Generation Interconnection Feasibility Study Report (Web Version)

For

PJM Generation Interconnection Request Queue Position W1-015

Shade Gap115 kV

PJM DOCS No. 602599 v1
July, 2010

Feasibility Study Report
Shade Gap PN (W1-015) Generation Project

Introduction

This Feasibility Study report provides the documentation of an assessment that has been performed by PJM Interconnection and FirstEnergy (FE) in response to a request made by Interconnection Customer for the connection of a 70.2 MW (9.1 MW Capacity) Shade Gap PN (W1-015) Wind Farm Generation Project to the Penelec Transmission System. As per the PJM RTEP study process, the Shade Gap PN (W1-015) Project 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 Interconnection Customer by participating in project 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, the "FE Requirements for Transmission Connected Facilities", and the "FE Study Guide".

Connection Facilities

In compliance with the Regional Transmission Expansion Planning (RTEP) protocol, Interconnection Customer has submitted a "Form of Generation Interconnection Feasibility Study Agreement" to PJM and a proposed single line diagram that identifies its plan to construct three strings of 13 x 1.8 MW Wind Turbine Generation Project with a total capability of 70.2 MW (9.1 MW Capacity) on a property that is approximately 6 miles northeast of the existing Shade Gap 115 kV substation (see Attachment 1). For purposes of this report, it has therefore been designated as the Shade Gap PN (W1-015) 115kV Project to reflect its interconnection voltage and its proximity to the Shade Gap substation. The direct connection of this project will be accomplished by the construction of a new 115 kV 3 breaker ring bus and the looping of the Shade Gap – Lewistown (K - 2) 115 kV line to it. This 115 kV direct connection is considered Primary POI. Procurement and construction of the 115 kV transmission line connecting the 3 breaker ring bus to the Wind Farm 115 kV export bus is the responsibility of Interconnection Customer as this facility is not owned by FirstEnergy Corp. Interconnection Customer will be responsible for acquiring all easements, properties and permits that may be required to construct both the project connection 3 breaker ring bus and the attachment facilities. Interconnection Customer will also be responsible for the rough grade of the property and an access road to the proposed 3 breaker ring bus site. A summary of the Shade Gap PN (W1-015) 115 kV Project direct connection facilities that will be required and their estimated costs are shown on Attachment 3. A 115 kV direct connection to the 115 kV bus at Shade Gap substation is also studied as the Secondary POI. No estimated costs are provided for the Secondary POI.

Transmission Service Provider (PJM) Analysis Results

Network Impacts

Queue project W1-015 was studied as a 70.2MW (9.1MW of which was Capacity) injection into PENELEC's system at two optional points of interconnection. The primary option was a tap point along the Shade Gap – Lewistown 115kV line between Shade Gap and Reed's Gap substations, while the secondary option was a direct connection to the Shade Gap 115kV substation. Project W1-015 was evaluated for compliance with reliability criteria for summer peak conditions in 2014. Potential network impacts were as follows:

Primary POI: Tap of Shade Gap – Lewistown 115kV line (Between Shade Gap and Reed's Gap substations)

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.

1. The LEWISTWN-JUNI BU2 230 kV line (from bus 200513 to bus 208005 ckt 1) loads from 92.1% to 97.72% (DC power flow) of its normal rating (488 MVA) for non-contingency condition. This project contributes approximately 27.41 MW to cause the thermal violation.

Secondary POI: Shade Gap 115kV

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.

1. The SHADE GP-ROXBURY 115 kV line (from bus 200522 to bus 200520 ckt 1) loads from 79.59% to 101.35% (DC power flow) of its normal rating (111 MVA) for non-contingency condition. This project contributes approximately 24.15 MW to cause the thermal violation.

