



**Generation Interconnection
Feasibility Study Report
for**

Queue Project AE2-136

MUSKINGUM RIVER-W. MILLERSPORT #1 345 KV

83.2 MW Capacity / 114 MW Energy

March 2020

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1 Preface

The intent of the feasibility study is to determine a plan, with ballpark cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the Interconnection Customer. The Interconnection Customer may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: (1) Direct Connections, which are new facilities and/or facilities upgrades needed to connect the generator to the PJM network, and (2) Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system.

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 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.

PJM utilizes manufacturer models to ensure the performance of turbines is properly captured during the simulations performed for stability verification and, where applicable, for compliance with low voltage ride through requirements. Turbine manufacturers provide such models to their customers. The list of manufacturer models PJM has already validated is contained in Attachment B of Manual 14G. Manufacturer models may be updated from time to time, for various reasons such as to reflect changes to the control systems or to more accurately represent the capabilities turbines and controls which are currently available in the field. Additionally, as new turbine models are developed, turbine manufacturers provide such new models which must be used in the conduct of these studies. PJM needs adequate time to evaluate the new models in order to reduce delays to the System Impact Study process timeline for the Interconnection Customer as well as other Interconnection Customers in the study group. Therefore, PJM will require that any Interconnection Customer with a new manufacturer model must supply that model to PJM, along with a \$10,000 fully refundable deposit, no later than three (3) months prior to the starting date of the System Impact Study (See Section 4.3 for starting dates) for the Interconnection Request which shall specify the use of the new model. The Interconnection Customer will be required to submit a completed dynamic model study request form (Attachment B-1 of Manual 14G) in order to document the request for the study.

The Feasibility 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.

2 General

The Interconnection Customer (IC) has proposed to install PJM project # AE2-136, a Solar generating facility and DC coupled Storage located in Fairfield County, Ohio. The installed facilities will have a total capability of 114 MW with 83.2 MW of this output being recognized by PJM as Capacity.

The Primary Point of Interconnection for the Solar and Storage facilities will be the 345 kV switching station to be constructed for the 220 MW (147.7 MW Capacity) AE2-048 solar and storage project, which connects to AEP's Muskingum – West Millersport #1 345 kV circuit. The AE2-136 project will connect at a different breaker position from AE2-048 project. The interconnection customer has indicated that the batteries will be charged only from the solar facility, and the energy and capacity values requested are based on the capabilities of the solar facility.

The Secondary Point of Interconnection for the Solar and Storage facilities will be the 345 kV switching station to be constructed for the AE2-048 solar and storage project, which connects to AEP's Muskingum – West Millersport #1 345 kV circuit. The AE2-136 project will interconnect behind AE2-048 project and will share the generator lead, main transformer and other facilities with AE2-048 in addition to the POI.

The proposed in-service date for this project is June 01, 2022. This study does not imply AEP's commitment to this in-service date.

The objective of this Feasibility 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.

The Feasibility Study includes Short Circuit and Peak Load steady state power flow analyses. The conduct of power flow studies at other load levels, stability analysis, and coordination with non-PJM Transmission Planners, as required under the PJM planning process, is not performed during the Generation Interconnection Feasibility Study phase of the PJM study process. Additional reinforcement requirements for this Interconnection Request may be defined during the conduct of these additional analyses which shall be performed following execution of the System Impact Study agreement.

| | |
|----------------------------|---------------------------------------|
| Queue Number | AE2-136 |
| Project Name | MUSKINGUM RIVER-W. MILLERSPORT 345 KV |
| State | Ohio |
| County | Fairfield |
| Transmission Owner | AEP |
| MFO | 114 |
| MWE | 114 |
| MWC | 83.2 |
| Fuel | Solar |
| Basecase Study Year | 2022 |

2.1 Primary Point of Interconnection

AE2-136 will interconnect with the AEP transmission system at the 345 kV switching station to be constructed for the Interconnection Customer's previous PJM project # AE2-048, which connects to AEP's Muskingum – West Millersport #1 345 kV circuit. The AE2-136 project will connect at a different breaker position from AE2-048 project.

