Generation Interconnection

System Impact Study Report

for

Queue Project AF2-127

LOCKWOOD ROAD 138 KV

24.9 MW Capacity / 38 MW Energy

February 2021

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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/existing Solar generating facility located in Defiance, Ohio. This project is an increase to the Interconnection Customer's AF1-063 project, which will share the same point of interconnection. The AF2-127 queue position is a 38 MW uprate (24.9 MW Capacity uprate) to the previous project. The total installed facilities will have a capability of 68 MW with 44.2 MW of this output being recognized by PJM as Capacity.

The proposed in-service date for this uprate project is March 31, 2022. This study does not imply a TO commitment to this in-service date.

Queue Number	AF2-127
Project Name	LOCKWOOD ROAD 138 KV
State	Ohio
County	Defiance
Transmission Owner	AEP
MFO	68
MWE	38
MWC	24.9
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

AF2-127 will interconnect with the AEP transmission system via the Lockwood Road 138 kV substation proposed to be constructed by the Interconnection Customer's previous PJM Project AF1-063.

Note: It is assumed that the 138 kV revenue metering system, gen lead and Protection & Control Equipment that will be installed for AF1-063 will be adequate for the additional generation requested in AF2-127. Depending on the timing of the completion of the AF1-063 interconnection construction relative to the AF2-127 completion, there may (or may not) be a need to review and revise relay settings for the increased generation of AF2-127.

5 Cost Summary

The AF2-127 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	$45,000
Allocation towards System Network Upgrade Costs*	$0
Total Costs	**$45,000**

*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
None	$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
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
Review line protection and control settings at the Lockwood Road 138 kV station	$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 Agreement execution.

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 AF2-127 was evaluated as a 38.0 MW (Capacity 24.9 MW) injection into the Lockwood Road 138 kV substation in the AEP area. Project AF2-127 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF2-127 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	CONTNAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONTNAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
100548615	238979	02NAPMUN	138.0	ATSI	238962	02MIDWAY	138.0	ATSI	1	ATSI-P1-2-TE-138-039	operation	179.0	114.94	116.74	AC	4.05
100548641	239127	02STRYKE	138.0	ATSI	238979	02NAPMUN	138.0	ATSI	1	ATSI-P1-2-TE-138-039	operation	181.0	98.58	100.73	AC	4.05

10.6 System Reinforcements

None

10.7 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".

10.7.1 Index 1

None

10.8 Contingency Descriptions

Contingency Name	Contingency Definition
ATSI-P1-2-TE-138-031B-B	CONTINGENCY 'ATSI-P1-2-TE-138-031B-B' /* LINE STRYKE-RICHLN 138 DISCONNECT BRANCH FROM BUS 960300 TO BUS 239127 CKT 1 /* AF2-321 TAP 138 02STRYKE 138 END
AEP_P1-2_#10755-A	CONTINGENCY 'AEP_P1-2_#10755-A' OPEN BRANCH FROM BUS 243029 TO BUS 243086 CKT 1 / 243029 05LCKWRD 138 243086 05S HICK 138 1 OPEN BRANCH FROM BUS 243086 TO BUS 959180 CKT 1 / 243086 05S HICK 138 959180 AF2-209 TAP 138 1 OPEN BRANCH FROM BUS 243086 TO BUS 243179 CKT 1 / 243086 05S HICK 138 243179 05S HICKSV 69.0 1 END
ATSI-P1-2-TE-138-039	CONTINGENCY 'ATSI-P1-2-TE-138-039' /* LINE ALLEN JCT TO E FAYETTE 138 DISCONNECT BRANCH FROM BUS 238531 TO BUS 239345 CKT 1 /* 02ALLNJ 138 02SIL_AE+ 138 DISCONNECT BRANCH FROM BUS 239345 TO BUS 238517 CKT 1 /* 02SIL_AE+ 138 02LYONS 138 DISCONNECT BRANCH FROM BUS 238712 TO BUS 238517 CKT 1 /* 02FAYET 138 02LYONS 138 DISCONNECT BRANCH FROM BUS 238712 TO BUS 239351 CKT 1 /* 02FAYET 138 02EASTFAYT 138 REMOVE LOAD O FROM BUS 238517 /* 02LYONS 138 REMOVE LOAD O FROM BUS 238712 /* 02FAYET 138 END
ATSI-P2-3-TE-138-009A	CONTINGENCY 'ATSI-P2-3-TE-138-009A' /* STRYKER 13222 BREAKER TO NAPOLEON MUNI DISCONNECT BRANCH FROM BUS 239127 TO BUS 238979 CKT 1 /* 02STRYKE 138 02NAPMUN 138 DISCONNECT BUS 239127 /* 02STRYKE 138 REMOVE MACHINE 1 FROM BUS 239202 /* 02STRYCT 13 DISCONNECT BUS 239202 /* 02STRYCT 13 END
ATSI-P7-1-TE-138-034	CONTINGENCY 'ATSI-P7-1-TE-138-034' /* RICHL-RIDGV JCT NO.2 138 DISCONNECT BRANCH FROM BUS 239165 TO BUS 238960 CKT 1 /* 02WAUSON 138 02MIDW K 138 DISCONNECT BRANCH FROM BUS 238979 TO BUS 238962 CKT 1 /* 02NAPMUN 138 02MIDWAY 138 END

Contingency Name	Contingency Definition
ATSI-P1-2-TE-138-001B	CONTINGENCY 'ATSI-P1-2-TE-138-001B' /* RICHLAND-WAUSEON 138 DISCONNECT BRANCH FROM BUS 239070 TO BUS 239165 CKT 1 /* 02RICHLD 138 02WAUSEO 138 END
ATSI-P1-3-TE-138-012A	CONTINGENCY 'ATSI-P1-3-TE-138-012A' /* XFMR FAULT: 02MIDWAY 69KV TO 02MIDWAY 138KV 1 DISCONNECT BRANCH FROM BUS 238963 TO BUS 238962 CKT 1 /* 02MIDWAY 69 02MIDWAY 138 DISCONNECT BRANCH FROM BUS 238962 TO BUS 239263 CKT 1 /* 02MIDWAY 138 02STLUKE 138 DISCONNECT BRANCH FROM BUS 238962 TO BUS 238979 CKT 1 /* 02MIDWAY 138 02NAPMUN 138 DISCONNECT BRANCH FROM BUS 238962 TO BUS 238502 CKT 1 /* 02MIDWAY 138 02BRIM 138 REDUCE BUS 238962 SHUNT BY 100 PERCENT /* 02MIDWAY 138 END
ATSI-P2-4-TE-138-015	CONTINGENCY 'ATSI-P2-4-TE-138-015' /* MIDWAY 13303 TIE-BREAKER DISCONNECT BUS 238962 /* 02MIDWAY 138 DISCONNECT BUS 238960 /* 02MIDW K 138 END
Base Case	
ATSI-P2-2-TE-138-004	CONTINGENCY 'ATSI-P2-2-TE-138-004' /* STRYKER 138 BUS DISCONNECT BUS 239127 /* 02STRYKE 138 DISCONNECT BUS 239202 /* 02STRYCT 13 END
ATSI-P1-3-TE-138-022	CONTINGENCY 'ATSI-P1-3-TE-138-022' /* XFMR FAULT: 02WAUS 69KV TO 02WAUSEO 138KV CK 2 DISCONNECT BRANCH FROM BUS 239164 TO BUS 239165 CKT 2 /* 02WAUS 69 02WAUSEO 138 DISCONNECT BUS 239165 /* 02WAUSEO 138 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)

To be determined in the Facilities Study Phase.

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