Generation Interconnection Combined Feasibility/System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AC2-175

"Berkshire Solar 12 kV"

August 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

HESP SOLAR, the Interconnection Customer (IC), has proposed **solar** generating facilities located at 12 Berkshire Ave, Mount Arlington, New Jersey. The installed facilities for the **AC2-175 "Berkshire Solar 12 kV"** request will have a total capability of **1.6 MW** with **0 MW** of this output being recognized by PJM as capacity.

The proposed in-service date for this project is **December 31, 2018**. **This study does not imply a Jersey Central Power & Light (JCP&L) commitment to this in-service date.**

Point of Interconnection:

The IC requested the study of a primary Point of Interconnection (POI) only for this project. This report contains detailed connection requirements, costs and schedule, power flow analysis, short circuit analysis, and a cost and schedule for any associated system reinforcements for the Primary POI.

The proposed POI for the **AC2-175 "Berkshire Solar 12 kV"** generation project will be located 4.16 miles from the JCP&L Landing Substation and will be connected to the Landing Circuit 17743 line at 12.47 kV, grounded wye configuration. The IC will be responsible for acquiring all easements, properties and permits that may be required to construct both the associated

attachment facilities. A conceptual one-line diagram of the proposed interconnection of AC2-175 is shown in **Attachment 1**. An aerial view of the proposed location of the facility is shown in **Attachment 2**.

Cost Summary

The **AC2-175 "Berkshire Solar 12 kV"** project will be responsible for the following costs. These costs do not include Federal Income Tax Gross-up:

Description	Total Cost
Attachment Facilities	$ 40,000
Direct Connection Network Upgrades	$ 0
Non Direct Connection Network Upgrades	$ 145,000
Total Costs	**$ 185,000**

In addition, the AC2-175 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 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 **$28,176**.

The required Attachment Facilities, Direct Connection, and Non-Direct Connection work for the interconnection of the AC2-175 generation project to the JCPL system is detailed in the following sections. The associated one-line with the generation project is shown in **Attachment 1**.

All JCP&L costs are not subject to refundable provisions of the NJ-BPU Tariff for Electric service. 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.

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 30% 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 AC2-175 Project, the Attachment Facility work includes metering installation and SCADA integration. The metering will be installed on the Interconnection Customer's (IC) owned pole along with 100 K fuses that are IC owned. The customer's RTU will be integrated into the FirstEnergy SCADA system in the Distribution Control Center (DCC). See Attachment 3 for SCADA requirements. 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 Facilities work is given in the table below. These costs do not include Federal Income Tax Gross-up.

Description	Total Cost
Engineering review and site commissioning	$ 3,000
Integrate customer RTU into FirstEnergy SCADA system in the Distribution Control Center (DCC)	$ 17,000
Primary Meter Installation	$ 20,000
Total Attachment Facility Costs	**$ 40,000**

The Attachment Facility cost estimate for the AC2-175 "Berkshire Solar 12 kV" project is approximately **$40,000**.

Direct Connection Cost Estimate

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

Non-Direct Connection Cost Estimate

JCP&L will reconductor the existing two (2) phase to three (3) phase 12.5 kV primary line (1,800 feet) to the facility originating at JCP&L pole NJ45MB. A set of 140 K fuses will be installed on JCP&L pole NJ45MB, and 100 K fuses on BT70017MB will be replaced with 300 Amp Solid Blades. A new set of 300 Amp Solid Blades will be installed at JCP&L pole BT70033MB. The IC will be responsible for acquiring all easements, properties and permits that may be required to construct the associated facilities.

JCP&L will not require any upgrade at the Landing substation.

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

Description	Total Cost
Install new set of 300 Amp Solids at BT70033MB. Upgrade existing 12.5 kV primary line (1,800 feet) along Berkshire Ave up to the facility. Replace 100K fuse link at pole BT70017MB with 300 A Solid Blades. Install 140K Fuse link at pole NJ45MB and manually operable disconnect switches at the interconnection point	$ 140,000
Reprogram existing main line distribution reclosers	$ 5,000
Total Attachment Facility Costs	**$ 145,000**

The Non-Direct Connection cost estimate for the AC2-175 "Berkshire Solar 12 kV" project is approximately **$145,000**.

