Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AD2-210

“Cedar Knolls 12.5 kV”

0 MW Capacity / 2 MW Energy

July 2018

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 users, e.g. another generation interconnection, 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 will be deferred until the impact study is performed.

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 new battery storage generating facility to be located at 53 South Jefferson Road, Whippany, Hanover Township, NJ 07981. The installed facilities will have a total capability of **2 MW** with **0 MW** of this output being recognized by PJM as Capacity. The proposed in-service date for this project is **March 15, 2019**. **This study does not imply a Jersey Central Power & Light (JCPL) commitment to this in-service date.**

New Facilities	
Capacity:	0 MW
Energy:	2 MW
MFO:	2 MW
Fuel:	Storage

Point of Interconnection

The IC requested the study of a primary Point of Interconnection (POI) only for this project. The proposed **AD2-210 "Cedar Knolls 12.5 kV**" generation project is located 0.5 miles from the JCP&L Cedar Knolls Substation and will connect to the 37789 feeder at 12.47 KV wye. JCP&L will install one span of primary wire to a new IC (Interconnection Customer) owned distribution pole. This will be the POI and serve a new IC owned 2200 KVA (12.47 KV / 277-480 V) pad mount transformer for the battery storage facility. The IC will be responsible for acquiring all

easements, properties and permits that may be required to construct both the associated attachment facilities.

Attachments 1 and 1A show one-line diagrams of the proposed primary direct connection of the (AD2-210) generation project to the Jersey Central Power & Light transmission systems. **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 line.

Cost Summary

The **AD2-210 "Cedar Knolls 12.5 kV"** project will be responsible for the following costs. These costs do not include CIAC Tax Gross-up:

Description	Total Cost
Attachment Facilities	$ 85,000
Direct Connection Network Upgrades	$ 0
Non Direct Connection Network Upgrades	$ 0
Total Costs	**$ 85,000**

In addition, the AD2-210 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**

The transmission and substation costs given above exclude any applicable state or federal taxes. If at a future date Federal CIAC (contribution in aid of construction) taxes are deemed necessary by the IRS for this project, JPCL shall be reimbursed by the Interconnection Customer for such taxes. JPCL estimates the tax, if applicable, would be approximately **$13,600**.

The required Attachment Facilities, Direct Connection, and Non-Direct Connection work for the interconnection of the AD2-210 generation project to the JCPL Transmission System is detailed in the following sections. The associated one-lines with the generation project attachment facilities are shown in Attachments 1 and 1A.

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. It is accurate to within plus or minus 25 percent. Should the customer want to proceed with the connection of this facility, a contract with JCP&L 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

To accommodate the proposed AD2-210 Project, JCP&L will install one span of primary wire to a new IC (Interconnection Customer) owned distribution pole. This will be the POI and serve a new IC owned 2200 KVA (12.47 KV / 277-480 V) pad mount transformer for the battery storage facility. The IC will be responsible for acquiring all easements, properties and permits that may be required to construct both the associated attachment facilities.

The total preliminary cost estimate for the Attachment Facilities work is given in the table below. These costs do not include Federal Income Tax Gross-up.

Description	Total Cost
Install disconnect switch and extend one span of primary to IC owned riser pole	$ 9,000
Primary Metering- JCPL owned and installed on IC pole	$ 23,000
Upgrade upstream fuse to 200 K link	$ 3,000
Upgrade circuit egress	$ 30,000
Provide SCADA interface to JCPL EMS	$ 17,000
Engineering, Review and Commissioning	$ 3,000
Total Attachment Facility Costs	**$ 85,000**

Direct Connection Cost Estimate

There is no Direct Connection scope of work required for this project.

Non-Direct Connection Cost Estimate

There is no Non-Direct Connection scope of work required for this project.

Schedule

Based on the scope of the direct connection, it is expected to take a minimum of **four months (4)** from the date of fully executed applicable agreements to complete the installation required for the Project. Full payment of the estimated cost of the project will be required upon execution of the necessary agreement(s). A true up of the actual cost versus estimated cost of the project will be performed by FE at the end of the project.

The schedule 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. Full payment of the estimated cost of the project will be required upon execution of the necessary agreement(s). A true up of the actual cost versus estimated cost of the project will be performed by FE at the end of the project.

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.

JPCL Requirements

Battery Storage Facility to be metered separately and the IC shall provide the communication link required for the revenue meter data directly to PJM and JCP&L. The IC must meet the requirements of PJM and JCP&L. Please see Attachment 3 for meter requirements. Additionally a SCADA interface of the Battery Storage System to JCP&L EMS will be required.

Work Requirements to interconnect proposed project:

Main Line

Due to the rated charging capacity of the project creating an overload of the existing distribution circuit egress cables, JCP&L will require an upgrade of the distribution egress on circuit 37789 at Cedar Knolls Substation.

At Substation

JCP&L will require upgrades at the substation transformer LTC (Load tap changer) control.

At Battery Storage Facility:

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

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: 141-9921, 519-19922, and 1453-20043.. To provide continuous monitoring of Power Quality performance,

[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

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 Battery Energy Storage System.

Anti-Island Protection

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

Additional requirements:

IC must meet all PJM, Reliability First and NERC reliability criteria and operating procedures required 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 Reliability First 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

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

IC's main breaker shall have a SEL 351 Multi-function relay (or equivalent) which is required for interconnection protection. This relay must have the capability to measure Reverse Power.

All breakers, lightning protection etc. should meet JCP&L/FE's minimum BIL Ratings.

