Generation Interconnection Combined Feasibility/System Impact Study Report

For

PJM Generation Interconnection Request Queue Position W1-082

Milford

July 2010

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

Fiberville Estates LLC, the Interconnection Customer (IC), has proposed a 20 MW (7.6 MW capacity) solar generating facility. The facility will be located near 10 Mill Road in Milford, New Jersey.

Point of Interconnection

W1-082 will interconnect with the Jersey Central Power & Light distribution system near the Warren Glen substation.

Network Impacts

The queue W1-082 project was studied as a 20.0MW (7.6MW of which was capacity) injection into JCPL‟s system at the Warren Glen 34.5kV substation. The project was studied on a combined feasibility-impact basis which utilizes an AC analysis, and incorporates all contingency types. Project W1-082 was evaluated for compliance with reliability criteria for summer peak conditions in 2014. Potential network impacts were as follows

Generator Deliverability

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

No problems identified.

Multiple Facility Contingency

(Double Circuit Tower Line Contingencies only with full energy output. Stuck Breaker and Bus Fault contingencies will be applied during the Impact Study)

No problems identified.

Contribution to Previously Identified Overloads

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have % allocation of cost responsibility which will be calculated and reported for the Impact Study.)

No problems identified.

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)

None.

Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of the surrounding generation. Any potential 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 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 analyzes

all overload conditions associated with the overloaded element(s) identified. As a result of the aggregate energy resources in the area, the following violations were identified.

No problems identified.

Short Circuit

Not required.

Stability Analysis

Not required.

Attachment 1

Results of First Energy Feasibility Study

FE Feasibility Study

34.5 kV Transmission Connection

for

Fiberville Estates LLC

Mill Road (W1-082) Generation Project

July, 2010

Prepared by
FirstEnergy Corp
Energy Delivery, Planning and Protection Department

and

Jersey Central Power & Light
Northern New Jersey Regional Engineering Department

FirstEnergy Feasibility Study
Mill Road (W1-082) Generation Project

Introduction

This Feasibility Study report provides the documentation of a system assessment performed by FirstEnergy (FE) in response to a request made by Fiberville Estates LLC for the connection of a solar power project with a total capability of 20 MW to the Jersey Central Transmission network. This assessment was accomplished by: 1. Evaluating the reliability impact of the proposed facilities and connection on the interconnected transmission system by the performance of a power flow study; 2. Ensuring compliance with the NERC, ReliabilityFirst, PJM and FE Reliability Standards by identifying the system reinforcements that will need to be installed for an interconnection of the proposed project; 3. Coordinating and cooperating with the PJM staff and Fiberville Estates LLC by conducting meetings and issuing this report as a part of the RTEP study process; 4. Performing a Steady State, Short-Circuit and Dynamics Study as necessary; 5. Conducting all studies in accordance with the PJM Manuals and the "FE Requirements for Transmission Connected Facilities" documents to assure that the assessment performed incorporates study assumptions, follows the documented system performance procedures, considers alternative connection and reinforcement plans, and jointly coordinates the study recommendations.

Connection Facilities

In compliance with the Regional Transmission Expansion Planning (RTEP) protocol, Fiberville Estates LLC has submitted a "Form of Generation Interconnection Feasibility Study Agreement" to PJM (see Attachment 6) that identifies its plan to construct a Mill Road (W1-082) Generation Project comprised of photo-voltaic solar panels and inverters on a plot of land near 10 Mill Road, Milford, New Jersey (Attachment 1). The installed facilities will have a total capability of 20 MW with 7.6 MW of this output being recognized by PJM as capacity. This means that the remaining 12.4 MW will be curtailable should a system reliability constraint occur. The proposed in-service date for this Mill Road (W1-082) Project is May 1, 2011.