Schedule

Based on the extent of the JCP&L primary direct connection required to support the AC2-175 generation project, it is expected to take a minimum of **9 months** from the date of fully executed applicable agreements to complete the installation required for the project. This schedule includes 3 months to complete the necessary design work packages and an additional 6 months to complete the identified infrastructure upgrades.

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.

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

Revenue metering will be owned, operated, and maintained by the Interconnection Customer. Operational metering will be owned, operated, and maintained by the party owning the metering and will be provided to PJM via ICCP.

HESP Solar 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

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

HESP Solar will also be required to meet all PJM, ReliabilityFirst and NERC reliability criteria and operating procedures for standards compliance. For example, HESP Solar 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 JCP&L system.

JCPL Analysis:

The Study scope is to identify any facility modifications needed to accommodate the installation of 1.6 MW of the AC2-175 Project at the POI described above. The output of the proposed 1.6 MW photovoltaic generation facility represents 17% of the recent peak in load and 32% of the minimum daytime load on the distribution circuit feeding this PV facility. At minimum daytime load, this proposed generation facility represents 18% of substation transformer.

Short Circuit Study:

The available fault current on the existing 12.47 kV distribution system at the primary terminals of the pad mounted transformer, without the AC2-175 Project proposed generation, is 4973 Amperes for 3 phase and 5715 Amperes for single line to ground.

Voltage Study:

Distribution circuit 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 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.

Control Systems:

The Generator interconnection shall provide access to Supervisory Control and Data Acquisition (SCADA) Remote Terminal Unit (RTU) which will be connected via dedicated digital cellular circuit to First Energy's System Control Center. The purchase and installation of SCADA equipment is required to provide information in a compatible format to the FE System Control Center. The RTU, the communications channel and all related equipment will be furnished and maintained by the Interconnection Customer (IC). The RTU must communicate with the FirstEnergy EMS via DNP 3.0 protocol. The SCADA requirements are listed in Attachment 3.

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 from the PV facility is not expected to cause a reverse power flow condition on the Landing substation transformer.

At Interconnection Customer (IC) Facility:

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[1], 519- 1992[2], and 1453-2004[3]. To provide continuous monitoring of Power Quality

[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 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

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 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 JCP&L/FE distribution system within two seconds of the formation of an island (per IEEE 1547).

Interconnection Customer 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.

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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

- 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 in 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 execution of a back-up retail service agreement with the electric distribution company to serve the customer load supplied from the (AC2-175) generation project interconnection point when the units are out-of-service.

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

Network Impacts

The Queue Project AC2-175 was evaluated as a 1.6 MW (Capacity 0.0 MW) injection at the Landing 34.5 kV substation in the JCPL area. Project AC2-175 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC2-175 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

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).

