Generation Interconnection

Feasibility Study Report

for

Queue Project AE2-249

BEDFORD NORTH-PENNSYLVANIA HOLLOW 23 KV

8.1 MW Capacity / 13.5 MW Energy

July, 2019

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2 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 Penelec.

3 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.

4 General

The Interconnection Customer (IC) has proposed a Solar generating facility located in Bedford County, Pennsylvania. The installed facilities will have a total capability of 13.5 MW with 8.1 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is September 1, 2021. This study does not imply a Transmission Owner (TO) commitment to this in-service date.

Queue Number	AE2-249
Project Name	BEDFORD NORTH-PENNSYLVANIA HOLLOW 23 KV
Interconnection Customer	
State	PA
County	Bedford
Transmission Owner	PENELEC
MFO	13.5
MWE	13.5
MWC	8.1
Fuel	Solar
Basecase Study Year	2022

5 Point of Interconnection

AE2-249 will interconnect with the Penelec distribution system via a tap on the 23 kV Pennsylvania Hollow circuit at pole # 7-2101673. The IC's proposed generating unit site is approximately 3.9 miles northwest of Bedford, PA., near Astor Road.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AE2-249 generation project to connect to the Penelec distribution 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 Penelec distribution system's direct connection facilities.

6 Cost Summary

The AE2-249 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 138,900
Direct Connection Network Upgrade	$ 0
Non Direct Connection Network Upgrades	$ 14,500
Total Costs	$ 153,400

In addition, the AE2-249 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	$4,500,000

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

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 AE2-249 generation project to the Penelec Distribution System is detailed in the following sections. The associated one-line with the generation project Attachment Facilities and the Primary Direct Connection facilities are shown in Attachment 1.

7 Transmission Owner Scope of Work

The AE2-249 project will interconnect with the Penelec distribution system via a tap on the 23 kV Pennsylvania Hollow circuit at pole # 7-2101673. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct the new interconnection station and the associated facilities.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AE2-249 generation project to connect to the Penelec distribution system. Attachment 2 provides the proposed location for the point of interconnection. The 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 distribution system's direct connection facilities.

8 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
Tap near pole 7-2101673, new SCADA switch, new primary metering.	$ 138,900
Total Attachment Facility Costs	$ 138,900

9 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.

None

10 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
Bedford North 23kV SS. Adjust Remote Relay and Metering Settings.	$ 14,500
Total Non-Direct Connection Facility Costs	$ 14,500

11 System Reinforcements Cost Estimate

Facility	Upgrade Description	Cost
26GARRETT 115.0 kV - 01GARRET 115.0 kV Ckt 1	PE-0006 (85) : Reconductor 2 miles of 336 ACSR Line Conductor Project Type : FAC Cost : $4,500,000 Time Estimate : 30.0 Months	$4,500,000
	TOTAL COST	**$4,500,000**

12 Schedule

Based on the scope of work for the Direct and Non-Direct Connection facilities, it is expected to take a minimum of 6 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. Full initial deposit will be required for the Non-Direct Connection work and Network Upgrades. 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 that any distribution system outages will be allowed when requested.

It should be noted that to resolve overload violations identified in the "Network Impacts" section of this report, Baseline RTEP project b3081 needs to be placed in-service prior to the AE2-191 going to Commercial Operation. The current projected in-service date for b3081 is 6/1/2022.

13 Transmission Owner Analysis

Penelec performed an analysis of its distribution system. The AE2-249 project did not contribute to any overloads on the distribution system.

14 Interconnection Customer Requirements

14.1 System Protection

An analysis was conducted to assess the impact of the Bedford North-Pennsylvania 23 kV (AE2-249) Project on the system protection requirements in the area. The results of this review show that the following relay additions will be required:

Proposed single line diagrams show IC constructing a generation facility they call **"BE-Astor"** tapping Penelec's Bedford North – 23 kV Pennsylvania Hollow at pole 7-2101673.

The 23 kV interconnection proposal will require Developer to meet applicable "Technical Requirements" as outlined in First Energy's document titled "Technical Requirements for the Interconnection of Customer-Owned Generation to the FirstEnergy Distribution System".