Transmission Owner (FirstEnergy-Penelec) Results

Power Flow Analysis

A Power Flow study was conducted to determine the reliability impact of the proposed Shade Gap PN (W1-015) 115 kV Project on the FE Transmission System. This included the performance of a contingency analysis to identify any facility overload or voltage condition that violates the FE Planning Criteria. Any such violation that is either directly attributable to this project or for which it will have a shared responsibility is included in this report with a least cost plan identified to mitigate them.

The Shade Gap PN (W1-015) 115 kV Project Power Flow Analysis was performed using a 2014 summer peak load base case power flow provided by the PJM staff. This base case included a detailed representation of the Penelec transmission system in the area of the proposed Shade Gap 115 kV substation. A simulation of all possible contingencies within the NERC and FE Planning Standards that are impacted by the Shade Gap PN (W1-015) 115 kV Project was conducted to test for criteria compliance.

The direct connection of the Shade Gap PN (W1-015) 115 kV Project to the Penelec transmission system was studied for two different points of interconnection (POI); The Primary POI is an interconnection to the Shade Gap – Lewistown 115 kV line between Shade Gap Sub and the Reeds Gap Switching Station, and Secondary POI is an interconnection to the 115kV bus at the Shade Gap Sub.

The results from the study Power Flow Analysis showing a comparison of the FE and PJM contingency study results are detailed on Attachment 4. As shown, the conclusion from this analysis is that there are no new upgrades required for the Shade Gap PN (W1-015) 115 kV Project. Note that on Attachment 4, the Primary POI is designated as "Option 1" while the Secondary POI is shown as "Option 2."

However, the findings show that there are criteria violations which will have an impact on network congestion and local energy deliverability. These were identified and explained in the Transmission Service Provider's (PJM) Analysis Results above.

The Interconnection Customer will therefore be subject to generation curtailment in order to mitigate these violations.

Short Circuit and Dynamics Analysis

PJM has completed the short circuit analysis of the W1-015 queue project Shade Gap 115kV. Two POIs were considered during this study, as outlined earlier in this report. The short circuit analysis was performed for impacts in each of the Penelec, MetEd, PPL and APS territories. The analysis found no new breakers to be over-duty in these transmission areas. The study also showed no significant fault current contribution to the breakers which have already been identified as over-duty. This study was performed on the 100 kV and above system.

System Protection Analysis

An analysis was conducted to assess the impact of the Shade Gap PN (W1-015) 115kV Project (Primary POI) on the system protection requirements in the area. The results of this review show that the following relay additions and upgrades will be required:

Shade Gap Substation –

W1-015 115kV line exit (formerly Lewistown exit) Line relays to use fiber.

- Remove existing SEL311B backup relaying and install SEL311L line current differential relaying.
- Utilize existing line SEL321 primary relaying if possible (may need more I/O) and purchase fiber transceivers to interface with fiber comm channel.
- Remove Z ph wave trap and associated PLC equipment.
- Add new set of three slipover CTs on Bus side of Bkr (and add new SEL311L backup relaying as referenced above), and relocate SEL501 and Satek to these CTs.
- Install SEL351A reclosing relay.
- Install RFL9745 for DTT to W1-015 generation.

- Roxbury exit breaker and Three Springs exit breaker 'b' contacts to be wired into RFL-9745.

Lewistown Substation --

W1-015 115kV line exit (formerly Shade Gap exit)

- Utilize existing line relaying with SEL321 primary relaying (DCB over PLC) and Z ph wave trap and SEL311B backup relaying.
- Install RFL-9780, wave trap, LTU, CCVT on ph X for DTT to W1-015 generation.
- Lewistown TRF1, TRF2, TRF3 115kV exit breaker 'b' contacts to be wired into RFL-9780.

W1-015 Interconnection Substation --

- Install 3 new ring bus breakers with SEL352 BF/SC relaying (one per bkr) and 3 sets of CCVTs.
- Install 351A Reclosing Relay for Tie breaker of 3 breaker ring bus
- Add SEL2020 and GPS clock.

