Generation Interconnection Feasibility Study Report Web Version

For

PJM Generation Interconnection Request Queue Position W3-099

Erie East 230 kV Project

August, 2011

Feasibility Study Report

Erie East 230kV Generation Project

Introduction

This Feasibility Study report provides the documentation of an assessment that has been performed by PJM Interconnection LLC (PJM) and FirstEnergy (FE) in response to a request made by Interconnection Customer (IC) for the connection of a 100 MW (13 MW Capacity) Erie East 230kV Wind Farm Generation Project to the Penelec Transmission System. IC has proposed a backfeed date of September 2014 and commercial operation date of December 2014 for the proposed Erie East 230kV facility. As per the PJM Generation Interconnection study process, the Erie East 230kV 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 IC by participating in project meetings and issuing this report as a part of the Generation Interconnection 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 PJM Generation Interconnection protocol, IC has submitted a "Form of Generation Interconnection Feasibility Study Agreement" to PJM and a proposed single line diagram that identifies its plan to construct a 56 x 1.8 MW Wind Turbine Generation Project with a total capability of 100 MW (13 MW Capacity) on a property that is adjacent to the Erie East – Erie South 230kV line (see Attachment 1). IC has requested the study of both a Primary and Secondary Point of Interconnection (POI) for the Erie East 230kV Project. This report contains detailed connection requirements, direct connection costs and schedule, power flow analysis, short circuit analysis, and a cost and schedule for any associated system reinforcements for the Primary POI. For the Secondary POI, this report only provides the results of the power flow analysis and short circuit analysis. It does not contain a cost/schedule associated with direct connection or any identified system reinforcements pertaining to the analysis performed.

PJM Interconnection Study Results

The following is the report describing the results of the analysis performed by PJM engineers with respect to the transmission system impacts.

Network Impacts

The Queue Project #W3-099 was studied as a 100.0MW (Capacity13.0MW) injection between Erie East and Erie South stations in the Penelec area. Project #W3-099 was evaluated for compliance with reliability criteria for summer peak conditions in 201 4. Potential network impacts were as follows:

Generator Deliverability

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

No violations identified.

Multiple Facility Contingency

(Double Circuit Tower Line, Line with Failed Breaker and Bus Fault contingencies for the full energy output)

No violations identified.

Short Circuit

No breakers were found to be overdutied as a result of this project.

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

Will be addressed in the System Impact Study phase

Stability and Reactive Power Requirement

Will be addressed in the System Impact Study phase

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

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.

1. The Lewis Run-Farmers Valley 115 kV line (from bus 200667 to bus 200668 ckt 1) loads from 106.13% to 106.69% (**DC power flow**) of its rating (149 MVA) for the single line contingency ('B_PN230-SX-#25_WARR-FALC_SPS'). This project contributes approximately 5.15 MW to the thermal violation.

CONTINGENCY 'B_PN230-SX-#25_WARR-FALC_SPS' /* FOREST - GLADE 230 KV
DISCONNECT BRANCH FROM BUS 200581 TO BUS 200593 CKT 1
DISCONNECT BRANCH FROM BUS 200579 TO BUS 135277 CKT 1
END

2. The Shelocta-Keystone 230 kV line (from bus 200795 to bus 200810 ckt 1) loads from 113.06% to 113.23% (**DC power flow**) of its rating (841 MVA) for the single line contingency ('B_PN345-SX-#6'). This project contributes approximately 9.17 MW to the thermal violation.

CONTINGENCY 'B_PN345-SX-#6' /* HANDSOME LAKE - WAYNE (WHL) 345 KV - (PJM-PN33A)
DISCONNECT BRANCH FROM BUS 200826 TO BUS 200595 CKT 1
END

Transmission Owner's Analysis Results

The following is the report generated by the Transmission Owner (TO) which includes costs and schedules for any transmission and, if applicable, distribution system upgrades.

Primary Point of Interconnection: Erie East – Erie South 230kV Line
The Primary POI for this project will be accomplished by the construction of a new 230kV 3 breaker ring bus and the looping of the Erie East – Erie South 230kV line to it. The new 230kV 3 breaker ring bus will be approximately 2.6 miles from Erie East substation. IC will be responsible for acquiring all easements, properties and permits that may be required to construct both the new 230kV 3 breaker ring bus interconnection substation and the associated attachment facilities. IC 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 Erie East 230kV Project direct connection facilities that will be required for the Primary POI and their estimated costs are shown on Attachment 3.

