



**Generation Interconnection
Feasibility Study Report
for
Queue Project AF1-336
NORTHKILL 69 KV
12 MW Capacity / 20 MW Energy**

January 2020

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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 Mid-Atlantic Interstate Transmission (MAIT – Meted zone).

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.

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.

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 an update to a planned solar generating facility located in Berks County, Pennsylvania. This project is an increase to the Interconnection Customer's AF1-334 project, which will share the same property and point of interconnection. The AF1-336 queue position is a 20 MW update (12 MW Capacity update) to the previous project. The total installed facilities will have a capability of 40 MW with 24 MW of this output being recognized by PJM as Capacity (see table below for clarity). The proposed in-service date for this update project is March 1, 2021. This study does not imply a TO commitment to this in-service date.

Queue	Maximum Facility Output (MFO) (MW)	Energy (MW)	Capacity (MW)
AF1-334	20	20	12
AF1-336	20	20	12
Total	40	40	24

Queue Number	AF1-336
Project Name	NORTHKILL 69 KV
State	Pennsylvania
County	Berks
Transmission Owner	ME
MFO	20
MWE	20
MWC	12
Fuel	Solar
Basecase Study Year	2023

4 Point of Interconnection (POI)

4.1 Primary POI

This project is an increment to the preceding AF1-334 project. Increasing the MFO of the project to exceed 20 MW will require the POI to be as follows:

The interconnection of the project at the Primary POI will be accomplished by constructing a new 69 kV three (3) breaker ring bus substation and looping the Northkill – Bern Church 69 kV line into the new station. The new substation will be located approximately 2.95 miles from Northkill 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 Campbelltown and North Lebanon substations.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AF1-336 generation project to connect to the FirstEnergy (“FE”) transmission system. IC will be responsible for constructing 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.

4.2 Secondary POI

The customer requested a secondary POI be evaluated as an uprate to the AF1-334 project at a tap off of the PPL Electric Utilities’ Robeson-Berks 69 kV line (1.9 miles away from Robeson Substation). No physical interconnection costs are provided for the secondary POI. Analysis results can be found in the “Network Impacts – Secondary POI” section of this report.

5 Cost Summary

The AF1-336 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	\$305,400
Direct Connection Network Upgrade	\$6,452,900
Non Direct Connection Network Upgrades	\$1,235,700
Total Costs	\$7,994,000

The AF1-336 project does not require any network upgrades:

Description	Total Cost
System Upgrades	\$0

The Feasibility Study is used to make a preliminary determination of the type and scope of Attachment Facilities, Local Upgrades, and Network Upgrades that will be necessary to accommodate the Interconnection Request and to provide the Interconnection Customer a preliminary estimate of the time that will be required to construct any necessary facilities and upgrades and the Interconnection Customer's cost responsibility. The System Impact Study provides refined and comprehensive estimates of cost responsibility and construction lead times for new facilities and system upgrades. Facilities Studies will include, commensurate with the degree of engineering specificity as provided in the Facilities Study Agreement, good faith estimates of the cost, determined in accordance with Section 217 of the Tariff,

- (a) to be charged to each affected New Service Customer for the Facilities and System Upgrades that are necessary to accommodate this queue project;
- (b) the time required to complete detailed design and construction of the facilities and upgrades; and
- (c) a description of any site-specific environmental issues or requirements that could reasonably be anticipated to affect the cost or time required to complete construction of such facilities and upgrades.

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/or Non-Direct Connection work for the interconnection of the AF1-336 generation project to the FE Transmission System is 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.

6 Transmission Owner Scope of Work

This project is an increment to the preceding AF1-334 project. Increasing the MFO of the project to exceed 20 MW will require the POI to be as follows:

The interconnection of the project at the Primary POI will be accomplished by constructing a new 69 kV three (3) breaker ring bus substation and looping the Northkill – Bern Church 69 kV line into the new station. The new substation will be located approximately 2.95 miles from Northkill 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 Northkill and Bern Church substations.

7 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
Construct a new 3-bkr 69kV Ring Bus looping into the 69kV Northkill-North Temple line between Northkill and Bern Church. @ AF1-336 (Line Terminal portion of work)	\$242,700
Review customer nameplates and drawings	\$62,700
Total Attachment Facility Costs	\$305,400

8 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
Construct a new 3-bkr 69kV Ring Bus looping into the 69kV Northkill-North Temple line between Northkill and Bern Church. @ AF1-336	\$6,452,900
Total Direct Connection Facility Costs	\$6,452,900

9 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
Relay upgrades @ Northkill	\$338,300
Relay upgrades @ North Temple	\$338,300
Loop the 835 (North Temple-Northkill) 69kV line into the new AF1-336 customer substation. @ 835 (North Temple-Northkill) 69kV line loop	\$559,100
Total Non-Direct Connection Facility Costs	\$1,235,700

10 Schedule

Based on the scope of work for the Attachment Facilities and the Direct and/or Non-Direct Connection facilities, it is expected to take a minimum of **20 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 Attachment Facilities and Direct Connection work. Full initial payment is required for the Non-Direct Connection 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.

11 Transmission Owner Analysis

Power Flow Analysis

At the Primary POI, the AF1-336 project contributes to overloads on the FE transmission <100 kV system as shown below. PJM Supplemental project s1894 mitigates the identified overload.

Contingency Description	Overloaded Element	Rating (MVA)	% Loading After [QUEUE]	Final % Loading	[QUEUE] MW Contrib.	FE Comments/Reinforcements
N-1-1 Loss of Northkill - AF1-335 & North Temple - AF1-335	Bern Church - Cambridge Lee 69 kV Line	56	114.6%	114.6%	13.09	PJM Supplemental project s1894 mitigates this overload.

12 Interconnection Customer Requirements

12.1 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 project enters the construction phase.

12.2 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 69 kV circuit breaker to protect the AF1-336 generator lead line. A single circuit breaker must be used to protect this line; if the project has 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 AF1-336 generation project 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.

12.3 Power Factor Requirements

The IC shall design its solar-powered non-synchronous Customer Facility with the ability to maintain a power factor of at least 0.95 leading (absorbing VARs) to 0.95 lagging (supplying VARs) measured at the high-side of the facility substation transformer(s) connected to the FE transmission system.

13 Revenue Metering and SCADA Requirements

13.1 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.

13.2 ME 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>

14 Network Impacts – Primary POI

The Queue Project AF1-336 was evaluated as a 20.0 MW (Capacity 12.0 MW) injection tapping the Bernville Church to Northkill 69 kV Line in the ME area. Project AF1-336 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-336 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Load Flow

14.1 Generation Deliverability

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

None

14.2 Multiple Facility Contingency

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

None

14.3 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

14.4 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

14.5 System Reinforcements

None

Affected Systems

14.6 Affected Systems

None

Short Circuit

14.7 Short Circuit

The following Breakers are overduty:

None

15 Network Impacts – Secondary POI

The Queue Project AF1-336 was evaluated as a 20.0 MW (Capacity 12.0 MW) injection tapping the Robesonía to Berks 69 kV line in the PPL area. Project AF1-336 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-336 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Load Flow

15.1 Generation Deliverability

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

None

15.2 Multiple Facility Contingency

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

None

15.3 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

15.4 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

Affected Systems

15.5 Affected Systems

None

Short Circuit

15.6 Short Circuit

The following Breakers are overduty:

None

16 Attachment One: One Line Diagram