As defined by the Fiberville Estates LLC and shown on Attachment 2, the connection point for the Mill Road (W1-082) Project will be located along the Gilbert - Morris Park (A27) 34.5 kV line about 3.5 miles from the Gilbert substation. In compliance with the FE Connection Requirements, a new three breaker ring bus will be constructed for the project attachment at or near pole NJ88 of Gilbert - Morris Park (A27) 34.5 kV path. A conceptual one-line diagram for the new Mill Road (W1-082) Project 34.5 kV substation is shown on Attachment 3. While FE will construct, own and operate the new Mill Road (W1-082) Project 34.5 kV substation and the facilities for its attachment to the FE system, the Fiberville Estates LLC will be responsible for acquiring all easements, properties and permits that will be required. The Fiberville Estates LLC will also be responsible for providing a level graded site for the new Mill Road (W1-082) 34.5 kV substation and an access road as a prerequisite before work can begin. A summary of the Mill Road (W1-082)

Project Direct Connection facilities that will be required and their estimated cost are shown on Attachment 4.

Power Flow Analysis

A Power Flow study was conducted to determine the reliability impact of the proposed Mill Road (W1-082) Project on the FE Transmission System. This study was completed using a 2014 summer peak load power flow that contains a detailed representation of the Jersey Central transmission networks in the area of the proposed Mill Road (W1-082) Project. The findings and the recommendations from this analysis are based on a contingency review that was performed to identify the facility loadings and/or voltage conditions that violate the ReliabilityFirst, PJM or FE Planning Criteria and are attributable to this project.

The results of the FE analysis show that there are no network upgrades required for the deliverability of the Mill Road (W1-082) Project generation to the Jersey Central transmission system. There also are no reinforcements defined for previous projects for which this project will have an impact.

Short Circuit and Dynamics Analysis

In accordance with the RTEP process, a short circuit analysis will not be conducted by PJM since the Mill Road (W1-082) Project connection is to the Jersey Central 34.5 kV system. An FE Protection staff analysis was conducted and showed that no FE circuit breaker will exceed its interrupting capability with the implementation of the Mill Road (W1-082) Project. Therefore no reinforcements will be required.

Note that stability studies will be conducted by the PJM staff should this project proceed to the Facilities Study stage of the RTEP process.

System Protection Analysis

An analysis was conducted to assess the impact of the Mill Road (W1-082) Project on the system protection requirements in the area. The results of this review have identified the following minimum requirements:

Under the assumption that the 20MW Mill Road Solar Generation Project (W1-082) will not supply fault current to the JCP&L system and the ring bus is located within 150 feet of the step-up transformer (for the transformer differential relaying), there will be the following protection upgrades needed for the A27 line exits and step up transformer bays of the three breaker ring bus:

Mill Road 34.5 kV Substation

1. Construct a new control building to accommodate the SCADA equipment required for the Direct Connection facilities. A final determination will be made as a part of the Facilities Study.
2. Breakers must be rated to interrupt 40kA
3. Two independent high-speed zones of protection to sense and clear faults on the interconnection transformer. (SEL-387 and SEL-587)
4. Breaker failure protection for each of the three ring bus breakers (Two SEL-501 relays)

5. Two independent high-speed zones of protection to sense and clear Gilbert line (A27) faults (SEL-321 and SEL-311B)
6. Two independent high-speed zones of protection to sense and clear Morris Park line (X24) faults (SEL-321 and SEL-311B)
7. Three SATEC Meters (two line exits and one attachment point)

Fault current on the 34.5kV A27 line, 3.5 miles from Gilbert substation are listed below. These values are for the current system configuration. Any system changes in the area could have a significant impact on these values.

Three phase: 7,145 amperes (X/R Ratio = 3.55)
Line-to Ground: 3,230 amperes (X/R Ratio = 5.48)

Fiberville Estates LLC will also be responsible for installing all project facilities beyond the point of interconnection and at its generation substation in compliance with the FE and regional requirements. This includes breaker protection, unit over/under voltage protection, over/under frequency protection and zero sequence voltage protection as may be required. Fiberville Estates LLC will also be responsible for all leasing costs for the circuits that may be required for the communication of data to PJM. FE will not provide a cost estimate for these facilities as a part of this report.

The cost estimate for the required FE system protection facilities is included on Attachment 4.

Metering

Fiberville Estates LLC will be required to comply with all FE Revenue Metering Requirements for Generation Interconnection Customers. These FE requirements are detailed on Attachment 5 to this report.