Secondary Point of Interconnection: Erie East 230kV Substation
The Secondary POI for this project will be accomplished by adding two 230kV circuit breakers to the existing Erie East 230kV substation to create a 4 breaker ring bus. As mentioned previously, there is not an estimated cost or schedule provided for the Secondary POI.

Power Flow Analysis

A Power Flow study was conducted to determine the reliability impact of the proposed Erie East 230kV 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 Erie East 230kV Project Power Flow Analysis was performed using a 2014 summer peak load base case provided by the PJM staff. This base case included a detailed representation of the Penelec transmission system in the area of the Erie East 230kV substation. A simulation of all possible contingencies within the NERC and FE Planning Standards that are impacted by the Erie East 230kV Project was conducted to test for criteria compliance. The direct connection of the Erie East 230kV Project to the Penelec transmission system was studied at both the Primary and Secondary POI.

The results from the study Power Flow Analysis showing a comparison of the FE and PJM contingency study results are detailed on Attachment 4. Please note that the Power Flow Analysis results were similar for both the Primary and Secondary POI. As shown, the conclusion from this analysis is that there are no new upgrades required for the Erie East 230kV Project. However, the Warren – Falconer WF 115kV line does overload for a double tower line outage for local capacity deliverability. The Warren – Falconer WF 115kV line has a Special Protection Scheme (SPS) that would trip the line post-contingency for this outage to avoid

overload. The Warren – Falconer WF 115kV line does overload under baseline conditions for the local energy deliverability and as a result would be opened normally. With the Warren – Falconer WF 115kV line open for local energy deliverability, the FE findings show that there are criteria violations which will have an impact on network congestion and local energy deliverability. However, the FE findings show that there are criteria violations which will have an impact on network congestion and local energy deliverability. IC will therefore be subject to generation curtailment in order to mitigate these violations.

Short Circuit and Dynamics Analysis

For both the Primary and Secondary POI, a short circuit analysis has been performed by PJM and the findings were confirmed by FirstEnergy. The findings show that no circuit breakers are newly over dutied with the addition of the Erie East 230kV Project. The study also showed no significant fault current contribution to the breakers which are near the over-duty limit.

System Protection Analysis

An analysis was conducted to assess the impact of the Erie East 230kV Project on the system protection requirements in this area. This study assumes no dual pilot relaying is required for stability on the Erie South – W3-099 interconnection substation 230kV line. It also assumes that the W3-099 interconnection substation and W3-099 collector substation are adjacent to each other. The results of this review show that the following relay additions and upgrades will be required:

Erie East – W3-099 interconnection substation 230kV line
Install fiber optic cable (2.6 miles) for dual pilot protection and DTT to W3-099 generation.

Erie East 230kV Substation –
W3-099 interconnection substation 230kV line exit (formerly Erie South exit) relays are required to use fiber optic communication. Remove the existing primary GE DLP primary relaying and install SEL311L line current differential relaying. Replace the existing line SEL321 backup relaying with new SEL321 relays and transceivers capable of interfacing with fiber optic communication (DCB over mirrored bits). Replace the existing MCTI BF relaying with new SEL352 BF relaying. Install RFL9745 transmitter for DTT via fiber optic cable to W3-099 generation.

Erie South – W3-099 interconnection substation 230kV line –
Retain existing on-off carrier scheme (DCB over PLC) utilizing new relaying and install DTT to W3-099 generation.

Erie South 230kV Substation -
At the W3-099 interconnection substation 230kV line exit (formerly Erie East exit), remove the existing primary GE DLP primary relaying and install new SEL421 relays (DCB over PLC).

Replace existing Z phase wave trap if not possible to retune to dual frequency by replacing wave trap tuning device. Install RFL-9780 transmitter, new LTU, coax, hybrids, and filters for DTT to W3-099 generation. Replace existing on-off carrier set with RFL9785. Replace existing MCTI BF relaying with new SEL352 BF relaying.

W3-099 230kV Interconnection Substation -
Install 3 new ring bus breakers with SEL352 BF/SC relaying (one per breaker) and 3 sets of CCVTs. Add new SEL351A for reclosing. Add SEL2020, Satek metering, and GPS clock.