The Battery Storage System must not interfere with operation of FE voltage line regulating equipment including voltage regulators, line capacitors and substation LTC.

IC must meet applicable FE Technical Standards and Requirements for Distribution Connected Facilities which can be found under:

http://www.pjm.com/~/media/planning/plan-standards/private-fe/generation-interconnection-technical-requirements-for-distribution-connected-facilities.ashx

Frequency response systems participating in the PJM Ancillary Services Market respond to an automatic signal from PJM in order to correct for short-term changes in electricity use that might affect the stability of the power system by matching generation and load to maintain system frequency. Consequently, because of the magnitude and frequency of load changes, additional analysis is required during the review process.

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[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

Presence of frequency response may significantly increase costs to reconfigure system to accommodate future load growth or inhibit / prevent system reconfiguration. Additional costs to reconfigure system because of frequency response may be passed on to IC or Frequency Response may be required to cease interconnection operations.

Customer generation shall be capable of maintaining Power Factor between .95 leading to .95 lagging measured at the Point of Interconnection. JCP&L may require customer generation to absorb vars after the generation is operational.

Distributed generation must not interfere or degrade the quality of service to any other FirstEnergy Corp. customers (service voltage, voltage flicker, harmonics, service reliability etc.)

IC must install, operate, test and maintain the metering for battery storage facilities used in PJM's frequency regulation market and settled via PJM's ancillary market. JCP&L will own and install retail revenue metering at the IC expense.

The above requirements are in addition to any metering required by PJM.

JCPL Analysis:

Control Systems

Due to the relatively low output capacity versus minimum loading on the circuit, Direct Transfer Trip will NOT be required for the proposed generation. The proposed 2000 KW of rated BESS generated capacity will be injected to the circuit at the POI. This power injection will decrease the load on the circuit serving this area but is not expected to cause a reverse power flow condition on the substation transformer.

Short Circuit Study

The available 3 phase fault current on the existing distribution system in this area without the project is 7,021 amps and 6,534 amps line to ground. The addition of the proposed project will require upgrades to the upstream protection devices.

Voltage Study

Distribution circuit analysis calculates the potential dynamic voltage changes to be less than a 1 % deviation from full charge to full discharge on the existing 12.47 kV primary system at peak and light load. This level of primary voltage deviation is within acceptable limits.

System Protection

The IC must design it's 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.

The IC has requested a non-standard GSU transformer winding configuration. This transformer is in violation of section 14.2.6 of FE's "Requirements for Transmission Connected Facilities" document and will not be accepted. The GSU transformer must have a grounded wye connection on the high (utility) side and a delta connection on the low (generator) side.

Network Impacts

The Queue Project AD2-210 was evaluated as a 2.0 MW (Capacity 0.0 MW) injection at the Cedar Knoll 34.5kV substation in the JCPL area. Project AD2-210 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD2-210 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis - 2021

Generator Deliverability

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

None

Multiple Facility Contingency

(Double Circuit Tower Line contingencies were studied for the full energy output. The contingencies of Line with Failed Breaker and Bus Fault will be performed for the Impact Study.)

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

(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

To be determined in the Impact Study Phase.

Short Circuit

(Summary of impacted circuit breakers)

PJM Analysis of transmission system: No circuit breakers are overdutied.

JCPL Analysis of lower voltage system: The available 3 phase fault current on the existing distribution system in this area without the project is 7,021 amps and 6,534 amps line to ground. The addition of the proposed project will require upgrades to the upstream protection devices.

Affected System Analysis & Mitigation

(Summary of impacts on systems external to PJM)

NYISO Impacts:

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

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.

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

Light Load Analysis

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

Stability and Reactive Power Requirement for Low Voltage Ride Through

(Summary of the VAR requirements based upon the results of the dynamic studies)

To be determined in the Impact Study phase.

System Reinforcements

Short Circuit

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

To be determined in Impact Study Phase

Stability and Reactive Power Requirement

(Results of the dynamic studies should be inserted here)

To be determined in Impact Study Phase

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. AD2-210 ‘Cedar Knolls 12.5 kV’ One Line Diagram

Attachment 1A. AD2-210 'Cedar Knolls 12.5 kV' Schematic Diagram

Attachment 2. AD2-210 ‘Cedar Knolls 12.5 kV’
Site Location

Attachment 3. AD2-210 'Cedar Knolls 12.5 kV' Behind the Meter Generation Facilities Participating in the PJM or Wholesale Energy Markets

The revenue metering requirements will be reviewed by FirstEnergy (FE) on a case-by-case basis.

In general, the FE Operating Company (FEOC) shall continue to own, operate, test, and maintain the existing revenue metering equipment per the applicable retail tariff or interconnection service agreement.

The Interconnection Customer (IC) must provide FE with a facility one line and the estimated bi-directional power flow at the existing FEOC metering point.

The existing FEOC billing meter at these locations will be replaced with a bi-directional revenue meter and the FEOC metering current transformers will be replaced with higher capacity units if required. This work will generally be completed at the IC's expense.

The bi-directional revenue meter provided and installed by the FEOC will record billing data in intervals of typically fifteen or thirty minutes. If applicable, the IC shall continue to provide, at its sole cost and expense, th communication link required by the FE billing data collection system for access to the meter.

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.

The FEOC will provide the IC access to bi-directional KWh and KVARh pulses from the FEOC meter at the IC's expense, if requested.

The IC shall provide FE with prior notification of any modifications at the facility that could affect the FEOC revenue meter measurements (substation reconfigurations, generator additions, etc.).