Compliance Issues

Fiberville Estates LLC will be responsible for meeting all FE criteria as defined in the FE Requirements for Transmission Connected Facilities document. This includes the provision of a reactive power capability sufficient to maintain a composite power delivery for the facility at the interconnection point at a power factor between .95 leading (absorbing 3.3 MVAR) and .90 lagging (producing 4.8 MVAR). If this capability cannot be provided by the solar units, a STATCOM or SVC device must be installed at the Mill Road (W1-082) Project substation at Fiberville Estates LLC cost.

Fiberville Estates LLC will also be required to meet all PJM, ReliabilityFirst and NERC reliability criteria and operating procedures for standards compliance. For example, the Developer 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.

FE Facility Upgrades and Costs

The results of the FE analysis shows that no planning criteria violations are attributable to the addition of the Mill Road (W1-082) Project for the conditions studied. Therefore the conclusion is that no transmission or distribution reinforcements will be required to provide the requested service.

The following is a summary of the FE facilities that will be required for the direct connection of the Mill Road (W1-082) Generation Project:

1. Construct new Mill Road 34.5 kV Substation in 3 beaker ring bus configuration for the project attachment. This includes the design and engineering, acquisition of materials and construction of the required facilities.
   (Cost Estimate $3,293,700)

2. Construct the dead-end 34.5 kV transmission structure and other facilities required for the looped connection of the Gilbert - Morris Park (A27) 34.5 kV line to the new Mill Road substation.
   (Cost Estimate $137,846)

All cost data contained in this document should be considered estimated. The applicant will be responsible for the actual cost of construction. FE herein reserves the right to return to any issues in this document and, upon appropriate justification, request additional monies to complete any connections to the transmission system.

Fiberville Estates LLC Requirements

In addition to the FE facilities, Fiberville Estates LLC will also be responsible for meeting all criteria as specified in the applicable sections of the "FE Requirements for Transmission Connected Facilities" document including:

1. 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.

2. The purchase and installation of a 34.5 kV interconnection metering instrument transformer. FE will provide the ratio and accuracy specifications based on the customer load and generation levels.

3. The purchase and installation of a revenue class meter for the Mill Road (W1-082) interconnection to measure the power delivered in compliance with the FE standards.

4. A compliance with the FE and PJM generator power factor requirements. Note that the generators may need to absorb reactive power at the point of interconnection during off peak periods to minimize the voltage change should the Mill Road (W1-082) Project units trip off line when at full output.

5. A compliance with the FE and PJM generator voltage control requirements. A voltage schedule to follow will be provided by the FE Transmission Dispatch Center.

6. The execution of a back-up service agreement to serve the customer load supplied from the Mill Road 34.5 kV substation when the units are out-of-service. This assumes the intent of Fiberville Estates LLC is to net the generation with the station load.

7. Any complaints from other customers (e.g. flicker complaints) will have to be corrected by Fiberville Estates LLC. Correction may include changing operation, reducing generation, disconnecting the generators from the Jersey Central system, or other measures.

8. 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. The RTU, the communications channel and all related equipment will be furnished and maintained by the Fiberville Estates LLC. The RTU must communicate with the FirstEnergy EMS via DNP 3.0 protocol.

9. The following status and metering points will be required:
   a. Interconnection breaker position.
   b. Generator real and reactive power output measured at the high-side of the generator step-up transformer.
   c. Generator voltage at the point of interconnection.

10. An installation of two independent high-speed zones of protection to sense and clear faults on the interconnection transformer.

The above requirements are in addition to any metering or other requirements imposed by PJM.

Note that an assumption of this study is that the Mill Road (W1-082) Project generation will automatically be disconnected whenever the local area network is islanded. If this assumption is not correct, a direct transfer trip scheme will need to be implemented for such situations at the Fiberville Estates LLC cost.