Erie South 230kV exit - Install line relaying with SEL421 primary relaying (DCB over PLC) and Z phase wave trap and SEL321 backup relaying. Install RFL-9780 receiver, wave trap, LTU, for DTT to W3-099 generation for loss of FE source. On-off carrier to be implemented using RFL9785 on Z phase along with DTT.

Erie East 230kV exit - Line relays to use fiber optic communication. Install SEL311L line current differential primary and SEL321 backup relays (DCB over mirrored bits). Install 9745 receiver for DTT scheme to trip W3-099 generation on loss of FE source.

W3-099 Collector Substation line exit - Dual bus protection schemes utilizing SEL587Z and SEL387 relays to be installed. Install scheme for DTT to W3-099 generation for loss of FE source.

Metering

IC 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

IC 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.

IC must also meet all PJM, ReliabilityFirst 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 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 Erie East 230kV Project. Therefore in accordance with the Generation Interconnection procedures defined in the PJM Open Access Transmission Tariff and PJM Manuals, IC is not responsible for network upgrades. However, the FE findings show that there are criteria violations which will have an impact on network congestion and local energy deliverability for both the Primary and Secondary POI. IC will therefore be subject to generation curtailment in order to mitigate these violations. Note that the FE and PJM study results differ due to the differences in the study process and power flow programs utilized. The Primary POI direct connection costs 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. IC will be responsible for the actual cost of the direct connection that is implemented. 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.

IC Requirements

In addition to the FE facilities, IC 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 a fully rated circuit breaker on the high side of the W3-099 230/34.5kV step-up transformer.

2. 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.

3. The purchase and installation of a 230kV interconnection metering instrument transformer. FE will provide the ratio and accuracy specifications based on the customer load and generation levels.

4. The purchase and installation of a revenue class meter for each unit to measure the power delivered in compliance with the FE standards.

5. 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.

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

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

8. The execution of a back-up service agreement to serve the customer load supplied from the W3-099 230kV interconnection substation when the units are out-of-service. This assumes the intent of IC is to net the generation with the load.

9. The rough grade of the property for the W3-099 230kV interconnection 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 Erie East 230kV Project direct connection for the Primary POI will require the facility upgrades defined in Attachment 3. As shown, the total estimated cost of the 230kV three breaker ring bus substation is $6,066,800. The Erie East 230kV Project does not have any required network upgrades. However, the Warren – Falconer WF 115kV was identified as being normally open for the local energy deliverability.

Based on the scope of the direct connection for 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 Erie East 230kV 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 the W3-099 230kV interconnection substation. It also assumes that the Horizon Wind Energy LLC will provide the property for the W3-099 23kV interconnection 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
Erie East 230kV (W3-099) Generation Interconnection Project
Project Location

Attachment 2a
Erie East 230kV (W3-099) Generation Interconnection Project
Primary POI Interconnection Substation Configuration

Attachment 2b
Erie East 230kV (W3-099) Generation Interconnection Project
Secondary POI Interconnection Substation Configuration

Attachment 3
Erie East - Erie South 230kV (W3-021A) Feasibility Study
Direct Connection Requirements

UpgradeID	Description	Total Cost
PN-S-460-1	W3-099 Interconnect Sub: Install 230kV three position ring bus to serve as interconnect for the PJM W3-099 generation project. (ISD 9/30/2014)	$5,299,400.00
PN-S-460-2	Erie East Sub: Replace relaying on 230kV Erie South line to support the addition of the W3-099 generation interconnection substation. (ISD 9/30/2014)	$218,500.00
PN-S-460-3	Erie South Sub: Replace relaying on 230kV Erie East line to support the addition of the W3-099 generation interconnection substation. (ISD 9/30/2014)	$324,500.00
	Engineering Oversight and Commissioning Support of the Interconnection Customer generation substation including support of protective relay installation	$63,900.00
PN-T-132	Erie East-Erie South 230kV, Loop to Proposed Wind Farm: Loop, approx. 200' in length, consists of two 3-way deadend structures and rebuild of adjacent H-frame structures (rebuild outside suspension assemblies by installing 230kV horizontal post insulators). (ISD 9/30/2014)	$160,500.00
Total		$6,066,800.00

Attachment 4

(W3-099) Feasibility Study

FE Contingency Analysis Results

Primary POI: Erie South - Erie East 230 kV Line

Identified New Project Upgrades

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

Contributions To Previously Identified Overloads

Contingency	**Type**	**Outage Description**	**Overloaded Element**	**N/4-Hr Rating**	**MVA Flow**	**% Rating**	**MVA Flow**	**% Rating**	
C5_PN230-TW-#2	Tower	Glade - Forest 230kV and Glade - Lewis Run 230kV Lines	Warren - Falconer WF 115kV Line	80/118 MVA	145.5	123.3	160.2	135.8	WF 115kV would be opened automatically post-contingency per the Special Protection Scheme (SPS) and PJM Operating Procedure on this facility.

