Generation Interconnection Combined Feasibility/System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AE1-081

"Landing 12.47 kV Solar"

0.96 MW Capacity / 2.3MW Energy

January 2019

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 Section 8 of PJM 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.

General

ACCP NJ Solar I LLC, the Interconnection Customer (IC), has proposed to a new solar generating facility located at 400 Durban Avenue, Hopatcong, New Jersey 07843 (Sussex County). The installed facilities will have a total capability of **2.3 MW** with **0.96 MW** of this output being recognized by PJM as capacity. The proposed in-service date for this project is **December 31, 2020**. **This study does not imply a Jersey Central Power and Light Company (JCPL) commitment to this in-service date.**

Final attachment facilities and local upgrades (if required) along with terms and conditions to interconnect AE1-081 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.

Point of Interconnection (POI)

This area is presently served by the Landing Circuit 17740, 3 phase 12.47 KV grounded wye distribution circuit originating from JCP&L's Landing Substation located in Roxbury Township New Jersey, 07850. The POI to the AE1-081 project is to be established at 400 Durban Avenue, Hopatcong, New Jersey 07843.

See "One Line" in **Attachment 1** and "Site Plan" in **Attachment 2.**

Cost Summary:

Total estimated costs for the **AE1-081** project are **$174,600**. This cost includes a Federal Income Tax Gross Up charge of $23,660. This tax may or may not be charged based on whether or not this project meets the eligibility requirements of IRS Notice 88-129.

In addition to the costs for the physical interconnection point above, the **AE1-081** project may be responsible for a contribution to the following costs:

Description	Total Cost
New System Upgrades	$ 0
Previously Identified Upgrades	$ 0
Total Costs	**$ 0**

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

JCPL Connection Facility Requirements:

Main Line: Primary conductor line extension will be required.

- Construct a 3-Phase overhead primary line extension of one span off existing pole JC61038HO 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. $ 6000.
- Install two new Elastimold™ MVR[1] (Reclosers) with SEL 651R controls. Cost including engineering / programming. $ 75,000
- Upgrade of two Capacitor controls with field and engineering time. $6000
- 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: $3,500.

Substation: The proposed system will back-feed to our 34.5 KV sub-transmission system during light load periods. This will require engineering labor to re-program LTC[3] control and protective relays on the substation transformer, Landing Transformer Bank 1.

- Substation upgrade cost – Engineering labor for programming electronic substation relays and LTC Control: $ 20,000.

All JCPL costs are not subject to refundable 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.

Timetable for Construction:

- JCP&L estimates it will require 9 months from payment and execution of the Interconnection 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 #1

JCPL Interconnection Requirements

The proposed interconnection facilities must be designed in accordance with the FirstEnergy "Interconnection of Customer-Owned Generation to the FirstEnergy Distribution System" document:

https://pjm.com/-/media/planning/plan-standards/private-fe/generation-interconnection-technical-requirements-for-distribution-connected-facilities.ashx?la=en

JCPL Analysis Results

Power Flow Analysis

The output of the proposed 2.3 MW photovoltaic generation facility in Hopatcong Borough NJ represents 39% of the recent peak in load and 140% of the minimum daytime load on the distribution circuit feeding this PV facility. At minimum daytime load, this proposed generation facility represents 140% of substation transformer loading causing a reverse power flow through the substation transformer. The Landing Bank 1 transformer currently only serves this circuit.

This is a Winter peaking circuit and accordingly, the peak customer loads are experienced in January and February, due to customer heating and lighting loads. The circuit exhibits a minimum circuit customer load during the months of April and September 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 BT1244HO and BT2708HO. These locations will require the addition of programmable capacitor controls capable of voltage override control. The system voltage desired nominal value as normalized to 120 volts +/- 5%, is described in the NJ Administrative Code by the NJBPU for all EDC's[4] in New Jersey. Refer to "§14:5-3.2 Adequacy of service" dated July 17, 2015.[5]

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.

[4] EDC's = Energy Delivery Companies
[5] https://www.state.nj.us/bpu/pdf/rules/R%202015%20d%20138%20(47%20NJR%202165(c)).pdf

Short Circuit Analysis:

The available fault current on the existing 12.47KV distribution system at the primary POI[6] @ fuse pole JC61038HO, without the proposed generation, is calculated to be 1933 Amperes for 3 phase fault L-L-L to ground and 1344 Amperes L to Ground.

Stability Analysis

Not applicable for inverter-based generation.

System Protection

To provide the same or similar levels of reliability to 285 existing JCP&L customers, with a nominal peak load of 1 MVA on the same lateral serving the proposed solar installation, two existing main line fuses at poles NJ1952HO and NJ731HO' will require installation of electronic reclosers. Due to limited range of standard fuse link sizes, the electronic reclosers are required to maintain the same level of protection and reliability. New electronic reclosers are required for proper coordination of downstream line fault conditions. Electronic reclosers as specified will maintain the current level of CEMI[7] performance for the Landing 17740 circuit. JCP&L will provide (3) AB Chance Type 140-K pole mounted fuse links at the POI for the Solar System on Pole JC61038HO.

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[8], 519-1992[9], and 1453-2004[10].. 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.

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.

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[6] POI = Point of Interconnection

[7] CEMI = Customers Experiencing Multiple Interruptions

[8] 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

[9] IEEE Standard 519-1992, IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems, The Institute of Electrical and Electronics Engineers, Inc. 345 East 47th Street, New York, NY 10017-2394, USA

[10] IEEE Standard 1453-2004, IEEE Recommended Practices for Measurement and Limits of Voltage Fluctuations Associated with Light Flicker on AC Power Systems, The Institute of Electrical and Electronics Engineers, Inc. 345 East 47th Street, New York, NY 10017-2394, USA

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 Attachment O, Appendix 2, Section 8.