Lewistown 115kV exit –

- Install line relaying with SEL321 primary relaying (DCB over PLC) and Z ph wave trap and SEL311B backup relaying.
- Install RFL-9780, wave trap, LTU, CCVT on ph X for DTT to W1-015 generation for loss of FE source.

Shade Gap 115kV exit -- Line relays to use fiber.

- Install SEL321 primary and SEL311L backup relays.
- Install 9745 receiver.

W1-015 Generation Sub line exit --

- Line relaying to use Fiber utilizing dual SEL311L relays for line protection.
- Install RFL-9745 DTT transmitter.

Note that the W1-015 – Shade Gap 115 kV line will have fiber based relaying with dual pilot protection and DTT.

Metering

Interconnection Customer will be required to comply with all FE Revenue Metering Requirements for Generation Interconnection Customers. These FE requirements are detailed on Attachment 7 of this report.

Compliance Issues

Interconnection Customer will be responsible for meeting all FE criteria as defined in the FE Requirements for Transmission Connected Facilities document. While the voltage analysis is not performed for the feasibility study, any voltage criteria violations that would require the plant to provide reactive power, that

determination of reactive power requirements will be determined in the system impact study, which will include the low voltage ride through analysis.

Interconnection Customer must also meet all PJM, ReliabilityFirst and NERC reliability criteria and operating procedures required 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 from the FE power flow analysis (Attachment 4) show that there are no FE criteria violations that are directly attributable to the capacity of the Shade Gap PN (W1-015) 115 kV Project. However, there is one violation for the Primary POI direct connection, and another violation for the Secondary POI direct connection affecting network congestion and local energy delivery that the Shade Gap PN (W1-015) 115 kV Project will impact. Note that the FE and PJM study results differ somewhat due to the differences in the study process and power flow programs utilized. However, the overall conclusions reached by the FE and PJM staff are the same. In accordance with the RTEP procedures defined in the PJM Open Access Transmission Tariff and PJM Manuals, Interconnection Customer is not responsible for network upgrades. The Primary POI direct connection costs however are detailed in Attachment 3. The Secondary POI costs are not provided.

Note that all cost estimates contained in this document were produced without a detailed engineering review and are therefore subject to error. More accurate estimates will be determined as a part of the System Impact Study. Interconnection Customer will be responsible for the actual cost of the direct connection that is implemented. In addition, Interconnection Customer is responsible to provide the transmission line between W1-015 interconnecting substation and the W1-015 generating substation, as Interconnection Customer will own this transmission line. FE herein reserves the right to return to any issues in this document and, upon appropriate justification, request additional monies to complete any reinforcements to the transmission system.

Interconnection Customer Requirements

In addition to the FE facilities, Interconnection Customer 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 115 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 each unit to measure the power delivered in compliance with the FE standards.

4. 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.

5. The establishment of dedicated communication circuits for SCADA report to the FE Transmission System Control Center.

6. A compliance with the FE and PJM generator power factor and voltage control requirements.

7. The execution of a back-up service agreement to serve the customer load supplied from the Shade Gap 115kV substation when the units are out-of-service. This assumes the intent of Interconnection Customer is to net the generation with the load.

8. The rough grade of the property for the W1-015 Interconnection 115 kV Substation and an access road for the delivery of equipment to this site.