Summary

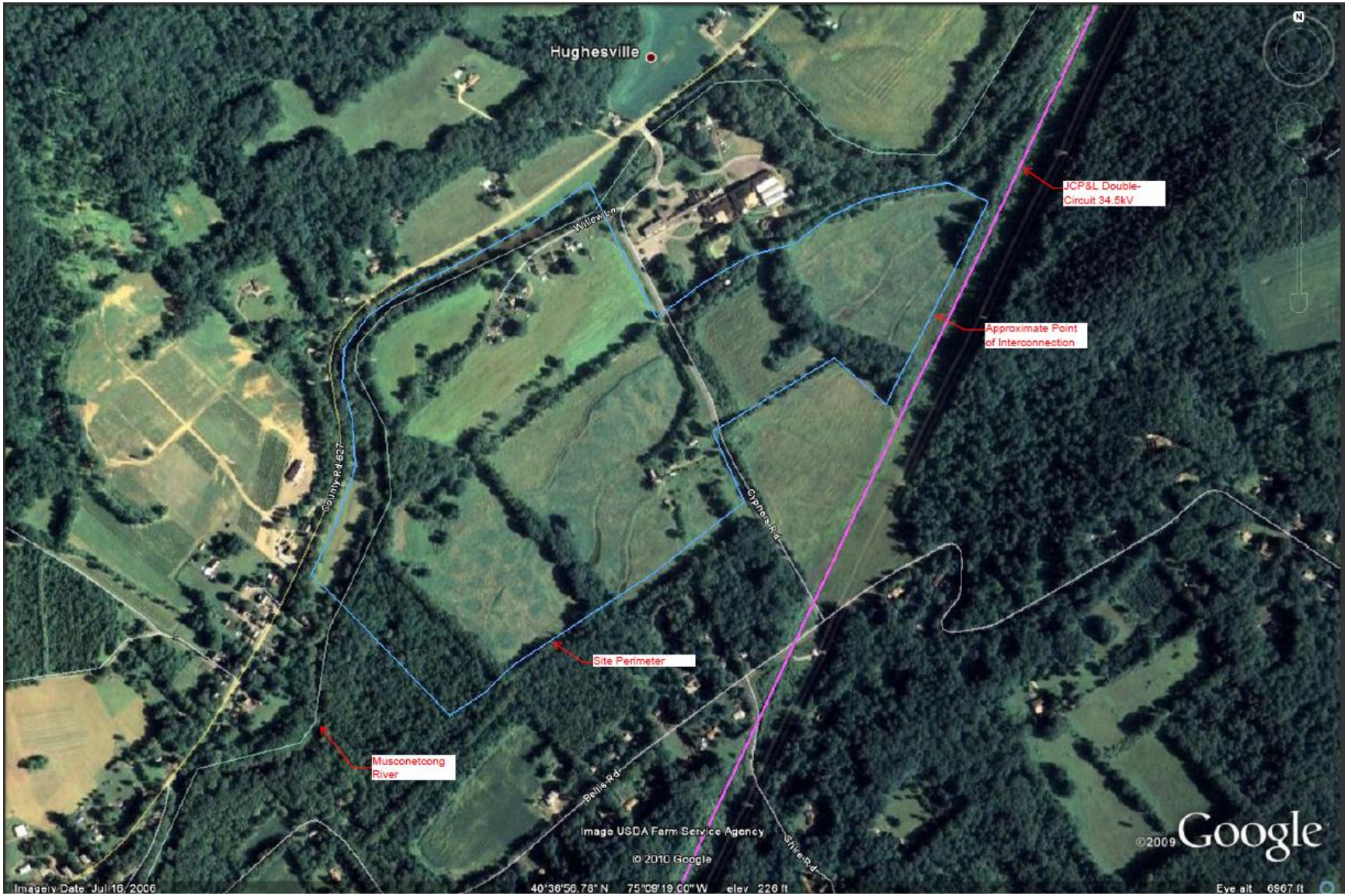
The connection of the Mill Road (W1-082) Project to the FE transmission system will require no network upgrades. Therefore Fiberville Estates LLC will only have a cost responsibility for the Direct Connection of the Mill Road (W1-082) Project to the Jersey Central transmission system. As shown on Attachment 4, the estimated cost of these facilities is $3,431,546.

