Generation Interconnection

Feasibility Study Report

for

Queue Projects AE2-167 and AE2-168

BELMONT-HARRISON 500 KV

1,315 MW Capacity / 1,335 MW Energy

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BELMONT-HARRISON 500 KV II

660 MW Capacity / 665 MW Energy

July, 2019

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1 Introduction

This Feasibility Study has been prepared in accordance with the PJM Open Access Transmission Tariff, 36.2, as well as the Feasibility Study Agreement between the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is Monongahela Power Company (Mon Power – part of Allegheny Power System, Inc. (APS)).

2 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.

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.

3 General

The Interconnection Customer (IC) has proposed two (2) Natural Gas generating facilities located in Doddridge County, WV. Queue project AE2-167 will have a total capability of 1,335 MW with 1,315 MW of this output being recognized by PJM as Capacity, and queue project AE2-168 will have a total capability of 665 MW with 660 MW of this output being recognized by PJM as Capacity. The AE2-167 and AE2-168 projects will share the same point of interconnection and were evaluated as a single combined project in this Feasibility Study. The installed AE2-167/168 facilities will have a total capability of 2,000 MW with 1,975 MW of this output being recognized by PJM as Capacity. The proposed in-service date for both projects is 7/1/2023. This study does not imply a Transmission Owner (TO) commitment to this in-service date.

Queue Number	AE2-167 and AE2-168
Project Name	BELMONT-HARRISON 500 kV and BELMONT-HARRISON 500 kV II
Interconnection Customer	
State	West Virginia
County	Doddridge
Transmission Owner	APS
MFO	2,000
MWE	2,000
MWC	1,975
Fuel	Natural Gas
Basecase Study Year	2022

3.1 Point of Interconnection

3.1.1 Primary POI

The interconnection of the projects at the Primary POI will be accomplished by constructing a new 500 kV three (3) breaker ring bus substation and looping the Belmont-Harrison 500 kV line into the new station. The new substation will be located approximately 32 miles from Belmont substation. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection switching station and the associated facilities. The IC will also be responsible for the rough grade of the property and an access road to the proposed three breaker ring bus site. The projects will also require non-direct connection upgrades at Belmont and Harrison substations.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AE2-167 and AE2-168 generation projects to connect to the FirstEnergy ("FE") transmission system. Attachment 2 provides the proposed location for the point of interconnection. IC will be responsible for constructing all of the facilities on its side of the POI, including the attachment facilities which connect the generator to the FE transmission system's direct connection facilities.

3.1.2 Secondary POI

The interconnection of the projects at a Secondary POI can be accomplished by constructing a new 500 kV two (2) breaker string at the proposed Flint Run substation. The new substation would be located approximately 36 miles from Belmont substation. A full scope of work or estimated cost is not provided for the proposed Secondary POI. Only network impacts are provided for the Secondary POI which can be found in the "Network Impacts- Secondary Point of Interconnection" section of this report.

3.2 Cost Summary

The AE2-167 and AE2-168 projects will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 1,680,250
Direct Connection Network Upgrade	$ 15,122,250
Non Direct Connection Network Upgrades	$ 9,092,000
Total Costs	$ 25,894,500

In addition, the AE2-167 and AE2-168 projects may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	$0[1]

[1] Overdutied breakers have been identified at Pruntytown 138 kV Substation. If the Customer chooses to move forward with the System Impact Study, FE will require an additional study to verify the fault current capability of the Pruntytown 138 kV substation equipment. This study may uncover additional required upgrades not identified as part of the Feasibility Study. The Customer will be responsible for any upgrades to the Pruntytown 138 kV substation to meet the increased fault current requirements.

The costs provided above exclude the Contribution in Aid of Construction ("CIAC") Federal Income Tax Gross Up charge. If, at a future date, it is determined that the CIAC Federal Income Tax Gross charge is required, the Transmission Owner shall be reimbursed by the Interconnection Customer for such taxes.

The required Attachment Facilities and Direct and Non-Direct Connection work for the interconnection of the AE2-167 and AE2-168 generation projects to the FE Transmission System are detailed in the following sections. The associated one-line with the generation project Attachment Facilities and the Primary Direct and Non-Direct Connection facilities are shown in Attachment 1.

4 Transmission Owner Scope of Work

The interconnection of the projects at the Primary POI will be accomplished by constructing a new 500 kV three (3) breaker ring bus substation and looping the Belmont-Harrison 500 kV line into the new station. The new substation will be located approximately 32 miles from Belmont substation. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection switching station and the associated facilities. The IC will also be responsible for the rough grade of the property and an access road to the proposed three breaker ring bus site. The project will also require non-direct connection upgrades at Belmont and Harrison substations.