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

Summary

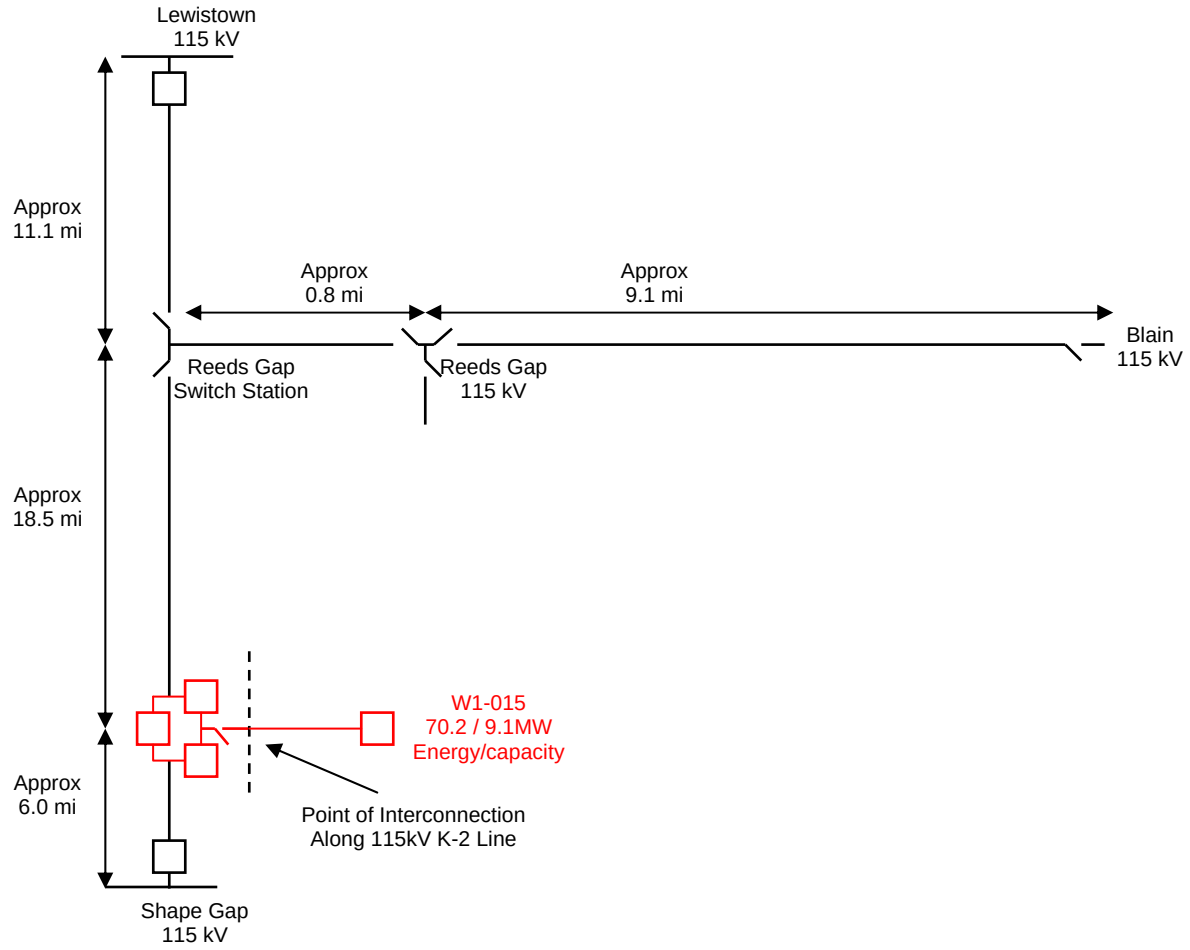
The Shade Gap PN (W1-015) Project direct connection will require the facility upgrades defined in Attachment 3. As shown, the total estimated cost of the new 115 kV three breaker ring bus substation and attachment lines is $5,127,500. The Shade Gap PN (W1-015) Project does not have any required network upgrades.

Based on the scope of the FE direct connection at the Primary POI, it is expected to take a minimum of two (2) years from the signing of a Connection Service Agreement to complete the installation required for the Shade Gap PN (W1-015) Project. This includes a preliminary payment that compensates FE for the first three months of the engineering design work that is related to the construction of a new W1-015 Interconnecting substation and the loop of the Penelec 115 kV lines to this site. It also assumes that the Interconnection Customer will provide the property for the attachment substation and all right-of-way, permits, easements, etc. 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 transmission system outages when requested.