Based on the extent of the FE direct connection and system upgrades required to support this project, it is estimated that it will take one (1) year from the date of a fully executed Interconnection Construction Service Agreement to complete the upgrades required for the Mill Road (W1-082) Project. This includes the requirement for Fiberville Estates LLC to make a preliminary payment to FE that funds the first three months of engineering design that is related to the construction of the Direct Connection facilities. It further assumes that Fiberville Estates LLC will provide the property for the attachment and right-of-way facilities that will be needed. A further assumption is 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 the necessary permits for implementing the defined direct connection and network upgrades, and that PJM will allow all 34.5 kV transmission system outages when requested.

Note that the FE findings were made from a conceptual review of this project. A more detailed review of the connection facilities and their cost will be identified in the Facilities Study. Further note that the cost estimate data contained in this document should be considered as only ballpark since it was produced without a detailed engineering review. The applicant will be responsible for the actual cost of construction. FE herein reserves the right to return to any issues in this document and, upon appropriate justification, request additional monies to complete any connections to the transmission system.

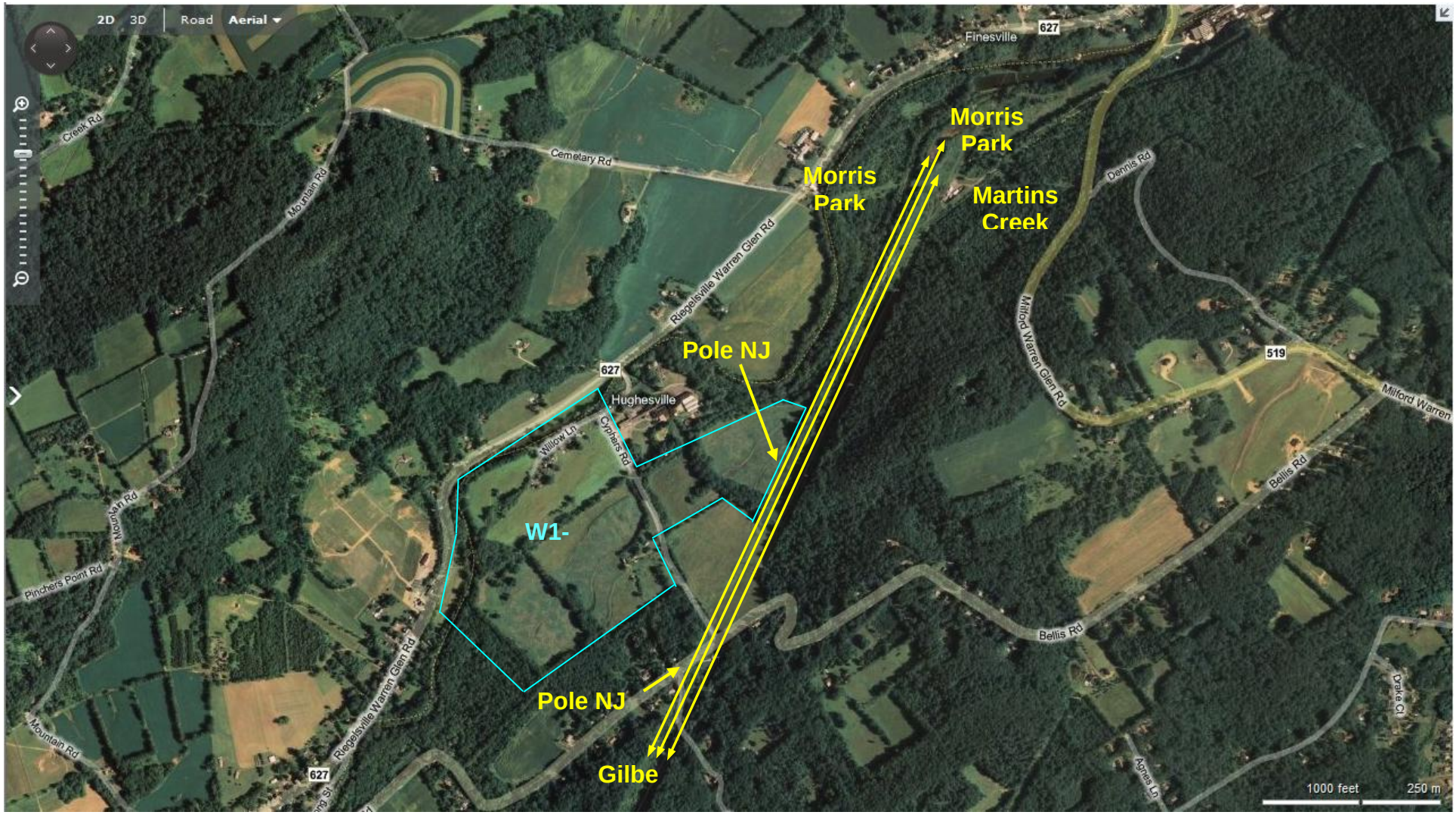
Attachment 1
Fiberville Estates LLC – Mill Road (W1-082) RTEP Project

