Generation Interconnection Combined Feasibility/System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AC1-018

"Morris Park 12.47 kV"

July 2017

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 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

HCE Strykers Road Solar, LLC, the Interconnection Customer (IC), has proposed a solar generating facility located at 190 Stryker Road, Phillipsburg, New Jersey. The installed facilities will have a total capability of **1.4 MW** with **0.5 MW** of this output being recognized by PJM as capacity. The proposed in-service date for this project is **December 31, 2016**. **This study does not imply a Jersey Central Power & Light (JCPL) commitment to this in-service date.**

Point of Interconnection

This area is presently served by Morris Park Circuit 27051, 3 phase 12.47 grounded wye distribution circuit originating from JCPL's Morris Park Substation located about **1.9 Miles** from the proposed **AC1-018 "Morris Park 12.47 kV"** site. The output of the proposed 1.4 MW photovoltaic generation facility (Capacity 0.5 MW) represents 21% of the recent peak in load and 85% of the minimum daytime load on the distribution circuit feeding this PV facility. At minimum daytime load, this proposed generation facility represents 40% of substation transformer loading this will not result in a reverse power flow through the substation transformer. Refer to **Attachment 1A** for site location.

Cost Summary

The **AC1-018** project will be responsible for the following costs. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
Attachment Facilities	$ 86,500
Direct Connection Network Upgrades	$ 0
Non Direct Connection Network Upgrades	$ 0
New System Upgrades	$ 0
Previously Identified Upgrades	$ 0
Total Costs	**$ 86,500**

The required Attachment Facilities, Direct Connection, and Non-Direct Connection work for the interconnection of the AC1-018 generation project to theJCPL Transmission System is detailed in the following sections. The associated one-line is shown in **Attachment 1B**.

The above costs do not include taxes. A Federal Income Tax Gross Up charge of 15.23% will be included to the amount above. This tax may or may not be charged based on whether or not this project meets the eligibility requirements of IRS Notice 88-129. It is accurate to within plus or minus 30 percent.

- The cost to construct 3-Phase overhead primary line extension with a new tap pole NJ1234LX and 100K fuses and conductors is $63,500.
- Metering cost - JCPL installing CTs and PTs: $ 20,000.
- Engineering review and site commissioning: $3,000.
- 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 JCPL 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.

Attachment Facilities

AC1-018 "Morris Park 12.47 kV" will interconnect to the JCPL transmission system at a approximately 1.9 miles from the Morris Park Substation. The primary connection will be off the Morris Park Circuit 27051 distribution circuit:

Main Line: To accommodate the proposed 1.4 MW of generation, equipment upgrades on the incoming distribution line are not required. A set of 100 K fuses will be installed on a JC Tap pole NJ1234LX. The metering will be installed on Interconnection Customer (IC) owned pole along with 65 K fuses that are IC owned. The 65 k fuses will coordinate from IC back to the Morris Park substation. The IC will be responsible for acquiring all easements, properties and permits that may be required to construct the associated facilities. (See **Attachments 1A and 1B**)

At Substation:
Equipment upgrades at the Morris Park substation are not required.

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
Construct 3-Phase overhead primary line extension with a new tap pole NJ1234LX and 100K fuses and conductors	$63,500
Metering cost - JCPL installing CTs and PTs	$20,000
Engineering review and site commissioning	$ 3,000
Total Attachment Facilities Cost	**$86,500**

The PJM Network Upgrade Number for this work is **n5226**.

Direct Connection Cost Estimate

None.

Non-Direct Connection Cost Estimate

None.

Interconnection Customer Requirements

In addition to the JCPL facilities, HCE Strykers Road Solar, LLC will also be responsible for meeting all criteria as specified below:

Metering and Communications

The bidirectional revenue meter provided and installed by JCPL will record billing data in fifteen minute intervals. Customer shall provide, at its sole cost and expense, the installation, operation, and maintenance of the communication link(s) required by JCPL billing data collection system for access to the meter.

For more details on JCPL metering requirements, refer to the FE "Generator Interconnection Technical Requirements for Distribution Connected Facilities" document located at the following link:

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

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: 141-19921, 519-19922, and 1453-20043.. To provide continuous monitoring of Power Quality performance, JCPL 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

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[1] 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

[2] 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

[3] 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

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 Point of Interconnection.

Anti-Island Protection

The proposed generation facility must be equipped with adequate interconnection relay protection to detect an island condition and disconnect from the JCPL/FE distribution system within two seconds of the formation of an island (per IEEE 1547).

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 JCPL/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 JCPL/FE standards and requirements which are included in the current JCPL Tariff for Electric Service.

- IC's inverter-based generation must be UL listed or certified to comply with the requirements of IEEE 1547. JCPL 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 JCPL/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 execution of a back-up service agreement to serve the customer load supplied from the AC1-018 generation project metering point when the units are out-of-service

Schedule

JCPL estimates it will require **6 months** from the time the IC acquires all easements, properties, and permits.

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 Sections 24.1 and 24.2.

