Generation Interconnection Feasibility Study Report Web Version

For

PJM Generation Interconnection Request Queue Position W3-021A

Corry East 115 kV Project

August, 2011

Feasibility Study Report

Corry East 115 kV 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 70 MW (9.1 MW Capacity) Corry East 115kV (W3-021A) 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 Corry East 115kV (W3-021A) facility. As per the PJM Generation Interconnection study process, the Corry East 115kV (W3-021A) 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 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 35 x 2.0 MW Wind Turbine Generation Project with a total capability of 70 MW (9.1 MW Capacity) on a property that is approximately 3.5 miles south of the existing Corry East 115kV substation (see Attachment 1). For purposes of this report, it has therefore been designated as the Corry East 115kV (W3-021A) Project to reflect its interconnection voltage and its proximity to the Corry East substation. IC has requested the study of both a Primary and Secondary Point of Interconnection (POI) for the Corry East 115kV (W3-021A) 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. It does not contain short circuit analysis, 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 #W3-021A was studied as a 70.0MW(Capacity 9.1MW) injection at Corry East substation in the Penelec area. Project #W3-021A 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 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 are 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)

1. The Warren-Falconer 115 kV line (from bus 200579 to bus 135277 ckt 1) loads from 122.56% to 135.83% (**DC power flow**) of its normal rating (118 MVA) for the tower line contingency ('C5_PN230-TW-#2'). This project contributes approximately 15.66 MW to the thermal violation.

```
CONTINGENCY 'C5_PN230-TW-#2'                    /* GLADE-FOREST &
GLADE-LEWIS RUN 230 KV
  DISCONNECT BRANCH FROM BUS 200581 TO BUS 200593 CKT 1
  DISCONNECT BRANCH FROM BUS 200593 TO BUS 200704 CKT 1
  DISCONNECT BRANCH FROM BUS 200704 TO BUS 200667 CKT 1
  DISCONNECT BRANCH FROM BUS 200704 TO BUS 200705 CKT 2
  DISCONNECT BUS 200704
  END
```

Steady-State Voltage Requirements

Will be addressed at Impact Study phase.

Stability and Reactive Power Requirement

Will be addressed at 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)

See reference to SPS in the Transmission Owner's portion of this report below.

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 99.73% to 105.83% (**DC power flow**) of its rating (149 MVA) for the single line contingency ('B_PN230-SX-#25_WARR-FALC_SPS'). This project contributes approximately 9.08 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 Warren-Falconer 115 kV line (from bus 200579 to bus 135277 ckt 1) loads from 109.53% to 124.06% (**DC power flow**) of its normal rating (80 MVA) for non-contingency condition. This project contributes approximately 11.62 MW to the thermal violation.

Transmission Owner's Analysis Results

The following is the report generated by the Transmission Owner (TO) based on their analysis of the project's impacts on the lower voltage system and the costs and schedules for any transmission and distribution system upgrades.

Primary Point of Interconnection: Corry East 115kV Substation

The Primary POI for this project will be accomplished by adding two 115kV circuit breakers to the existing Corry East 115kV substation to create a 3 breaker ring bus. Procurement and construction of the 3.5 mile 115kV transmission line connecting the Corry East 3 breaker ring bus to the new W3-021A 115/34.5kV collector substation is the responsibility of IC as this facility is not owned by FirstEnergy Corp. IC will be responsible for acquiring all easements, properties and permits that may be required to construct both the reconfiguration of Corry East substation and the associated attachment facilities. Please note that FE requires that an easement is granted or the property is owned for Corry East substation (where FE owned equipment resides). A summary of the Corry East 115kV (W3-021A) Project direct connection facilities that will be required for the Primary POI and their estimated costs are shown on Attachment 3. The one-line for the Primary POI is shown in Attachment 2a.

Secondary Point of Interconnection: Corry East – Warren 115kV Line

The Secondary POI for this project will be accomplished by the construction of a new 115kV 3 breaker ring bus and the looping of the Corry East – Warren 115kV line to it. As mentioned previously, there is not an estimated cost or schedule provided for the Secondary POI. The one-line for the Secondary POI is shown in Attachment 2b.

Power Flow Analysis

A Power Flow study was conducted to determine the reliability impact of the proposed Corry East 115kV (W3-021A) 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 Corry East 115kV (W3-021A) 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 proposed Corry East 115kV substation. A simulation of all possible contingencies within the NERC and FE Planning Standards that are impacted by the Corry East 115kV (W3-021A) Project was conducted to test for criteria compliance. The direct connection of the Corry East 115kV (W3-021A) 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 identical for both the Primary and Secondary POI. As shown, the conclusion from this analysis is that there are no new upgrades required for the Corry East 115kV (W3-021A) 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 under local energy deliverability, 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 the Primary 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 Corry East 115kV (W3-021A) 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 Corry East 115kV (W3-021A) Project on the system protection requirements in this area. The results of this review show that the following relay additions and upgrades will be required:

Buffalo Road Substation – Corry East 115kV line exit

- Breaker status information sent to Corry East/W3-021A Interconnection substation via CS28A carrier to trip W3-021A generation at W3-021A generation substation for breaker open at Buffalo Road.

Warren Substation – Corry East 115kV line exit

- Breaker status information sent to Corry East/W3-021A Interconnection substation via RFL-9785 to trip W3-021A generation at W3-021A generation substation for breaker open at Warren.