5 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
Install line exit take-off structure, foundations, disconnect switch and associated equipment at new ring bus substation.	$ 1,680,250
Total Attachment Facility Costs	$ 1,680,250

6 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
Build new three (3) breaker 500 kV ring bus at AE2-167/168	$ 15,122,250
Total Direct Connection Facility Costs	$ 15,122,250

7 Non-Direct Connection Cost Estimate

Description	Total Cost
Relay upgrades at Belmont 500 kV substation	$ 300,000
Relay upgrades at Harrison 500 kV substation	$ 300,000
Loop in the Belmont-Flint Run 500kV line to the new substation and connection to two developer generation facilities.	$8,492,000
Total Non-Direct Connection Facility Costs	$9,092,000

8 Schedule

Based on the scope of work for the Attachment Facilities and the Direct and Non-Direct Connection facilities, it is expected to take a minimum of 34 months after the signing of an Interconnection Construction Service Agreement to complete the installation. This includes the requirement for the IC to make a preliminary payment that compensates FE for the first three months of the engineering design work that is related to the construction of the interconnection substation. Full initial deposit will be required for the Non-Direct Connection and Network Upgrade work. This assumes that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the defined direct connection and network upgrades, and that all transmission system outages will be allowed when requested.

The schedule for the required Network Impact Reinforcements will be more clearly identified in future study phases. The estimate elapsed time to complete each of the required reinforcements is identified in the "System Reinforcements" section of the report.

9 Transmission Owner Analysis

9.1 Power Flow Analysis

FE performed an analysis of its underlying transmission <100 kV system. The AE2-167 and AE2-168 projects did not contribute to any overloads on the FE transmission system.

At the proposed Secondary POI, the AE2-167 and AE2-168 projects did not contribute to any overloads on the FE transmission system

10 Interconnection Customer Requirements

10.1 System Protection

The IC must design its Customer Facilities in accordance with all applicable standards, including the standards in FE's "Requirements for Transmission Connected Facilities" document located at: http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx. Preliminary Protection requirements will be provided as part of the Facilities Study. Detailed Protection Requirements will be provided once the projects enter the construction phase.

10.2 Compliance Issues and Interconnection Customer Requirements

The proposed Customer Facilities must be designed in accordance with FE's "Requirements for Transmission Connected Facilities" document located at: http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx. In particular, the IC is responsible for the following:

1. The purchase and installation of a fully rated 500 kV circuit breaker to protect the AE2-167 and AE2-168 generator lead line. A single circuit breaker must be used to protect this line; if the projects have several GSU transformers, the individual GSU transformer breakers cannot be used to protect this line.
2. The purchase and installation of the minimum required FE generation interconnection relaying and control facilities. This includes over/under voltage protection, over/under frequency protection, and zero sequence voltage protection relays.
3. The purchase and installation of supervisory control and data acquisition ("SCADA") equipment to provide information in a compatible format to the FE Transmission System Control Center.
4. Compliance with the FE and PJM generator power factor and voltage control requirements.
5. The execution of a back-up service agreement to serve the customer load supplied from the AE2-167 and AE2-168 generation projects metering point when the units are out-of-service. This assumes the intent of the IC is to net the generation with the load.

The IC will also be required to meet all PJM, ReliabilityFirst, and NERC reliability criteria and operating procedures for standards compliance. For example, the IC will need to properly locate and report the over and under voltage and over and under frequency system protection elements for its units as well as the submission of the generator model and protection data required to satisfy the PJM and ReliabilityFirst audits. Failure to comply with these requirements may result in a disconnection of service if the violation is found to compromise the reliability of the FE system.

10.3 Power Factor Requirements

The IC shall design its Customer Facility with the ability to maintain a power factor of at least 0.95 leading (absorbing VARs) to 0.90 lagging (supplying VARs) measured at the generator's terminals.

11 Revenue Metering and SCADA Requirements

11.1 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.

11.2 APS Requirements

The IC will be required to comply with all FE revenue metering requirements for generation interconnection customers which can be found in FE's "Requirements for Transmission Connected Facilities" document located at: http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx.

12 Network Impacts – Primary Point of Interconnection

The Queue Projects AE2-167 and AE2-168 were evaluated as a 2,000 MW (Capacity 1,975 MW) injection tapping the Belmont-Harrison 500 kV line in the APS area. Projects AE2-167 and AE2-168 were evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Projects AE2-167 and AE2-168 were studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Load Flow

12.1 Generation Deliverability

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

None

12.2 Multiple Facility Contingency

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

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 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

12.5 System Reinforcements

None

12.6 Flow Gate Details

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact. It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

None

Affected Systems

12.7 Affected Systems

12.7.1 LG&E

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

12.7.2 MISO

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

12.7.3 TVA

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

12.7.4 Duke Energy Progress

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

12.7.5 NYISO

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

12.8 Contingency Descriptions

None

Short Circuit

12.9 Short Circuit

The following Breakers are overduty:

Overdutied breakers have been identified at Pruntytown 138 kV Substation. If the Customer chooses to move forward with the System Impact Study, FE will require an additional study to verify the fault current capability of the Pruntytown 138 kV substation equipment. This study may uncover additional required upgrades not identified as part of the Feasibility Study. The Customer will be responsible for any upgrades to the Pruntytown 138 kV substation to meet the increased fault current requirements.

13 Network Impacts – Secondary Point of Interconnection

The Queue Projects AE2-167 and AE2-168 were evaluated as a 2,000 MW (Capacity 1975.0 MW) injection tapping the Belmont to Harrison 500kV line (at the future Flint Run substation) in the APS area. Projects AE2-167 and AE2-168 were evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Projects AE2-167 and AE2-168 were studied with a commercial probability of 53%. Potential network impacts were as follows:

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14 Attachment 1 – One Line Diagram

15 Attachment 2 – Project Location