Generation Interconnection

Combined Feasibility / Impact Study Report

for

Queue Project AE2-056

HOWELL 12.47 KV SOLAR I

1.6 MW Capacity / 3 MW Energy

July, 2019

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1 Introduction

This Combined Feasibility/System Impact Study report has been prepared in accordance with the PJM Open Access Transmission Tariff, 36.2, as well as the Feasibility Study Agreement between NJ Solar 2000 LLC, the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is Jersey Central Power and Light Company (JCPL).

2 Preface

The intent of the Combined Feasibility/System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

In some instances an Interconnection Customer may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection or merchant transmission upgrade, may also contribute to the need for the same network reinforcement. The possibility of sharing the reinforcement costs with other projects may be identified in the Feasibility Study, but the actual allocation, if any, is included in the System Impact Study.

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.

The 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 associated with them will be addressed when seeking an Interconnection Agreement as outlined below. Developer will also be responsible for providing and installing metering equipment in compliance with applicable PJM and Transmission Owner standards.

3 General

The Interconnection Customer (IC) has proposed a Solar generating facility located in Monmouth County, New Jersey. The installed facilities will have a total capability of 3 MW with 1.6 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is October 1, 2019. This study does not imply a Transmission Owner (TO) commitment to this in-service date.

Final attachment facilities and local upgrades (if required) along with terms and conditions to interconnect AE2-056 will be specified in a separate two party Interconnection Agreement (IA) between JCPL and the Interconnection Customer as this project is considered FERC non-jurisdictional per the PJM Open Access Transmission Tariff (OATT).

From the transmission perspective, no network impacts were identified as detailed in the "Network Impacts" section below.

Queue Number	AE2-056
Project Name	HOWELL 12.47 KV SOLAR I
Interconnection Customer	NJ Solar 2000 LLC
State	New Jersey
County	Monmouth
Transmission Owner	JCPL
MFO	3
MWE	3
MWC	1.6
Fuel	Solar
Basecase Study Year	2022

3.1 Point of Interconnection (POI)

AE2-056 will interconnect with the JCPL distribution system at the Howell 12.47kV substation. The location where the customer proposes to interconnect is presently served by the Howell Circuit 47050, 3 phase, 12.47 kV grounded-wye distribution circuit originating from JCP&L's Howell Substation located in Freehold Township New Jersey, 07728. The POI is to be established at 56 Willow Brook Rd, Freehold, NJ 07728.

Refer to Attachment 1 for the Project Location and Attachment 2 for the One Line.

3.2 Cost Summary

Total estimated cost for the required Interconnection Facilities is **$216,000**. This cost excludes a Federal Income Tax Gross Up charge of $33,955. This tax may or may not be charged based on whether this project meets the eligibility requirements of IRS Notice 88-129. If, at a future date, it is determined that the Federal Income Tax Gross charge is required, the Transmission Owner shall be reimbursed by the Interconnection Customer for such taxes.

From the transmission perspective, no network impacts were identified as detailed in the "Network Impacts" section below.

4 Transmission Owner Scope of Work

4.1 Connection Facility Requirements

4.1.1 Main Line:

- Primary conductor line extension will be required. Construct 3-Phase overhead primary line extension of one span off existing pole JC1297FRT with set of three fuse cutouts with 140K fuse links. At an Interconnection Customer (IC) owned metering pole, JCP&L will install metering equipment, i.e. CT's and PT's. Additionally, the IC shall provide manually operable disconnect switches past the interconnection point for supplying a visible break. The BIL rating shall be 110 KV: $ 6,000.
- Upgrade existing recloser to a new Elastimold™ MVR[1] with SEL 651R controls (or equivalent). Cost: $ 40,000.
- Upgrade of two Capacitor controls with field and engineering time: $6,000.
- Communication costs - installing SCADA system into our DCC[2] center: $ 20,000.
- Metering cost - JCP&L installing CTs and PTs: $ 20,000.
- Engineering review and site commissioning: $4,000.

4.1.2 Substation:

The proposed system will back-feed to our 34.5 KV sub-transmission system during light load daytime periods. This will require engineering labor to upgrade LTC[3] control and protective relays on the substation transformer, Howell Transformer Bank 2.

- Substation upgrade cost – Engineering labor for upgrading substation relays and LTC Control: $ 120,000.

All JCPL costs are not subject to refund provisions of the NJ-BPU Tariff for Electric service.

Note- This is an estimate based on similar work orders previously worked by JCP&L for the types of work described in the analysis above. Should the customer want to proceed with the connection of this facility a contract with JCPL will be developed based on these costs and a true-up of actual charges will be made at the completion of the project.

5 Schedule

- JCP&L estimates it will require **9 months** from payment and execution of construction agreement to complete the identified infrastructure upgrades.

[1] MVR = Molded Vacuum Recloser
[2] DCC = Distribution Control Center
[3] LTC = Load Tap Changer as a component part of Substation Transformer bank #2

6 Transmission Owner Analysis

6.1 Power Flow Analysis

The output of the proposed 3.0 MW photovoltaic generation facility in Freehold Borough NJ represents 24% of the recent peak in load and 147% of the minimum daytime load on the distribution circuit feeding this PV facility. At minimum daytime load, this proposed generation facility represents 100.7% of substation transformer loading causing a reverse power flow through the substation transformer.