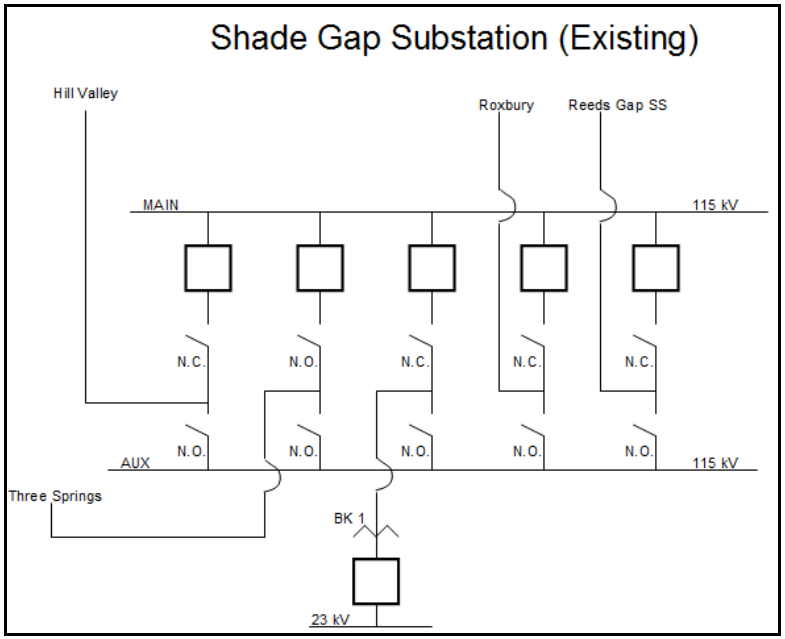
Attachment 1
Shade Gap PN (W1-015) RTEP Project
Project Location

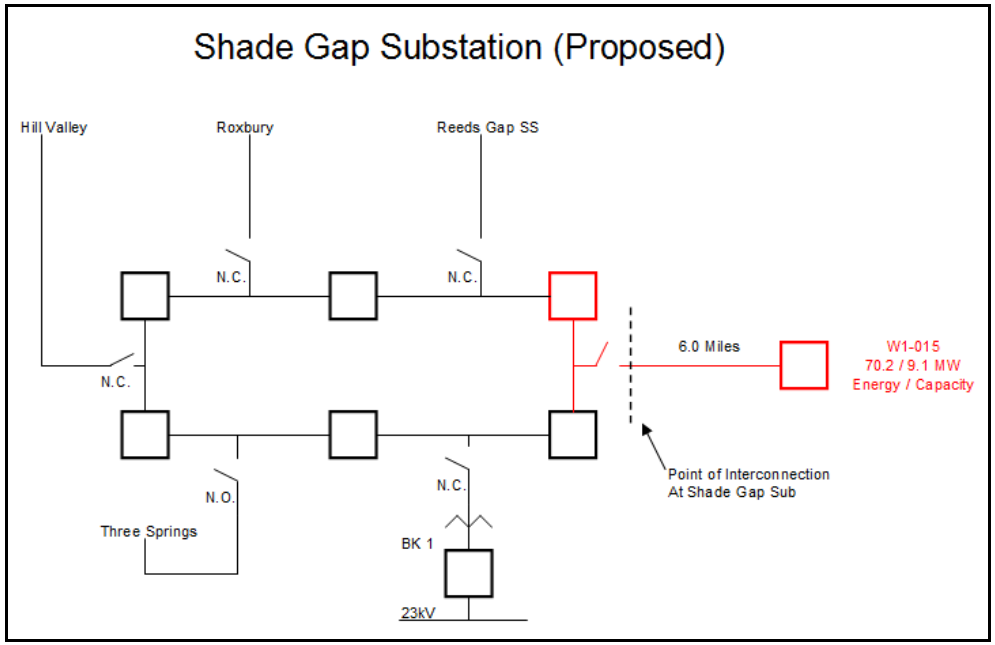
(Deleted to protect developer identity)

