Generation Interconnection

Feasibility Study Report

for

Queue Project AE2-142

GLEN GARDNER-WASHINGTON SOLAR 34.5 KV

1.68 MW Capacity / 4 MW Energy

July, 2019

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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 Jersey Central Power & Light Company (JCPL).

Preface

The intent of the feasibility study is to determine a plan, with approximate 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.

General

The Interconnection Customer (IC), has proposed a Solar generating facility located in Warren County, New Jersey. The installed facilities will have a total capability of **4 MW** with **1.68 MW** of this output being recognized by PJM as Capacity. The proposed in-service date for this project is **March 2, 2020**. **This study does not imply a Jersey Central Power & Light Company (JCPL) commitment to this in-service date.**

Queue Number	**AE2-142**
Project Name	GLEN GARDNER-WASHINGTON 34.5 KV
Interconnection Customer	
State	New Jersey
County	Warren
Transmission Owner	JCPL
MFO	4
MWE	4
MWC	1.68
Fuel	Solar
Basecase Study Year	2022

Point of Interconnection

Primary POI

The interconnection of the project at the Primary POI will be accomplished by tapping the Glen Gardner – Washington 34.5 kV line. The transmission line tap will be located approximately 4.4 miles from Glen Gardner substation and 3.6 miles from Washington substation. The primary direct connection of this project will be accomplished by building a new facility consisting of 125 kW inverters with solar panels. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection line tap and the associated attachment facilities. The project will also require non-direct connection upgrades at Glen Gardner and Washington substations.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AE2-142 generation project 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.

Cost Summary

The AE2-142 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 248,650
Direct Connection Network Upgrade	$ 745,950
Non Direct Connection Network Upgrades	$ 27,800
Total Costs	**$ 1,022,400**

In addition, the AE2-142 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	**$ 5,655,000**

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 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 AE2-142 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.

Transmission Owner Scope of Work

The interconnection of the project at the Primary POI will be accomplished by tapping the Glen Gardner – Washington 34.5 kV line. The transmission line tap will be located approximately 4.4 miles from Glen Gardner substation and 3.6 miles from Washington substation. The primary direct connection of this project will be accomplished by building a new facility consisting of 125 kW inverters with solar panels. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection line tap and the associated attachment facilities. The project will also require non-direct connection upgrades at Glen Gardner and Washington substations.

Attachment Facilities

To accommodate the proposed AE2-142 Project, JCPL will install a 34.5 kV tap switch, associated line extension, and provide a 34.5 kV revenue meter package. The IC will be responsible for acquiring all easements, properties and permits that may be required to construct the associated 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 34.5 kV Tap Switch and associated line extension. Provide 34.5 kV Revenue Meter Package.	$ 248,650
Total Attachment Facility Costs	**$ 248,650**

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 Glen Gardner-Washington 34.5 kV line to AE2-142 developer substation.	$ 745,950
Total Non-Direct Connection Facility Costs	**$ 745,950**

The Glen Gardner – Washington 34.5 kV line to the AE2-142 developer substation will need to be tapped to facilitate the interconnection of the new generation.

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
Glen Gardner 34.5 kV Substation – Adjust Remote Relay and Metering Settings	$ 13,900
Washington 34.5 kV Substation – Adjust Remote Relay and Metering Settings	$ 13,900
Total Non-Direct Connection Facility Costs	**$ 27,800**

Remote relay and metering setting changes will need to be made at Glen Gardner and Washington Substations to facilitate the interconnection of the new generation.

Schedule

Based on the extent of the JCPL primary Attachment Facilities and Non-Direct Connection work required to support the AE2-142 generation project, it is expected to take a minimum of **eight (8)** months from the date of a fully executed Interconnection Construction Service Agreement to complete the installation. This includes the requirement for the IC to make a preliminary payment to FE which funds the Non-Direct Connection work and the first three months of engineering design that is related to the construction of the Attachment Facilities. It further assumes that the IC will provide all rights-of-way, permits, easements, etc. that will be needed. A further assumption is 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 Attachment Facilities and Non-Direct Connection work, and that all 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.

Transmission Owner Analysis

Power Flow Analysis

PJM performed a power flow analysis of the transmission system using a 2022 summer peak load flow model and the results were verified by FE. The AE2-142 project did not contribute to any overloads on the FE transmission system. Additionally, FE performed an analysis of its underlying transmission <100 kV system. At the Primary POI, the AE2-142 project contributes to overloads on the <100 kV system as shown below. The estimated cost of system reinforcements necessary to mitigate these overloads is $5,655,000.