None

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

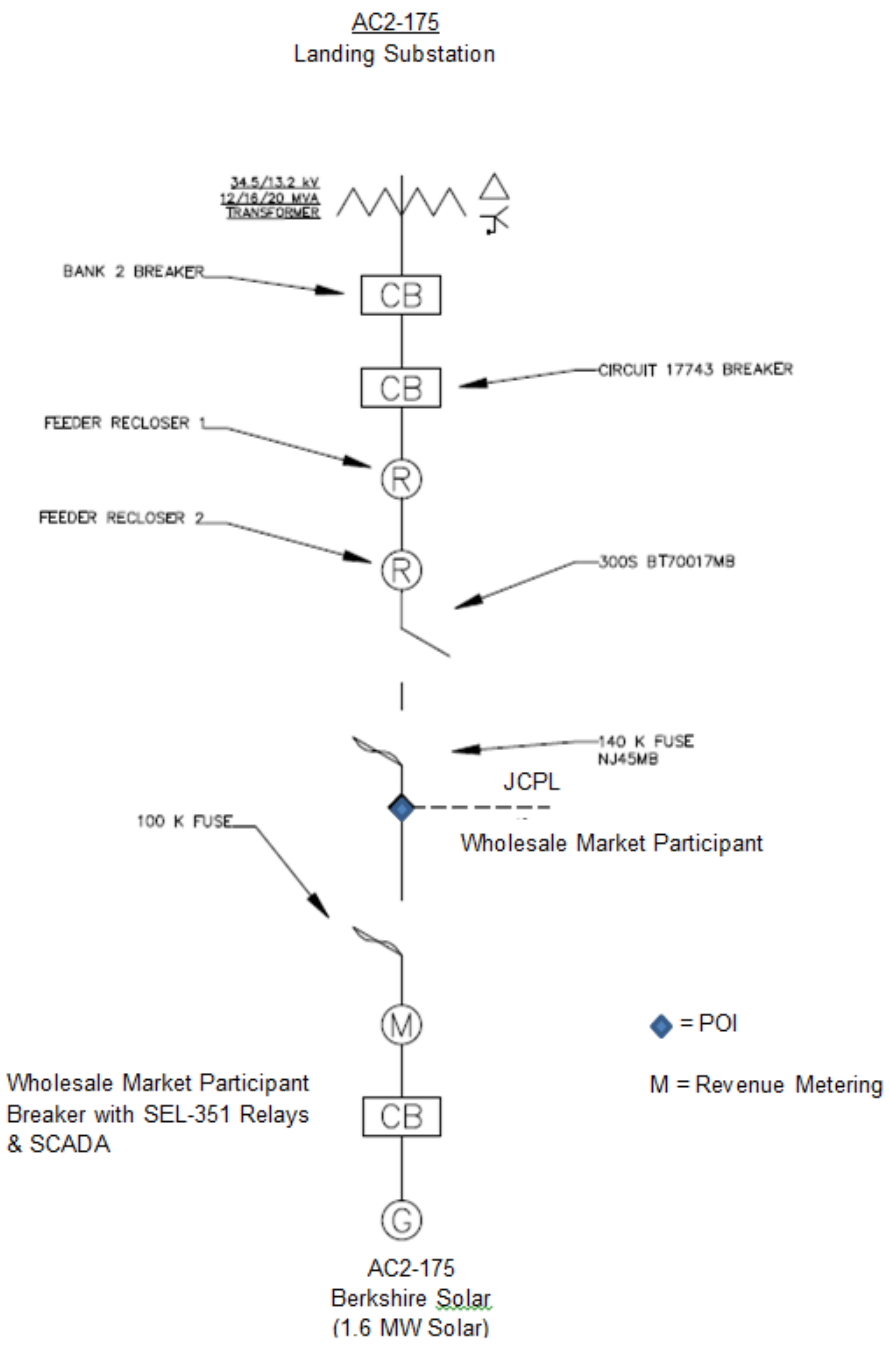
New System Reinforcements
(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)

None

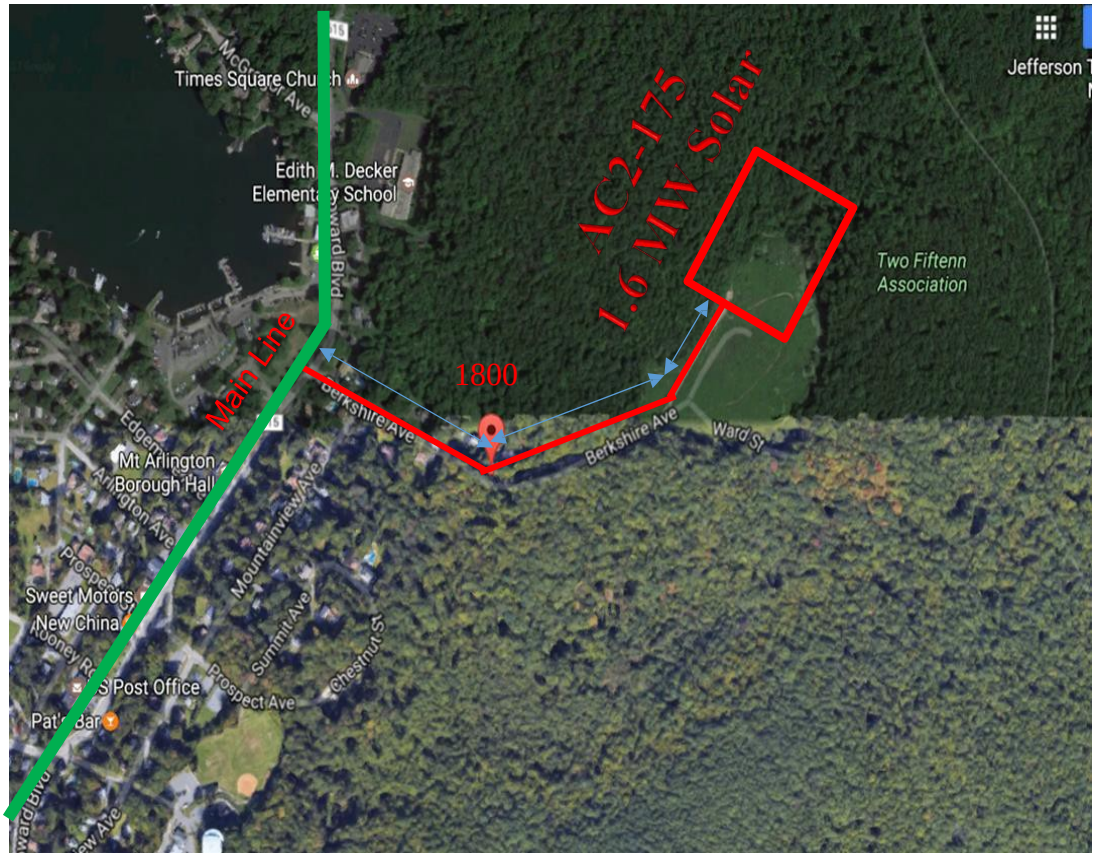
Contribution to Previously Identified System Reinforcements
(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)
(Summary form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