Local Site Plan
10 Mill Road, Milford, NJ (20 MW)



Attachment 2
Fiberville Estates LLC – Mill Road (W1-082) RTEP Project

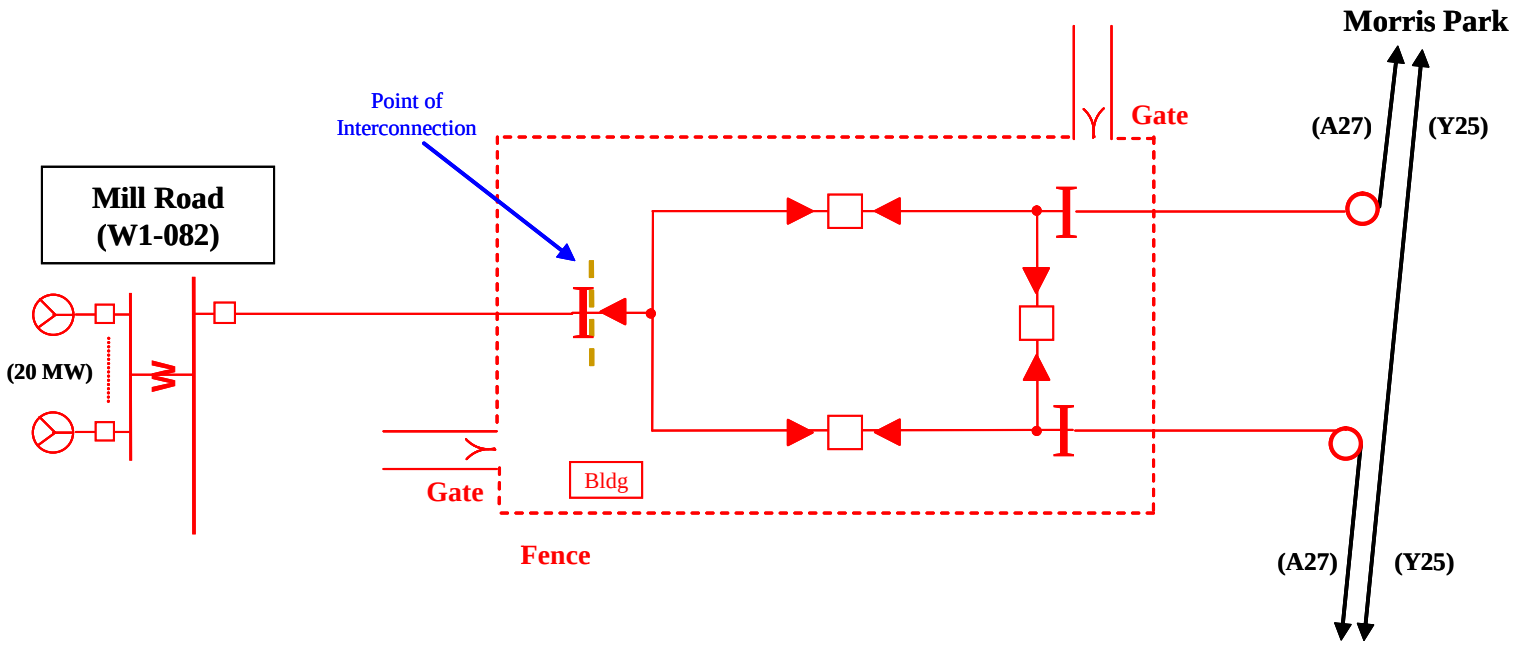
Aerial View
10 Mill Road, Milford, NJ (20 MW)



