



**Generation Interconnection
System Impact Study Report
for**

Queue Project AF1-062

JUG STREET 138 KV

80 MW Capacity / 200 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.

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 Storage generating facility located in Licking County, Ohio. The installed facilities will have a total capability of 200 MW with 80 MW of this output being recognized by PJM as Capacity.

The proposed in-service date for this project is August 22, 2022. 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 | AF1-062 |
| Project Name | JUG STREET 138 KV |
| State | Ohio |
| County | Licking |
| Transmission Owner | AEP |
| MFO | 200 |
| MWE | 200 |
| MWC | 80 |
| Fuel | Storage |
| 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

AF1-062 will interconnect with the AEP transmission system via a direct connection to the Jug Street 138 kV station.

To accommodate the interconnection at the Jug Street 138 kV substation, the substation will have to be expanded requiring the installation of one (1) 138 kV circuit breaker (see Attachment 1). Installation of associated protection and control equipment, 138 kV line risers, SCADA and 138 kV revenue metering will also be required.

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.

5 Cost Summary

The AF1-062 project will be responsible for the following costs:

| Description | Total Cost |
|---|--------------------|
| Attachment Facilities | \$788,000 |
| Direct Connection Network Upgrade | \$631,000 |
| Non Direct Connection Network Upgrades | \$45,000 |
| Allocation for New System Upgrades* | \$0 |
| Contribution to Previously Identified Upgrades* | \$0 |
| Total Costs | \$1,464,000 |

*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

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 |
|--|------------------|
| 138 kV Revenue Metering | \$388,000 |
| Generator lead first span exiting the POI station, including the first structure outside the fence | \$400,000 |
| Total Attachment Facility Costs | \$788,000 |

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 |
|---|------------------|
| The Jug Street 138 kV substation will have to be expanded requiring the installation of one (1) 138 kV circuit breaker. Installation of associated protection and control equipment, 138 kV line risers, and SCADA will also be required. | \$631,000 |
| Total Direct Connection Facility Costs | \$631,000 |

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 |
|---|-----------------|
| Review and revise the P&C relay settings at Jug Street 138 kV | \$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 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 AF1-062 was evaluated as a 200.0 MW (Capacity 80.0 MW) injection at the Jugg St 138 kV substation in the AEP area. Project AF1-062 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-062 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)

| ID | FROM BUS# | FROM BUS | kV | FROM BUS AREA | TO BUS# | TO BUS | kV | TO BUS AREA | CK T ID | CONT NAME | Type | Rating MVA | PRE PROJE T LOADIN G % | POST PROJE T LOADIN G % | AC/D C | MW IMPAC T |
|----------|-----------|----------|-------|---------------|---------|----------|-------|-------------|---------|---------------------------------|---------|------------|------------------------|-------------------------|--------|------------|
| 44989656 | 243553 | 05POLARS | 138.0 | AEP | 243590 | 05WSTRV3 | 138.0 | AEP | 1 | AEP_P4_#9732_05M ALIS 138_M2 | breaker | 226.0 | 98.51 | 103.94 | AC | 12.27 |

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

None

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.

None

11.6 System Reinforcements

| ID | Idx | Facility | Upgrade Description | Cost | Cost Allocated to AF1-062 | Upgrade Number |
|----------|-----|--|--|------------|---------------------------|----------------|
| 44989656 | 3 | 05POLARS 138.0 kV - 05WSTRV3 138.0 kV Ckt 1 | 2020 baseline upgrade B3104 to perform a sag study on the line will raise the SE rating to 310 MVA. Projected in-service date for B3104 is presently July 2021. | \$0 | \$0 | B3104 |
| | | | Total Cost | \$0 | \$0 | |

11.7 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".

11.7.1 Index 1

None

11.7.2 Index 2

None

11.7.3 Index 3

| ID | FROM BUS# | FROM BUS | FROM BUS AREA | TO BUS# | TO BUS | TO BUS AREA | CK T ID | CONT NAME | Type | Rating MVA | PRE PROJECT LOADIN G % | POST PROJECT LOADIN G % | ACID C | MW IMPACT |
|----------|-----------|----------|---------------|---------|----------|-------------|---------|----------------------------|---------|------------|------------------------|-------------------------|--------|-----------|
| 44989656 | 243553 | 05POLARS | AEP | 243590 | 05WSTRV3 | AEP | 1 | AEP_P4_#9732_05MALIS138_M2 | breaker | 226.0 | 98.51 | 103.94 | AC | 12.27 |

| Bus # | Bus | Gendeliv MW Impact | Type | Full MW Impact |
|------------|-------------|--------------------|-----------------------|----------------|
| 943943 | AF1-062 BAT | 12.2700 | Merchant Transmission | 12.2700 |
| WEC | WEC | 0.0406 | Confirmed LTF | 0.0406 |
| NEWTON | NEWTON | 0.0258 | Confirmed LTF | 0.0258 |
| G-007A | G-007A | 0.0887 | Confirmed LTF | 0.0887 |
| VFT | VFT | 0.2386 | Confirmed LTF | 0.2386 |
| PRAIRIE | PRAIRIE | 0.0310 | Confirmed LTF | 0.0310 |
| CHEOAH | CHEOAH | 0.0395 | Confirmed LTF | 0.0395 |
| MADISON | MADISON | 1.2096 | Confirmed LTF | 1.2096 |
| MEC | MEC | 0.1017 | Confirmed LTF | 0.1017 |
| GIBSON | GIBSON | 0.0633 | Confirmed LTF | 0.0633 |
| CALDERWOOD | CALDERWOOD | 0.0398 | Confirmed LTF | 0.0398 |
| BLUEG | BLUEG | 0.4097 | Confirmed LTF | 0.4097 |
| TRIMBLE | TRIMBLE | 0.1347 | Confirmed LTF | 0.1347 |
| CATAWBA | CATAWBA | 0.0129 | Confirmed LTF | 0.0129 |
| CBM-W1 | CBM-W1 | 0.4879 | Confirmed LTF | 0.4879 |

11.8 Contingency Descriptions

| Contingency Name | Contingency Definition |
|------------------------------------|--|
| | |
| | |
| AEP_P4_#9732_05MALIS 138_M2 | CONTINGENCY 'AEP_P4_#9732_05MALIS 138_M2' OPEN BRANCH FROM BUS 243513 TO BUS 243537 CKT 2 / 243513 05GENOA 138 243537 05MALIS 138 2 OPEN BRANCH FROM BUS 243526 TO BUS 243537 CKT 2 / 243526 05HYATT 138 243537 05MALIS 138 2 END |

12 Light Load Analysis

The Queue Project AF1-062 was evaluated as a 200.0 MW injection at the Jugg St 138 kV substation in the AEP area. Project AF1-062 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-062 was studied with a commercial probability of 100.0 %. Potential network impacts were as follows:

12.1 Generation Deliverability

(Single or N-1 contingencies)

None

12.2 Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies)

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)

None

12.4 Steady-State Voltage Requirements

None

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.

None

12.6 System Reinforcements

None

13 Short Circuit Analysis

The following Breakers are overdutied

None

14 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

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 and Point of Interconnection Map