Attachment 2
Shade Gap (W1-015) RTEP Project
Conceptual 115 kV Interconnection Substation Configuration (Primary POI)



Attachment 2
Shade Gap (W1-015) RTEP Project
Conceptual 115 kV Interconnection Substation Configuration (Secondary POI)





Attachment 3

Shade Gap PN 115kV (W1-015) Feasibility Study

Direct Connection Requirements (Primary POI)

UpgradeID	Description	Total Cost
PN-S-418-1	W1-015 Interconnect Substation: Install 115kV 3 position ring bus substation between Lewistown and Shade Gap substations. New ring bus will serve as interconnection for the PJM W1-015 generation project. To proceed with design work, Protection and Measurements Equipment Specifications document required by 11/01/2012. (ISD 10/31/2013)	$4,108,200
PN-S-418-2	Lewistown Sub: Modify relaying on the 115kV Shade Gap line in support of the PJM W1-015 generation project. To proceed with design work, Protection and Measurements Equipment Specifications document is required by 04/01/2013. (ISD 10/31/2013)	$189,300
PN-S-418-3	Shade Gap Sub: Modify relaying on the 115kV Lewistown line in support of the PJM W1-015 generation project. To proceed with design work, Protection and Measurements Equipment Specifications document is required by 06/01/2013. (ISD 10/31/2013)	$193,600
	Engineering Oversight and Commissioning Support of the Interconnection Customer generation substation including support of protective relay installation	$63,900
	Install approx 6 Miles of Fiber Optic Cable from Shade Gap to W1-015 Interconnect Sub. Assumed to be a TX installation OPGW.	$572,500
Total		$5,127,500

Attachment 4
Shade Gap PN 115kV (W1-015) Feasibility Study
FE Contingency Analysis Results

OPTION #1

Identified New Project Upgrades

				FirstEnergy Results		PJM Results	
Type	**Outage Description**	**Overloaded Element**	**N/4-Hr Rating**	**MVA Flow**	**% Rating**	**MVA Flow**	**% Rating**

Contributions To Previously Identified Overloads

				FirstEnergy Results		PJM Results	
Type	**Outage Description**	**Overloaded Element**	**N/4-Hr Rating**	**MVA Flow**	**% Rating**	**MVA Flow**	**% Rating**

Potential Congestion due to Local Energy Deliverability

				FirstEnergy Results		PJM Results	
Type	**Outage Description**	**Overloaded Element**	**N/4-Hr Rating**	**MVA Flow**	**% Rating**	**MVA Flow**	**% Rating**
Normal	Full Energy case (Open Tie Roxbury - 01Greene 115kV)	LEWISTWN-JUNI BU2 230 kV line	488 / 617	483	99	477	97.7

OPTION #2

Identified New Project Upgrades

				FirstEnergy Results		PJM Results	
Type	**Outage Description**	**Overloaded Element**	**N/4-Hr Rating**	**MVA Flow**	**% Rating**	**MVA Flow**	**% Rating**

Contributions To Previously Identified Overloads

				FirstEnergy Results		PJM Results	
Type	**Outage Description**	**Overloaded Element**	**N/4-Hr Rating**	**MVA Flow**	**% Rating**	**MVA Flow**	**% Rating**

Potential Congestion due to Local Energy Deliverability

				FirstEnergy Results		PJM Results	
Type	**Outage Description**	**Overloaded Element**	**N/4-Hr Rating**	**MVA Flow**	**% Rating**	**MVA Flow**	**% Rating**
Normal	Full Energy case (Open Tie Roxbury - 01Greene 115kV)	SHADE GP-ROXBURY 115 kV line	111 / 149	113	101.4	113	101.4

Attachment 5
Shade Gap PN (W1-015) RTEP Project
FE Network Facility Reinforcement Conceptual Cost Estimates

None Required

Attachment 6
Shade Gap PN (W1-015) RTEP Project
FE Network Facility Reinforcement Conceptual One Line Diagrams

None Required

Attachment 7

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.