Potential Congestion due to Local Energy Deliverability

					FirstEnergy Results		PJM Results		
Contingency	**Type**	**Outage Description**	**Overloaded Element**	**N/4-Hr Rating**	**MVA Flow**	**% Rating**	**MVA Flow**	**% Rating**	
Baseline	None	-	Warren - Falconer WF 115kV Line	80/118 MVA	93.4	116.7	99.3	124.1	During Energy Deliverability, WF 115kV would be opened automatically pre-contingency per the Special Protection Scheme (SPS) and PJM Operating Procedure on this facility.
Baseline	None	-	Lewistown - Juniata 230kV Line	488/617 MVA	520.2	106.6	-	-	WF 115kV Open
B_PN230-SX-#25	Single	Forest - Glade 230kV Line	Lewis Run - Farmers Valley 115kV Line	111/149 MVA	145.9	97.9	158.9	106.7	WF 115kV Open
B_PN345-SX-#6	Single	Handsome Lake - Wayne 345kV Line	Homer City - Shelocta 230kV Line	702/842 MVA	981.4	116.5	-	-	WF 115kV Open. PJM reported 841MVA rating for this facility.
B_PN345-SX-#6	Single	Handsome Lake - Wayne 345kV Line	Shelocta - Keystone 230kV Line	702/842 MVA	952.8	113.2	-	-	WF 115kV Open. PJM reported 841MVA rating for this facility.
KEYSTONE_JACKMTN1_1	Single	Keystone - Juniata 500kV Line	Keystone - Conemaugh 500kV Line	2407/2983 MVA	5009.8	167.9	-	-	WF 115kV Open. PJM reported 2982MVA rating for this facility.

Secondary POI: Erie East 230 kV Substation

Identified New Project Upgrades

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

Contributions To Previously Identified Overloads

C5_PN230-TW-#2	Tower	Glade - Forest 230kV and Glade - Lewis Run 230kV Lines	Warren - Falconer WF 115kV Line	80/118 MVA	145.5	123.3	160.2	135.8	WF 115kV would be opened automatically post-contingency per the Special Protection Scheme (SPS) and PJM Operating Procedure on this facility.

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					FirstEnergy Results		PJM Results		
Contingency	**Type**	**Outage Description**	**Overloaded Element**	**N/4-Hr Rating**	**MVA Flow**	**% Rating**	**MVA Flow**	**% Rating**	
Baseline	None	-	Warren - Falconer WF 115kV Line	80/118 MVA	93.4	116.7	99.3	124.1	During Energy Deliverability, WF 115kV would be opened automatically pre-contingency per the Special Protection Scheme (SPS) and PJM Operating Procedure on this facility.
Baseline	None	-	Lewistown - Juniata 230kV Line	488/617 MVA	521.7	106.9	-	-	WF 115kV Open
B_PN345-SX-#6	Single	Handsome Lake - Wayne 345kV Line	Homer City - Shelocta 230kV Line	702/842 MVA	974.7	115.8	-	-	WF 115kV Open. PJM reported 841MVA rating for this facility.
B_PN345-SX-#6	Single	Handsome Lake - Wayne 345kV Line	Shelocta - Keystone 230kV Line	702/842 MVA	953.7	113.3	-	-	WF 115kV Open. PJM reported 841MVA rating for this facility.
KEYSTONE_JACKMTN1_1	Single	Keystone - Juniata 500kV Line	Keystone - Conemaugh 500kV Line	2407/2983 MVA	5018.7	168.2	-	-	WF 115kV Open. PJM reported 2982MVA rating for this facility.

Attachment 5
Erie East Erie South 230kV (W3-099) Generation Interconnection Project
FE Network Facility Reinforcement Conceptual Cost Estimates

None Required

Attachment 6
Erie East Erie South 230kV (W3-099) Generation Interconnection 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.
an audit.