None

Attachment 1. One Line Diagram
Berkshire Solar 12 kV (AC2-175) Generation Project



Attachment 2. Project Location
Berkshire Solar 12 kV (AC2-175) Generation Project



Attachment 3.
Supervisory Control and Data Acquisition (SCADA) Requirements

SCADA Control System

The Developer will be responsible for designing, furnishing and installing a SCADA RTU system connected to its interconnection breaker and install the telecommunication circuits necessary for the RTU to provide information to the JCP&L's Regional Dispatch Office at:

Jersey Central Power &
Light 300 Madison Avenue

Morristown, New Jersey 07960-
1911 Main Directory Number: 973-
455-8200

The Developer must be responsible to have trained technical personnel on RTU equipment. This is necessary to have discussions with JCP&L RTU technicians. RTU technicians have a language of their own which requires trained personnel.

The information on the RTU will include, but not limited to:

1) Request to trip only (not to close) developer's breaker.
2) Status points as follows:
    a) open/closed indication on developer's breaker
    b) on/off indication for generation
    c) on/off indication for EMS/RTU
    d) transfer trip and/or comm. trouble status as required
3) Analog points are as follows:
    a) KW Total
    b) KVAR Total
    c) Phase amps
    d) Phase volts

SCADA Circuit Requirements

CDMA is a wireless solution and will require coordination with Joe Whalen in JCP&L Network Engineering.

The Interconnection Customer is responsible for the installation and maintenance of the SCADA communications circuit. FirstEnergy currently requires a digital cellular circuit for SCADA communications.

Interface to the FirstEnergy network requires the customer to acquire and install an Encore Networks Bandit II IP Legacy Router equipped with a cellular modem. The router is configured to encapsulate frame relay over dual IPSec tunnels in order to provide redundant communications to FirstEnergy head-end routers located at geographically diverse network control centers. An RS-232 serial interface is used for the connection between the Bandit II and the Interconnection Customer RTU.

The Interconnection Customer can select the cellular carrier of their choice. It is recommended that the cellular signal at the customer site be stable, with minimum RSSI of -85dBm.

FirstEnergy can conduct comparative RSSI testing at the customer site, if requested. Once the carrier is selected, the customer will place the order for the Bandit II, specifying the carrier so that the correct modem is installed. Encore Networks will provide the customer with the IMEI and/or ESN number associated with the modem, and a SIM card may also be required, depending upon the carrier selected. The customer will use this information in order to activate the modem in the carrier's network.

Encore Networks can pre-configure the Bandit II IP Legacy Router for operation within the First Energy system prior to delivery to the customer. The Encore Networks contact is:

Scott Burk

Director of Sales – Northeast/Midwest Strategic
Accounts Office: 703.318.4385

Mobile: 703.888.6835

Fax: 703.787.4625

Email: sburk@encorenetworks.com

Encore networks, Inc.

3800 Concorde Parkway, Ste 1500

Chantilly, VA 20151

www.encorenetworks.com

The customer will provide a contact name / number for future maintenance and repair issues, as well as the modem IMEI / ESN data, and MTN and Static Public IP information when it is obtained from the carrier so that FirstEnergy can document the circuit.