To accommodate the interconnection at the AE2-048 345 kV switching station, the substation will have to be expanded requiring the installation of one (1) 345 kV circuit breakers. Installation of associated protection and control equipment, 345 kV line risers, SCADA, and 345 kV revenue metering will also be required.

2.2 Cost Summary

The AE2-136 project will be responsible for the following costs:

| Description | Total Cost |
|--|--------------|
| Attachment Facilities | \$350,000 |
| Direct Connection Network Upgrade | \$0 |
| Non Direct Connection Network Upgrades | \$2,000,000* |
| Total Costs | \$2,350,000 |

In addition, the AE2-136 project may be responsible for a contribution to the following costs

| Description | Total Cost |
|-----------------|------------|
| System Upgrades | \$0 |

Cost allocations for these upgrades will be provided in the System Impact Study Report.

*Assumes AE2-048 and AE2-136 are designed and constructed concurrently. If AE2-136 is placed in service significantly after AE2-048, AE2-136 may require review and revision of relay settings. Estimated cost would be \$100,000.

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 |
|--|------------------|
| 345 kV Revenue metering | \$350,000 |
| Total Attachment Facility Costs | \$350,000 |

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 |
|---|------------|
| Total Direct Connection Facility Costs | \$0 |

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 |
|---|--------------------|
| To accommodate the interconnection at the AE2-048 345 kV switching station, the substation will have to be expanded requiring the installation of one (1) 345 kV circuit breaker. | \$2,000,000 |
| Total Non-Direct Connection Facility Costs | \$2,000,000 |

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 the IC is responsible for all costs associated with this interconnection. The costs above are reimbursable to AEP. The cost of the IC's generating plant and the costs for the line connecting the generating plant to the AE2-048 345 kV switching station 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 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:

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 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 – Option 1

The Queue Project AE2-136 was evaluated as a 114 MW (Capacity 83.2 MW) injection at the AE2-048 345 kV switching station which connects to Muskingum – West Millersport #1 345 kV circuit in the AEP area. Project AE2-136 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-136 was studied with a commercial probability of 53%. 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.

None

16 System Reinforcements

None

Affected Systems

17 Affected Systems

17.1 LG&E

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

17.2 MISO

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

17.3 TVA

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

17.4 Duke Energy Progress

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

17.5 NYISO

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

Short Circuit

18 Short Circuit

The following Breakers are over-duty

None

Secondary Point of Interconnection

AE2-136 will interconnect with the AEP transmission system at the 345 kV switching station to be constructed for the Interconnection Customer's previous PJM project # AE2-048, which connects to AEP's Muskingum – West Millersport #1 345 kV circuit. The AE2-136 project will interconnect behind AE2-048 project and will share the generator lead, main transformer and other facilities with AE2-048 in addition to the POI.

Note: It is assumed that the 345 kV revenue metering system, gen lead and Protection & Control Equipment that will be installed for #AE2-048 will be adequate for the additional generation requested in AE2-136. Depending on the timing of the completion of the AE2-048 interconnection construction relative to the AE2-136 completion, there may (or may not) be a need to review and revise relay settings for the increased generation of AE2-136.

19 Network Impacts – Option 2

The Queue Project AE2-136 was evaluated as a 114.0 MW (Capacity 83.2 MW) injection at AE2-048 345 kV switching station which connects to Muskingum – West Millersport #1 345 kV circuit in the AEP area. Project AE2-136 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-136 was studied with a commercial probability of 0.53. Potential network impacts were as follows:

Summer Peak Load Flow

20 Generation Deliverability

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

None

21 Multiple Facility Contingency

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

None

22 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

23 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

24 System Reinforcements

None

Affected Systems

25 Affected Systems

25.1 LG&E

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

25.2 MISO

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

25.3 TVA

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

25.4 Duke Energy Progress

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

25.5 NYISO

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

Short Circuit

26 Short Circuit

The following Breakers are over-duty

None