Attachment 3

Fiberville Estates LLC – Mill Road (W1-082) RTEP Project

34.5 kV Connection Substation



Attachment 4
Mill Road (W1-082) Solar Project Feasibility Study
Looped Connection from Gilbert - Morris Park (A27) 34.5 kV Line

	Connection Facilities	Fully Loaded Cost ($)
Mill Road 34.5 kV	Construct New 34.5 kV Substation for 3 Breaker Ring Bus	
	Include Control Building for Relay Panels, SCADA, etc.	
	Install Three 34.5 kV Circuit Breakers - Standard 3000 Amp, 40 kA Interrupting Capability each	
	Install Six New Disconnect Switches for Circuit Breakers- Standard 2000 Amp each	
	Install One New Disconnect Switch for Radial Generator Attachment - Standard 2000 Amp each	
	Install 795 ACSR Substation Conductor or Bus-bar as Needed	
	Install Three Line Termination Structures for the 34.5 KV Attachment Lines	
	Install Drop Loops for the Three Attachment Lines - 795 ACSR Wire	
	Miscellaneous Protection, Metering, RTU, SCADA	
	Total Substation Costs:	**3,293,700**

Connection Facility	Network Upgrade Detail	Cost ($)
Gilbert - Morris Park (A27) 34.5	Construct New Double Circuit Line from Gilbert - Morris Park (A27) 34.5 kV to the new Mill Road Substation (300 feet)	
	- Install Two 34.5 kV Circuit Poles For Loop along Gilbert - Morris Park (A27) 34.5 kV Line	
	- Install Two 34.5 kV Double Circuit Poles or Four Single Circuit Poles For Extension to New Substation	
	- Install Line Conductor for Loop and Disconnect Switch - 397.5 Kcmil 26/7 ACSR Wire or Better (600 feet)	
	Total Transmission Costs:	**137,846**
	Total Direct Connection Upgrade Costs (Excluding Taxes):	**3,431,546**

Attachment 5

FirstEnergy Revenue Metering Requirements for Generation Interconnection Customer

Interconnection Customer shall install, own, operate, test and maintain the necessary revenue quality Metering Equipment. This includes current transformers, voltage transformers, mounting structures, wiring, meters, communication circuits, and associated devices. The Metering Equipment must meet the specifications listed in the FirstEnergy and regional transmission organization (RTO) connection documents. The FirstEnergy "Requirements for Transmission Connected Facilities" are located at: http://www.firstenergycorp.com/feconnect

The Metering Equipment shall be located at the generation facility on the high voltage side of the generator step-up transformers or facility main step-up transformer and/or station service power transformers. Power flows to and from the facility shall be compensated to the Point of Interconnection.

FirstEnergy will provide revenue quality Metering Equipment for a station service power supply at a generation facility if the supply is from the local FirstEnergy distribution system.

The revenue quality Metering Equipment shall be capable of collecting and storing bidirectional billing data. The billing data shall be stored in intervals specified by FirstEnergy, typically fifteen minutes or thirty minutes. The Interconnection Customer must provide FirstEnergy with remote access to the billing data in the Metering Equipment via a dedicated voice-grade analog telephone circuit. The Interconnection Customer shall provide FirstEnergy with contact information for the person or persons responsible for meter programming and Metering Equipment maintenance.

The Interconnection Customer shall consult with FirstEnergy regarding the revenue quality metering system design and provide the following information:

- Facility one line and revenue metering installation drawings (schematics, wiring diagrams, etc.)
- Estimated power flows to and from the facility at all revenue metering points
- Current transformer and voltage transformer specifications, including manufacturer, type, nameplate drawings, and certified accuracy test reports
- Revenue meter specifications including manufacturer, type, model number, and accuracy
- Revenue meter program information including but not limited to billing data recorder channel assignments, recorder pulse weights (Ke), and read-only password for access to interval data by the FirstEnergy billing data collection system (MV-90)
- Revenue meter telephone number
- Revenue meter loss compensation data (if applicable)

The Interconnection Customer shall provide FirstEnergy with prior notification of any modifications at the facility that will affect the revenue meter measurements, including substation reconfigurations and meter program changes.