Protection requirements are included in the "Technical Requirements" document.

14.2 General Concerns

It is to be understood, for abnormal operation of the Penelec system, which could cause IC's generation facility to be electrically isolated from the Penelec system synchronous source via the tripping of a interconnecting primary voltage line or device, IC will, via Penelec's direction, be required to disconnect the generation from Penelec's system and remain disconnected (**units are required to be OFF LINE**), until the Penelec system normal circuitry is restored. These abnormal conditions will be reviewed by Penelec system operators as to the need for the generation facility to be disconnected.

14.3 Requirements for Owner's/IC's generation IPP Facility

The proposed interconnection Owner's/IC's facilities must be designed in accordance with the document titled *FirstEnergy Distribution Engineering Practices Interconnection of Customer-Owned Generation to the FirstEnergy Distribution System* dated 11/17/14 located at the following link:

http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx

The document is referred to as engineering practice EP(# 02-280) with section 4 part C specifically referencing the "interconnection technical requirements". Certain protection requirement are shown.

Additionally, Owner/IC is responsible to provide adequate protection (for their equipment) under any distribution system operating condition' - which includes 'Separation from supply' (i.e. tripping of F.E. circuit breakers) and 'Re-synchronizing the generation after electric restoration of the supply' (i.e. reclosing of F.E. circuit breakers).

Owner's/IC's protection must be designed to coordinate with the reclosing practices of FirstEnergy line protective devices. The generator must cease to energize the FirstEnergy circuit to which it is connected prior to reclosing of any (FE) automatic reclosing devices.

Owners/IC's electrical protection and control schematics shall be provided to FE for consideration. FE may request modifications, if required, to meet the technical requirements.

15 Compliance Issues

IC will be responsible for meeting a power factor between 0.95 lagging (producing MVARs) to 0.95 leading (absorbing MVARs) and assure that voltage deviation will be less than 1.0 volt as measured at the POI under all Solar Gen operating conditions due to the inherent dynamic reactive power capability of this solar facility.

Generators with no inherent VAR (reactive power) control capability, or those that have a restricted VAR capability less than the defined requirements, must provide dynamic supplementary reactive support located at the generation facility with electrical characteristics equivalent to that provided by a similar sized synchronous generator. A Dynamic Reactive Compensation (either Static VAR Compensator (SVC) or STATCOM) or other method be applied in order to maintain the required specifications at the POI. IC is responsible for the installation of equipment on its side of the POI in order to adhere to the criteria stated above by FirstEnergy.

16 Revenue Metering and SCADA Requirements

16.1 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.

16.2 PENELEC Requirements

IC will be required to comply with all FE Revenue Metering Requirements for Generation Interconnection Customers. These FE requirements are the following:

The FE operating company (Penelec) shall provide, own, operate, test, and maintain the revenue metering equipment at the Interconnection Customer's (IC) expense. The revenue metering equipment includes, but is not limited to, current transformers, voltage transformers, secondary wires, meter socket, bidirectional revenue meter, and associated devices. The IC shall mount the instrument transformers unless otherwise agreed to by Penelec. The instrument transformers and meter socket shall be installed in a location that is readily accessible to authorized Penelec representatives. Penelec will provide the IC access to bidirectional kWh and kVARh pulses from the Penelec meter at the IC's expense if requested. The IC shall, at its expense, install, own, operate, test, and maintain any metering and telemetry equipment that may be required to provide real-time meter data to FE or PJM.

17 Network Impacts

The Queue Project AE2-249 was evaluated as a 13.5 MW (Capacity 8.1 MW) injection at Bedford North 23 kV Substation (physical interconnection is to a tap on the 23 kV Pennsylvania Hollow circuit at pole # 7-2101673) in the PENELEC area. Project AE2-249 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-249 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Load Flow

18 Generation Deliverability

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

None

19 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	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
7275797	200762	26GARRETT	PENELEC	235470	01GARRET	AP	1	AP-P2-3-WP-500-463T	breaker	160.0	99.24	100.09	DC	1.35

20 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

21 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	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
7276685	200762	26GARRETT	PENELEC	235470	01GARRET	AP	1	Base Case	operation	133.0	100.32	100.78	DC	1.34

22 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
7275797	1	**26GARRETT 115.0 kV - 01GARRET 115.0 kV Ckt 1**	PE-0006 (85) : Reconductor 2 miles of 336 ACSR Line Conductor Project Type : FAC Cost : $4,500,000 Time Estimate : 30.0 Months	$4,500,000
			TOTAL COST	**$4,500,000**

23 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.