This is a summer peaking circuit and accordingly, the peak customer loads are experienced in July through September, due to customer air conditioning and lighting loads. The circuit exhibits a minimum circuit customer load during the months of February and March in any given year.

The proposed system will back-feed onto our 34.5 KV sub transmission system during light load periods. Two distribution line capacitor locations on the circuit serving the generating facility have been identified @ poles JC4338FRT and BT2842FRT. These locations will require the addition of programmable capacitor controls capable of voltage override control.

Customer generation must not interfere or degrade the quality of service to any other JCP&L/FE customers (service voltage, voltage flicker, harmonics, service reliability etc.). If excessive voltage harmonic and current distortion, high or low voltage or objectionable flicker arises due to the normal operation or frequent starting and stopping of the customer generation, the IC may be required to disconnect its generation equipment from FirstEnergy system until the problem is fully resolved.

6.2 Short Circuit Analysis:

The available fault current on the existing 12.47KV distribution system at pole JC1297FRT, without the proposed generation, is calculated to be 3271 Amperes for 3 phase fault L-L-L to ground and 2717 Amperes L to Ground.

PJM performed a short circuit analysis and the results were verified by FE. The connection of AE2-056 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.

6.3 Stability Analysis

Not applicable for this project.

7 Interconnection Customer Requirements

7.1 System Protection

An electronic recloser is required to maintain the same level of protection and reliability to 1808 existing JCP&L customers. The existing ABB main line recloser will be replaced at pole BT2844FRT. Electronic recloser as specified will maintain the current level reliability performance for the Howell 47050 circuit. JCP&L will provide (3) 140-K pole mounted fuse links at the POI for the Solar System on Pole BT2844FRT.

7.2 Power Quality

The connected facility shall comply with harmonic voltage and current limits specified in IEEE Standards as they now exist. These IEEE standards include, but not limited to: 141-1992[4], 519-1992 and 1453-2004. To provide continuous monitoring of Power Quality performance, JCP&L will require the installation of a Power Quality Meter (SEL-735 with intermediate PQ option) to monitor and capture power quality information, and the provision of a communications circuit, to permit ongoing assessment of compliance. This unit will be installed at the circuit breaker dedicated to the interconnecting system.

7.3 Power Factor

Interconnection Customer shall design its generation facility to operate at unity power factor with a power inverter capable of varying its power factor from 0.95 leading to 0.95 lagging measured at the high side of the facility substation transformers.

[4] IEEE Standard 141-1993, IEEE Recommended Practice for Electric Power Distribution for Industrial Plants, The Institute of Electrical and Electronics Engineers, Inc. 345 East 47th Street, New York, NY 10017-2394, USA

8 Revenue Metering and SCADA Requirements

8.1 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.

8.2 JCPL Requirements

This project will be metered separately, and the IC shall provide the required communication link for the meter data directly to PJM. All costs associated with the meter upgrades shall be the responsibility of the IC. IC shall provide, at its sole cost and expense, the installation, operation, and maintenance of the communication link(s) required by JCP&L billing data collection system. First Energy shall provide, own, operate, test and maintain the revenue metering at the IC's expense. The IC will be require 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

9 Compliance Issues and Interconnection Customer Requirements

The proposed Customer Facilities must be designed in accordance with FE's "Distribution Engineering Practices – Interconnection of Customer-Owned Generation to the FirstEnergy Distribution System" 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 [PRI POI VOLTAGE] circuit breaker to protect the AE2-056 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 AE2-056 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.

9.1 Additional requirements:

- IC's main breaker shall have an SEL 351 electronic relay which is required for interconnection protection. This relay must have the capability to measure reverse power. The main breaker must be on the high side of the IC's transformer. All equipment, breakers, lightning protection, etc., should meet JCP&L/FE's minimum BIL Ratings.

- IC must not interfere with the proper operation of the distribution system, including causing power quality problems, the detection and clearing of faults on the First Energy system.

- IC must meet all applicable JCP&L/FE standards and requirements which are included in the current JCP&L Tariff for Electric Service.

- IC's inverter-based generation must be UL listed or certified to comply with the requirements of IEEE 1547. JCP&L will require a witness test of this functionality.

- IC may be required to implement inverter controls that will ramp the A/C output up to the maximum output over a 5 minute period due to the large capacity of the solar generation.

- IC shall design its interconnection protection scheme to prevent the generation facility from being connected to a de-energized FirstEnergy circuit. The generation facility shall not reconnect to the FirstEnergy system following a trip from a system protection device, until the FirstEnergy system has been re-energized and recovered to within the acceptable voltage and frequency limits for a period of 5 minutes.

- IC must meet applicable "Technical Requirements for the Interconnection of Parallel Operated Generation to the JCP&L/FE Distribution System".
  https://www.firstenergycorp.com/content/dam/feconnect/files/wholesale/DG-Tech-Requirements.pdf

- The IC's transformer must be grounded Wye to grounded Wye.

