Generation Interconnection

Feasibility Study Report

for

Queue Project AF1-139

THOMPSON 34.5 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- Penelec 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 a Solar generating facility located in Wayne County, Pennsylvania. The installed facilities will have a total capability of 20 MW with 12 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is 06/01/2022. This study does not imply a TO commitment to this in-service date.

Final attachment facilities and local upgrades (if required) along with terms and conditions to interconnect AF1-139 will be specified in a separate two party Interconnection Agreement (IA) between WPP and the Interconnection Customer as this project is considered FERC non-jurisdictional per the PJM Open Access Transmission Tariff (OATT).

Queue Number	**AF1-139**
Project Name	THOMPSON 34.5 KV
State	Pennsylvania
County	Wayne
Transmission Owner	PENELEC
MFO	20
MWE	20
MWC	12
Fuel	Solar
Basecase Study Year	2023

3.1 Points of Interconnection

This project is being studied for a primary and a secondary point of interconnection (POI). The primary POI is a 34.5kV interconnection via a tap on the Lake Como circuit at the Penelec-owned Thompson substation. The secondary POI is a 34.5kV interconnection via a tap on the Starrucca circuit at the Penelec-owned Thompson substation. The IC's proposed generating unit site is approximately 0.2 miles southwest of Lakewood, PA., near Tully Road.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AF1-139 generation project to connect to the Penelec distribution system. 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.

3.2 Cost Summary

The AF1-139 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 0
Direct Connection Network Upgrade	$ 131,100
Non Direct Connection Network Upgrades	$ 74,900
Total Costs	**$ 206,000**

In addition, the AF1-139 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	**$ 3,419,900**

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 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 required Attachment Facilities and Direct and Non-Direct Connection work for the interconnection of the AF1-139 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.

4 Transmission Owner Scope of Work

The AF1-139 will interconnect with the Penelec distribution system via a tap on the 34.5 kV Lake Como circuit at pole # SLC-18065. 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.

5 Attachment Facilities

There are no Attachment Facilities identified for this project

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
Tap the existing Thompson-Starrucca 34.5kV line at an existing pole or interspersed pole on Penelec' s existing distribution circuit (00446-65) near pole SLC-18065, new SCADA recloser tap to interconnect queue project AF1-139. Install 34.5 kV metering in customer's facilities. The customer is responsible to build their own line from their site to Penelec' s existing facilities.	$ 131,100
Total Direct Connection Facility Costs	**$ 131,100**

7 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
Nameplates and customer drawing review at AF1-139 customer substation	$ 74,900
Total Non-Direct Connection Facility Costs	**$ 74,900**

8 Schedule

Based on the scope of work for the Direct and Non-Direct Connection facilities, it is expected to take a minimum of 10 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. 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.

9 Transmission Owner Analysis

Penelec performed an analysis of its distribution system. The AF1-139 project did contribute to overloads on the distribution system. The Thompson #1 transformer loads to 117.8% of the rating for the primary POI. The Thompson #1 transformer loads to 117.7% of the rating and line regulators load to 194.5% for the secondary POI.

10 Interconnection Customer Requirements

10.1 System Protection

An analysis was conducted to assess the impact of the Thompson 34.5 kV (AF1-139) 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 the IC constructing a generation facility they call **"WA-Tully"** tapping Penelec's Thompson - 34.5kV Lake Como circuit at pole SLC-18065.

The 34.5kV 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". Anti-islanding system shall meet IEEE 1547 and UL 1741 therefore no Direct Transfer Trip (DTT) will be required.

10.2 General Concerns

It is to be understood, for abnormal operation of the Penelec system, which could cause Developer's generation facility to be electrically isolated from the Penelec system synchronous source via the tripping of a interconnecting primary voltage line or device, Developer 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.

10.3 Requirements for Owner's/Developer's generation IPP Facility

The proposed interconnection Owner's/Developer'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/Developer 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/Developer'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/Developer's electrical protection and control schematics shall be provided to FE for consideration. FE may request modifications, if required, to meet the technical requirements.

10.4 Compliance Issues

The IC will be responsible for meeting a power factor between 0.90 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. The 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.

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.

11.1.1 Meteorological Data Reporting Requirement

The solar generation facility shall provide the Transmission Provider with site-specific meteorological data including:

- Temperature (degrees Fahrenheit)
- Atmospheric pressure (hectopascals)
- Irradiance
- Forced outage data

11.2 PENELEC Requirements

The 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.

12 Network Impacts – Primary Point of Interconnection

The Queue Project AF1-139 was evaluated as a 20.0 MW (Capacity 12.0 MW) injection at the Thompson 34.5 kV substation in the Penelec area. Project AF1-139 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-139 was 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.

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
4122640 5	20070 8	26OXBO W	230. 0	PENELE C	20800 9	LAC K	230. 0	PPL	1	AP-P1-2-WP-230-324T_FSA_A-A	operatio n	984.0	99.76	100.2	DC	9.42

12.5 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
		Thompson #1 TR	Replace the #1 transformer and relay settings changes at the Thompson substation	$ 3,419,900
			TOTAL COST	**$ 3,419,900**

12.6 Flow Gate Details

The following indices contain additional information about each flowgate presented in the body of the report. For each index, 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.

12.6.1 Contingency Descriptions

Contingency Name	Contingency Definition
AP-P1-2-WP-230-324T_FSA_A-A	CONTINGENCY 'AP-P1-2-WP-230-324T_FSA_A-A' /* MOSHANNON-MARSHALL 230KV APS-PN TIE DISCONNECT BRANCH FROM BUS 235220 TO BUS 945070 CKT 1 /* 01MOSHAN 230 AF1-172 TAP 230 END

Short Circuit

12.7 Short Circuit

The following Breakers are overdutied:

None

13 Network Impacts – Secondary Point of Interconnection

The Queue Project AF1-139 was evaluated as a 20.0 MW (Capacity 12.0 MW) injection at the Thompson 34.5 kV substation in the Penelec area. Project AF1-139 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-139 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Load Flow

13.1 Generation Deliverability

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

None

13.2 Multiple Facility Contingency

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

None

13.3 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

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Short Circuit

13.6 Short Circuit

The following Breakers are overdutied:

None

Affected Systems

14 Affected Systems

14.1 LG&E

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

14.2 MISO

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

14.3 TVA

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

14.4 Duke Energy Progress

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

14.5 NYISO

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

Attachment 1

System Configuration