Corry East Substation / W3-021A Interconnection Ring Bus Substation

- Buffalo Road Exit – primary protection utilizing DLP and CS28A carrier for DCB protection, backup using DLP. (at Corry East Sub) Wiring from CS28A carrier to trip W3-021A generation for breaker at Buffalo Road substation open to Corry East/W3-021A generation interconnection substation.
- Warrren Exit – primary protection utilizing SEL-321 and RFL-9785 for DCB protection, backup using SEl-311B. Wiring from RFL-9785 receiver to trip W3-021A generation for

breaker at Warren substation open to Corry East/W3-021A generation interconnection substation.

- W3-021A Generation Exit – dual bus protection utilizing SEL-311L relays; DTT via fiber to trip W3-021A generation.
- SEL-352 BF/SC relaying required (one per breaker)

(DTT will trip W3-021A generation breaker if an open breaker/loss of guard signal is received from both Buffalo Road substation and Warren substation. If one substation is still closed the generation will not trip.)

W3-021A Generation Substation

- DTT via fiber to trip W3-021A generation
- Additional relaying to protect this substation supplied by the customer. Customer required to have 2 zones of high-speed protection to clear faults on the 115kV system.

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 Corry East 115kV (W3-021A) 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. In addition, IC is responsible to provide the 115kV transmission line between Corry East substation and the W3-021A 115.34,5kV collector substation, as IC 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.

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 W3-021A 115/34.5kV 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 an 115kV 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 Corry East 115kV 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 Corry East W3-021A Interconnection 115kV 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 Corry East 115kV (W3-021A) Project direct connection for the Primary POI will require the facility upgrades defined in Attachment 3. As shown, the total estimated cost of the reconfigured 115kV three breaker ring bus substation and attachment line is $2,798,000. The Corry East 115kV (W3-021A) 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 Interconnection Service Agreement to complete the installation required for the Corry East 115kV (W3-021A) 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 Corry East/W3-021A Interconnecting substation. It also assumes that the IC will provide the property for the Corry East/W3-021A 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
Corry East 115kV (W3-021A) Generation Interconnection Project
Project Location

Attachment 2a
Corry East 115kV (W3-021A) Generation Interconnection Project
Primary POI Interconnection Substation Configuration

Attachment 2b
Corry East 115kV (W3-021A) Generation Interconnection Project
Secondary POI Interconnection Substation Configuration

Attachment 3
Corry East 115kV W3-021A Feasibility Study
Direct Connection Requirements

UpgradeID	Description	Total Cost
PN-S-258-1	Corry East Sub: Convert existing substation to three position ring bus. (ISD 12/31/2014)	$2,332,300
PN-S-258-2	Buffalo Road Sub: Revise relaying on the 115kV Corry East Line. (ISD 12/31/2014)	$144,500
PN-S-258-3	Warren Sub: Revise relaying on the 115kV Corry East Line. (ISD 12/31/2014)	$257,300
	Engineering Oversight and Commissioning Support of the Interconnection Customer generation substation including support of protective relay installation	$63,900
Total		$2,798,000

Attachment 4

(W3-021A) Feasibility Study

FE Contingency Analysis Results

Primary POI: Corry East 115 kV Substation

Identified New Project Upgrades

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

Contributions To Previously Identified Overloads

					FirstEnergy Results		PJM Results		
Contingency	**Type**	**Outage Description**	**Overloaded Element**	**N/A-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/A-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	516.3	105.8	-	-	WF 115kV Open
B_PN230-SX-#25	Single	Forest - Glade 230kV Line	Lewis Run - Farmers Valley 115kV Line	111/143 MVA	140.3	94.1	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	963.8	114.4	-	-	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	942.7	111.9	-	-	WF 115kV Open. PJM reported 841MVA rating for this facility.
KEYSTONE_JACKMTN1_1	Single	Keystone - Juniata 500kV Line	Keystone - Conemaugh 500kV Line	2407/2383 MVA	4991.8	167.3	-	-	WF 115kV Open. PJM reported 2382MVA rating for this facility.

Secondary POI: Corry East - Warren 115 kV Line

Identified New Project Upgrades

					FirstEnergy Results		PJM Results		FirstEnergy Comments
Contingency	**Type**	**Outage Description**	**Overloaded Element**	**N/A-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.

Contingency	**Type**	**Outage Description**	**Overloaded Element**	**N/A-Hr Rating**	**MVA Flow**	**% Rating**	**MVA Flow**	**% Rating**	

Potential Congestion due to Local Energy Deliverability

					FirstEnergy Results		PJM Results		
Contingency	**Type**	**Outage Description**	**Overloaded Element**	**N/A-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	516.3	105.8	-	-	WF 115kV Open
B_PN230-SX-#25	Single	Forest - Glade 230kV Line	Lewis Run - Farmers Valley 115kV Line	111/143 MVA	140.3	94.1	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	963.8	114.4	-	-	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	942.7	111.9	-	-	WF 115kV Open. PJM reported 841MVA rating for this facility.
KEYSTONE_JACKMTN1_1	Single	Keystone - Juniata 500kV Line	Keystone - Conemaugh 500kV Line	2407/2383 MVA	4991.8	167.3	-	-	WF 115kV Open. PJM reported 2382MVA rating for this facility.

Attachment 5
Corry East 115kV (W3-021A) Generation Interconnection Project
FE Network Facility Reinforcement Conceptual Cost Estimates

None Required

Attachment 6
Corry East 115kV (W3-021A) 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.