Contingency Description	Overloaded Element	Rating (MVA)	% Loading After AE2-142	Final % Loading	AE2-142 MW Contrib.	FE Comments/Reinforcements
MAINTENANCE OUTAGE (N-1-1 CONTINGENCY) b-NJC-L-PE-77_JC-P1-3-JCN-230-024 [N-1-1] /* OPEN BRANCH FROM BUS 206212 TO BUS 206660 CKT 1 / 206212 28CHESTER 34.5 206660 28NEWBRG E 34.5 1 OPEN BRANCH FROM BUS 206247 TO BUS 206219 CKT 1 / 206247 28POHATCNG 230 206219 28POHATCNG 34.5 1 END	Mobil Chem - Domin LN Solar T Ckt Q719 34.5 kV segment of the Pohatcong Mountain - Newburgh - Washington Q719 34.5 kV line	47.0 MVA	108.49	198.49	0.13	**JCPL** Description: a) Replace 6.5 Amp GCX17A Relay. All new terminal equipment should be rated above 52 MVA (Rate B). Time Estimate : 12 months Cost : $195,000
MAINTENANCE OUTAGE (N-1-1 CONTINGENCY) b-NJC-L-PE-83_JC-P1-3-JCN-230-024 [N-1-1] /* OPEN BRANCH FROM BUS 206216 TO BUS 206663 CKT 1 / 206216 28FLANDERS 34.5 206663 28NET R TP 34.5 1 OPEN BRANCH FROM BUS 206247 TO BUS 206219 CKT 1 / 206247 28POHATCNG 230 206219 28POHATCNG 34.5 1 END			109.31	109.31	0.15	
MAINTENANCE OUTAGE (N-1-1 CONTINGENCY) b-NJC-L-PE-83_JC-P1-2-JCN-230-014 [N-1-1] /* OPEN BRANCH FROM BUS 206216 TO BUS 206663 CKT 1 / 206216 28FLANDERS 34.5 206663 28NET R TP 34.5 1 OPEN BRANCH FROM BUS 206242 TO BUS 206247 CKT 1 / 206242 28KITATINY 230 206247 28POHATCNG 230 1 OPEN BRANCH FROM BUS 206247 TO BUS 206219 CKT 1 / 206247 28POHATCNG 230 206219 28POHATCNG 34.5 1 END	Port Murray - Mobil Chem Ckt Q719 34.5 kV segment of the Pohatcong Mountain - Newburgh - Washington Q719 34.5 kV Line	53.0 MVA	100.42	100.42	0.13	**JCPL** Description: a) Reconductor existing section of 397.5 ACSR 18/1 with 556.5 ACSR 26/7 "Dove" or a subtransmission conductor rated above 54 MVA (Rate B). Time Estimate : 18 months Cost : $5,460,000
TOTAL COST (Most severely overloaded conditions only)						$5,655,000

Short Circuit Analysis

PJM performed a short circuit analysis and the results were verified by FE. The connection of AE2-142 project to the system does not result in any newly overdutied circuit breakers on the FE transmission system and does not have a significant fault current contribution to existing overdutied circuit breakers.

Stability Analysis

PJM will complete a dynamic stability analysis, if necessary, as part of the System Impact Study. The results of this analysis will be reviewed by FE. Should stability concerns be identified in PJM's study, FE will develop appropriate system reinforcement(s) and included the estimated cost of any reinforcement(s) in FE's System Impact Study report.

Interconnection Customer Requirements

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.

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 34.5 kV circuit breaker to protect the AE2-142 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 AE2-142 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.

Power Factor Requirements

The IC shall design its 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.

Revenue Metering and SCADA Requirements

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.

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

JCPL 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.

Network Impacts

The Queue Project AE2-142 was evaluated as a 4.0 MW (Capacity 1.68 MW) injection on the Glen Gardner – Washington 34.5 kV line in the JCPL area. Project AE2-142 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-142 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Load Flow

Generation Deliverability

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

None.

Multiple Facility Contingency

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

None.

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.

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.

System Reinforcements

No system reinforcements required.

Affected Systems

Affected Systems

LG&E

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

MISO

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

TVA

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

Duke Energy Progress

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

NYISO

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

Short Circuit

Short Circuit

The following Breakers are overduty:

None.

Attachment 1 – One Line

Attachment 2 – Project Location