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 Metering 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.

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 12.5 kV circuit breaker to protect the AE1-081 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 AE1-081 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.

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 (Borough and County) and State level is the responsibility of the IC

Network Impacts (Transmission Results)

The Queue Project AE1-081 was evaluated as a 2.3 MW (Capacity 0.96 MW) injection onto Landing 34.5 kV Substation bus in the JCPL zone. Project AE1-081 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE1-081 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Analysis - 2022

Generator 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

Steady-State Voltage Requirements
(Results of the steady-state voltage studies should be inserted here)

None

Short Circuit
(Summary of impacted circuit breakers)

None

Affected System Analysis & Mitigation

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. 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 will study all overload conditions associated with the overloaded element(s) identified.

None

Light Load Analysis - 2022

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

Not required.

System Reinforcements

Short Circuit
(Summary form of Cost allocation for breakers will be inserted here if any)

None

Stability and Reactive Power Requirement
(Results of the dynamic studies should be inserted here)

None

Summer Peak Load Flow Analysis Reinforcements

New System Reinforcements
(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)

None

Contribution to Previously Identified System Reinforcements
(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)
(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

None

Light Load Load Flow Analysis Reinforcements

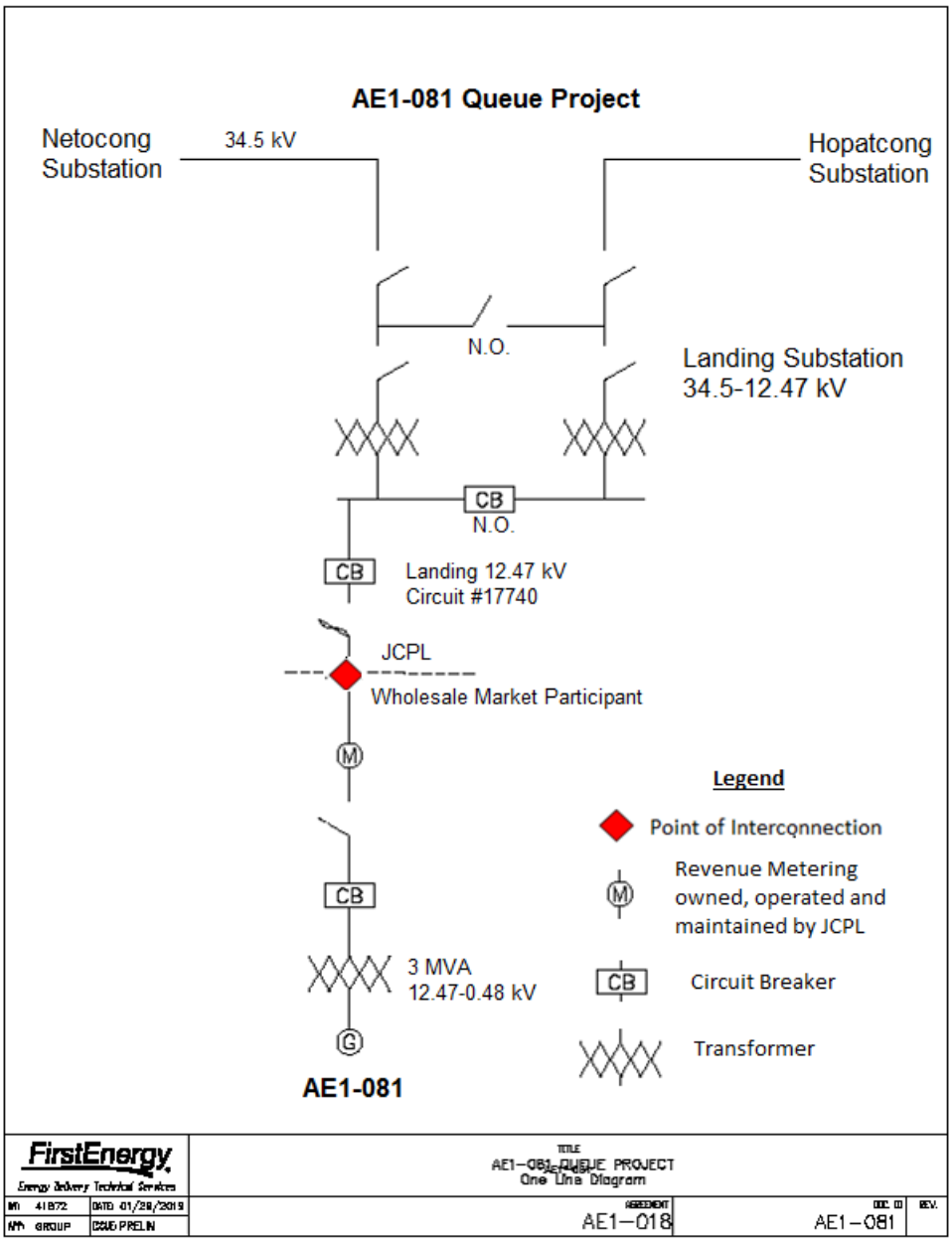
New System Reinforcements
(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)

None

Contribution to Previously Identified System Reinforcements
(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)
(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

None

Attachment 1. AE1-081 'Landing 12.47 kV Solar'
One Line Diagram



Attachment 2. Site Location

400 Durban Avenue, Hopatcong, New Jersey (Sussex County)