23.1 Index 1

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
7275797	200762	26GARRETT	PENELEC	235470	01GARRET	AP	1	AP-P2-3-WP-500-463T	breaker	160.0	99.24	100.09	DC	1.35

Bus #	Bus	MW Impact
200813	26YOUGH	0.38
200834	26SW_E13_K22	0.66
200835	26DSGENWIN	3.14
200840	26DEEPCRK1	0.87
200841	26DEEPCRK2	0.87
200864	K-013 E	2.3
200889	26STNY CRK	0.19
200890	26BF_G21_K23	0.19
200891	26CSLMN_L13	0.29
200892	26LOOKOUT	0.28
202225	26SCI_S29B	0.06
292340	K-022	0.02
292350	K-023	9.67
292542	L-013 1	9.67
293432	R-040 E	0.54
293603	O-018 E	3.57
293902	O-048 E	8.7
294903	P-060 E	6.15
296332	R-032 E	4.12
913141	Y1-033 C OP1	0.28
913142	Y1-033 E OP1	15.28
917672	Z2-108 E	6.04
918812	AA1-100 E	0.78
938351	AE1-053	3.02
938881	AE1-116	0.82
938991	AE1-128 C	7.22
938992	AE1-128 E	4.81
942361	AE2-249 C	0.81
942362	AE2-249 E	0.54
942903	AE2-309 BAT	0.48
BLUEG	BLUEG	2.2
CALDERWOOD	CALDERWOOD	0.24
CANNELTON	CANNELTON	0.13
CATAWBA	CATAWBA	0.15
CBM-N	CBM-N	0.69
CHEOAH	CHEOAH	0.22
CHILHOWEE	CHILHOWEE	0.08
COFFEEN	COFFEEN	0.23
COTTONWOOD	COTTONWOOD	0.91
DUCKCREEK	DUCKCREEK	0.49
EDWARDS	EDWARDS	0.22

Bus #	Bus	MW Impact
ELMERSMITH	ELMERSMITH	0.23
FARMERCITY	FARMERCITY	0.15
G-007A	G-007A	1.32
GIBSON	GIBSON	0.09
HAMLET	HAMLET	0.24
NEWTON	NEWTON	0.6
NYISO	NYISO	3.01
PRAIRIE	PRAIRIE	1.12
SANTEETLA	SANTEETLA	0.06
SMITHLAND	SMITHLAND	0.09
TATANKA	TATANKA	0.27
TILTON	TILTON	0.27
TRIMBLE	TRIMBLE	0.24
TVA	TVA	0.76
UNIONPOWER	UNIONPOWER	0.34
VFT	VFT	3.62

Affected Systems

24 Affected Systems

24.1 LG&E

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

24.2 MISO

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

24.3 TVA

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

24.4 Duke Energy Progress

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

24.5 NYISO

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

25 Contingency Descriptions

Contingency Name	Contingency Definition
Base Case	
AP-P2-3-WP-500-463T	CONTINGENCY 'AP-P2-3-WP-500-463T' /* 470 DISCONNECT BRANCH FROM BUS 235104 TO BUS 239280 CKT 1 /* 01CABOT 500 02CRNBRY 500 DISCONNECT BRANCH FROM BUS 235104 TO BUS 235153 CKT 2 /* 01CABOT 500 01CABOT 138 DISCONNECT BRANCH FROM BUS 235104 TO BUS 235153 CKT 4 /* 01CABOT 500 01CABOT 138 END

Short Circuit

26 Short Circuit

The following Breakers are overdutied:

None

27 Attachment 1 – One Line

28 Attachment 2 – Project Location