- All Rights of Way (ROW) are the responsibility of the IC to obtain. The IC will be responsible for providing all easements, properties and permits that may be required to construct the associated facilities. The schedule above is based on the assumption 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 any necessary permits, and that PJM will allow all transmission system outages when requested."

All necessary permitting at local and State level is the responsibility of the IC.

10 Network Impacts

The Queue Project AE2-056 was evaluated as a 3.0 MW (Capacity 1.6 MW) injection at the Howell 34.5kV substation in the JCPL area. Project AE2-056 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-056 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Load Flow

11 Generation Deliverability

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

None

12 Multiple Facility Contingency

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

None

13 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 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

15 Steady State Voltage Requirements

None

16 Stability

Not required for this project.

17 System Reinforcements:

None

18 Light Load Analysis

Not required for solar projects.

19 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

20 Affected Systems

20.1 LG&E

None

20.2 MISO

None

20.3 TVA

None

20.4 Duke Energy Progress

None

20.5 NYISO

None

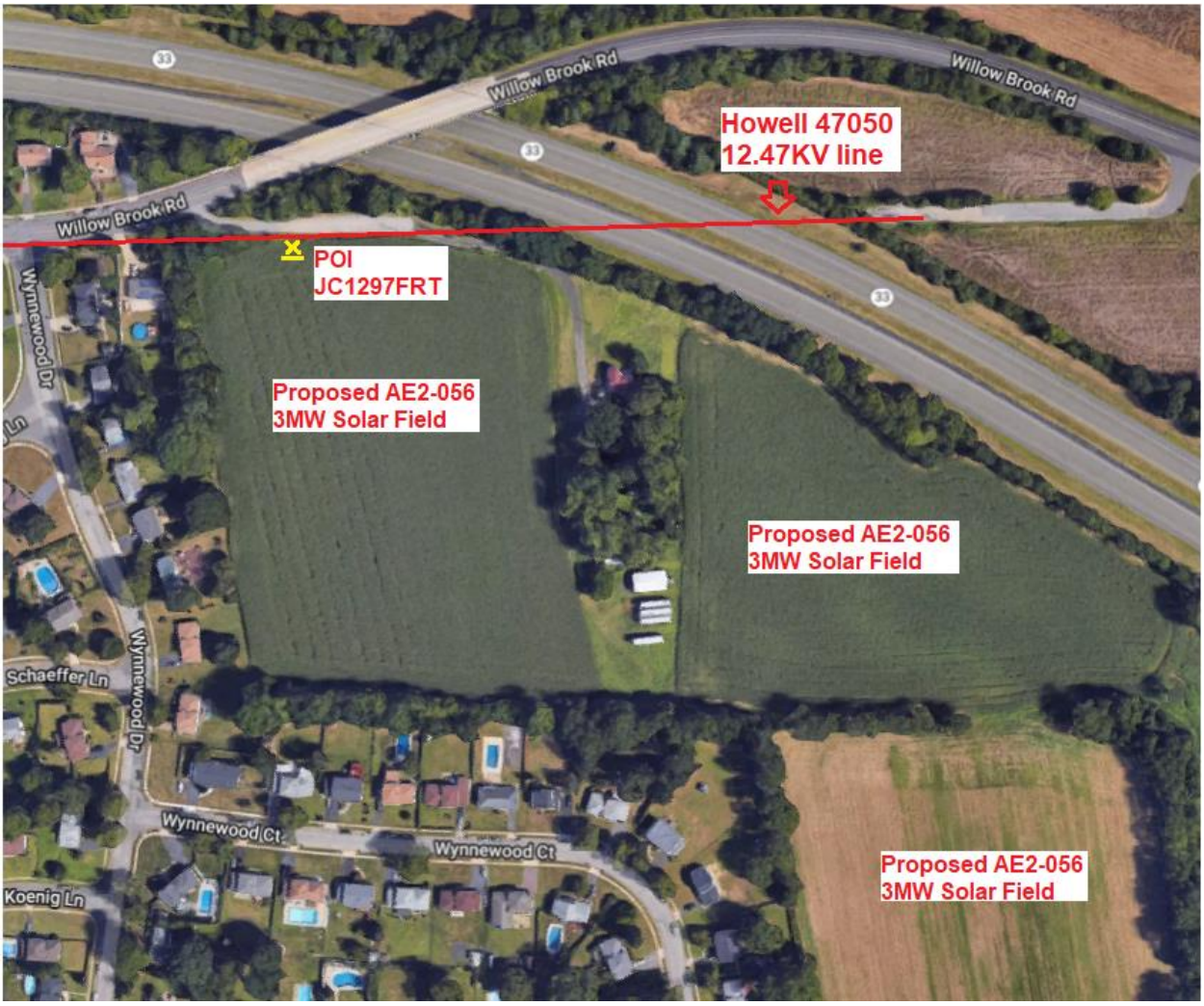
Short Circuit

21 Short Circuit

The following Breakers are overduty:

None

22 Attachment 1: Point of Interconnection



23 Attachment 2: One Line Diagram