEP_SUBT_P1-2_#726-B	CONTINGENCY 'AEP_SUBT_P1-2_#726-B' OPEN BRANCH FROM BUS 246516 TO BUS 246480 CKT 1 / 246516 05DAILEY 8 69.0 246480 05POKAGON 69.0 1 OPEN BRANCH FROM BUS 246516 TO BUS 246555 CKT 1 / 246516 05DAILEY 8 69.0 246555 05WOLVERIN 69.0 1 OPEN BRANCH FROM BUS 960980 TO BUS 246555 CKT 1 / 960980 AF2-389 TAP 69.0 246555 05WOLVERIN 69.0 1 END

Contingency Name	Contingency Definition
Base Case	
AEP_SUBT_P4_#1280_05POKAGON 69.0_F-AA	CONTINGENCY 'AEP_SUBT_P4_#1280_05POKAGON 69.0_F-AA' OPEN BRANCH FROM BUS 243360 TO BUS 246480 CKT 1 / 243360 05POKAGO 138 246480 05POKAGON 69.0 1 OPEN BRANCH FROM BUS 246506 TO BUS 246480 CKT 1 / 246506 05BARRETTZ 69.0 246480 05POKAGON 69.0 1 OPEN BRANCH FROM BUS 246516 TO BUS 246480 CKT 1 / 246516 05DAILEY 8 69.0 246480 05POKAGON 69.0 1 OPEN BRANCH FROM BUS 246516 TO BUS 246555 CKT 1 / 246516 05DAILEY 8 69.0 246555 05WOLVERIN 69.0 1 OPEN BRANCH FROM BUS 246464 TO BUS 246480 CKT 1 / 246464 05LAKE ST 69.0 246480 05POKAGON 69.0 1 OPEN BRANCH FROM BUS 960980 TO BUS 246555 CKT 1 / 957890 AF2-389 TAP 69.0 246555 05WOLVERIN 69.0 1 REMOVE SWSHUNT FROM BUS 246480 / 246480 05POKAGON 69.0 END
AEP_SUBT_P4_#1342_05VALLEY 69.0_A	CONTINGENCY 'AEP_SUBT_P4_#1342_05VALLEY 69.0_A' OPEN BRANCH FROM BUS 243204 TO BUS 243386 CKT 1 / 243204 05VALLEYEQ 999 243386 05VALLY 138 1 OPEN BRANCH FROM BUS 243204 TO BUS 246551 CKT 1 / 243204 05VALLEYEQ 999 246551 05VALLEY 69.0 1 OPEN BRANCH FROM BUS 243204 TO BUS 246550 CKT 1 / 243204 05VALLEYEQ 999 246550 05VALLEY 34.5 1 OPEN BRANCH FROM BUS 243261 TO BUS 243386 CKT 1 / 243261 05COLBYTAPSS 138 243386 05VALLY 138 1 OPEN BRANCH FROM BUS 243307 TO BUS 243386 CKT 1 / 243307 05HARTFO 138 243386 05VALLY 138 1 OPEN BRANCH FROM BUS 247329 TO BUS 243386 CKT 1 / 247329 05STINGER 138 243386 05VALLY 138 1 REMOVE SWSHUNT FROM BUS 243386 / 243386 05VALLY 138 OPEN BRANCH FROM BUS 246502 TO BUS 246509 CKT 1 / 246502 05ALMENA 69.0 246509 05CAMERON 69.0 1 OPEN BRANCH FROM BUS 246509 TO BUS 246551 CKT 1 / 246509 05CAMERON 69.0 246551 05VALLEY 69.0 1 OPEN BRANCH FROM BUS 247174 TO BUS 246550 CKT 1 / 247174 05ROTHDEW 34.5 246550 05VALLEY 34.5 1 END

11 Light Load Analysis

Not Applicable.

12 Short Circuit Analysis

The following Breakers are overdutied:

None.

13 Stability and Reactive Power

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

The AF2-083 Plant is able to ride-through or recover from all credible planning event contingencies studied consistent with NERC TPL-001-4, with the exception of those cases described in the study results section. For those cases that did not ride-through or recover it is likely due to the AF2-083 generator dynamic model settings, which can be reviewed/adjusted by the developer or PJM if desired. No suggested stability mitigation is required for AF2-083.

It was noted that the 60 cycle fault duration is outside of the PRC-024 no trip zone. The generator may trip if these scenarios were to occur and there would be no adverse impact to the AEP system.

14 Affected Systems

14.1 TVA

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

14.2 Duke Energy Progress

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

14.3 MISO

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

14.4 LG&E

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

15 Attachment 1: One Line Diagram and Project Site Location