The revenue metering system at each location shall be tested for accuracy by the Interconnection Customer once every two years. The Interconnection Customer shall give reasonable notice to FirstEnergy of the time when the testing is scheduled so that FirstEnergy may have representatives present. FirstEnergy and the RTO shall have the right to audit the revenue metering equipment and/or related documents. The Interconnection Customer shall be given a reasonable period of time to comply with any requests associated with an audit.

Attachment 6

FORM OF

Generation Interconnection Feasibility Study Agreement

FROM ATTACHMENT N OF THE PJM TARIFF

RECITALS

1. This Generation Interconnection Feasibility Study Agreement, dated as of April 27, 2010 is entered into, by and between Fiberville Estates LLC ("Interconnection Customer") and PJM Interconnection, L.L.C. ("Transmission Provider") pursuant to Part IV and Part VI of the PJM Interconnection, L.L.C. Open Access Transmission Tariff ("PJM Tariff"). Capitalized terms used in this agreement, unless otherwise indicated, shall have the meanings ascribed to them in the PJM Tariff.
2. Pursuant to Section 36.1.01, 110.1, or 111.1, of the PJM Tariff, the Interconnection Customer has submitted an Interconnection Request and has paid the applicable initial deposit to the Transmission Provider and the applicable non-refundable base deposit for a proposed interconnection of a generation facility over 20 MW; or the applicable initial deposit and the applicable non-refundable base deposit for a proposed interconnection of a generation facility 20 MW or less but greater than 2 MW, as applicable, to the Transmission Provider.
3. Interconnection Customer requests interconnection to the Transmission System of a generating project with the following specifications.
   a. Location of generating unit site:
      Property near 10 Mill Rd. Milford, NJ 08804

   b. Identification of evidence of ownership interest in, or right to acquire or control, the generating site:
      Property Deeds

   c. Size in megawatts of generating unit or increase in capacity of existing generating unit:
      A. Maximum Facility Output (as defined in section 1.18A.03 of the PJM Tariff) of the generating unit:
         20 MW
      B. If Interconnection Request is for an increase in capacity of existing generating unit, specify size in megawatts of the increase in capacity of existing generating unit:
      C. Specify any portion of the facility's capacity that you wish to be a Capacity Resource or Energy Resource.
         MW Capacity Resource: 7.6
         MW Energy Resource: 20
         PLEASE NOTE: THE CAPACITY INDICATED IN YOUR RESPONSE TO PART C OF THIS ITEM MAY BE REDUCED, BUT MAY NOT BE INCREASED, WITH RESPECT TO THIS INTERCONNECTION REQUEST FOR THIS PROJECT.
      D. Identify the fuel type of the generating unit.
         SOLAR

   d. Description of the equipment configuration:
      Solar PV connected to grid through inverters and transformers

   e. Planned date the generating unit or increase in capacity will be in service:
      May 1, 2011

   f. Is the generating unit to be evaluated as a Capacity Resource?: Yes
      If yes, check here to be evaluated also as an Energy Resource:

   g. Is the generating unit Behind The Meter Generation?
      No
      If Yes:

Attachment 6
(Continued)

A. Specify any portion of the facility's capacity that you wish to be a Capacity Resource or Energy Resource.

PLEASE NOTE: THE CAPACITY INDICATED IN YOUR RESPONSE TO PART A OF THIS ITEM MAY BE REDUCED, BUT MAY NOT BE INCREASED, WITH RESPECT TO THIS INTERCONNECTION REQUEST FOR THIS PROJECT.

B. Identify the type and size of the load located (or to be located) at the site of such generation.

C. Describe the electrical connections between the generation facility and the load.

h. Other information:

Project size to be discussed with JCP&L at scoping meeting