JCPL Requirements

HCE Strykers Road Solar, LLC will be required to comply with all FE revenue metering requirements for generation interconnection customers. The FE revenue metering requirements may be found in the FE "Generator Interconnection Technical Requirements for Distribution Connected Facilities" document located at the following link:

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

Compliance Issues

The proposed interconnection facilities must be designed in accordance with the FE "Generator Interconnection Technical Requirements for Distribution Connected Facilities" document located at:

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

HCE Strykers Road Solar, LLC will also be responsible for following the requirements of the FE "Approved Vendors and Contractors" document which is also located at the above link.

HCE Strykers Road Solar, LLC will also be required to meet all PJM, ReliabilityFirst and NERC reliability criteria and operating procedures for standards compliance. For example, HCE Strykers Road Solar, LLC 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 JCPL systems.

JCPL Analysis:

Short Circuit Study:

The available fault current on the existing 12.47KV distribution system at the primary terminals of the pad mounted transformer, without the proposed generation is calculated to be 3,592 Amperes for 3 phase and 3,216 Amperes for single line to ground.

Voltage Study:

The proposed system will not back feed onto our 34.5 KV sub transmission system during light load periods. Analysis shows no adverse impact on the JCPL circuit voltage profile as a result of the interconnection of the proposed generation.

Customer generation must not interfere or degrade the quality of service to any other JCPL/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.

Control Systems:

Generator interconnection is rated 1.4 MW, therefore no SCADA control system required.

Due to the relatively low output capacity versus minimum loading on the circuit, Direct Transfer Trip will NOT be required for the proposed interconnection. The power that is injected will decrease the load on the 27051 circuit, but is not expected to cause a reverse power flow condition on Morris Park substation transformer.

Network Impacts (PJM):

The **Queue Project AC1-018** was evaluated as a **1.4 MW** (Capacity **0.5 MW**) injection at the Morris Park 34.5kV substation in the JCPL area. Project AC1-018 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC1-018 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Analysis - 2020

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

NYISO Impacts:

None

Delivery of Energy Portion of Interconnection Request
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.

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 - 2020

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

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 Flow Analysis Reinforcements

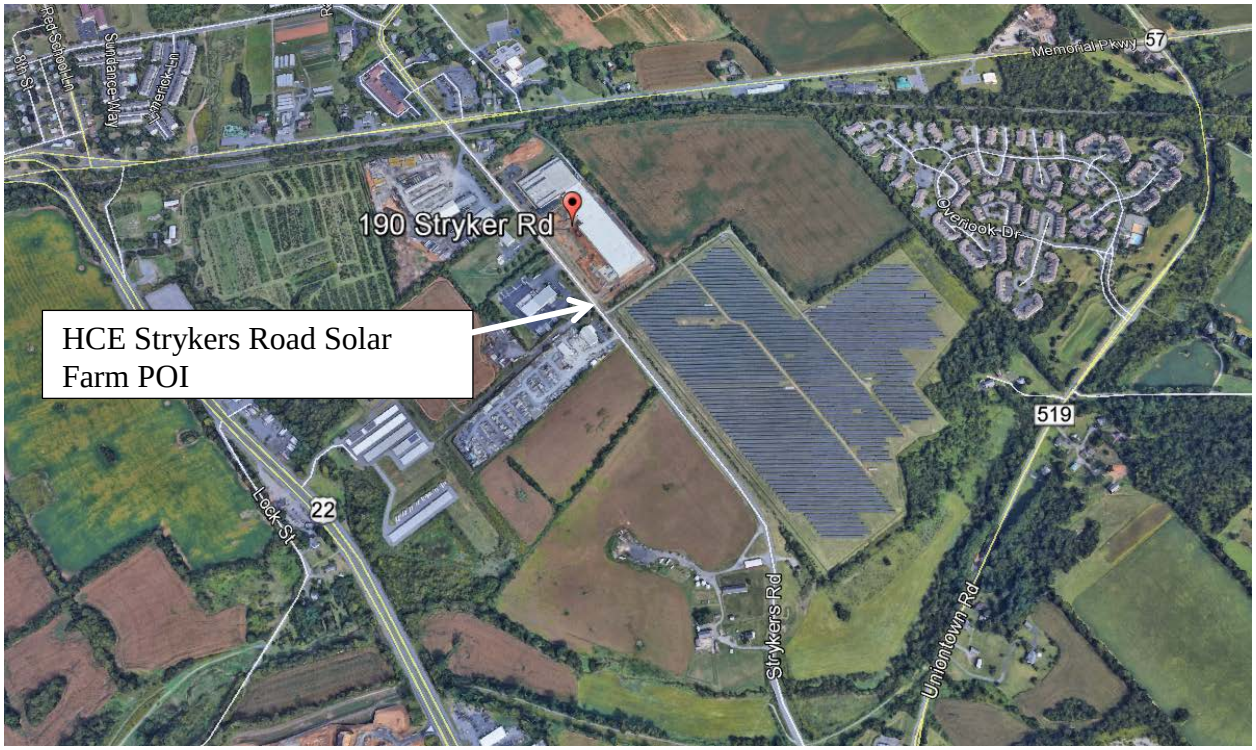
New System Reinforcements
(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)

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 1A
SITE PLAN



Attachment 1B
Project Location
"Morris Park 12.47 kV" (AC1-018) Generation Project