Generation Interconnection Feasibility Study Report-Web Version

For

PJM Generation Interconnection Request Queue Position Z1-042

Warrior Ridge – MacLane 46kV Project

February, 2014

Feasibility Study Report

Warrior Ridge – MacLane 46kV 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 (the Interconnection Customer or IC) for the connection of a 46 MW (5.98 MW Capacity) wind Generation Project (the Project) to the Penelec Transmission System. The IC has proposed a commercial operation date of December, 2015 for the Project. As per the PJM RTEP study process, the Warrior Ridge – MacLane 46kV (Z1-042) 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 the IC 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 a 46 MW wind Generation Project with a total capability of 46 MW (5.98 MW Capacity) on a property that adjacent to the Warrior Ridge – MacLane 46kV line (see Attachment 1). For purposes of this report, it has therefore been designated as the Warrior Ridge – MacLane 46kV (Z1-042) Project to reflect its interconnection voltage and its proximity to the Warrior Ridge – MacLane 46kV line. The IC has requested the study of both a Primary and Secondary Point of Interconnection (POI) for the 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.

Primary Point of Interconnection: Warrior Ridge – MacLane 46kV Line
The interconnection of the Project at the primary POI for will be accomplished by constructing a new 46kV three breaker ring bus and looping the Warrior Ridge -

MacLane 46kV line into the new station between Belleville Tap and MacLane. The new 46kV 3 breaker ring bus will be approximately 1.77 miles from Belleville Tap. The IC will be responsible for acquiring all easements, properties and permits that may be required to construct both the new 46kV three breaker ring bus interconnection substation and the associated attachment facilities. The IC will also be responsible for the rough grade of the property and an access road to the proposed three breaker ring bus site. A summary of the 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 2.

Secondary Point of Interconnection: Belleville 46kV Substation
The interconnection of the project at the secondary POI will be a new 46kV four breaker ring bus at the existing Belleville substation. The IC will be responsible for acquiring all easements, properties and permits that may be required to expand Belleville substation. The IC will also be responsible for the rough grade of the property and an access road to the proposed four breaker ring bus site. As mentioned previously, no estimated cost or schedule is provided for the Secondary POI.

PJM Interconnection Study Results

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

Network Impacts

The Queue Project #Z1-042 was studied as a 46.0 MW (Capacity 5.98 MW) injection at Raystown 46 kV substation in the Penelec area. Project #Z1-042 was evaluated for compliance with reliability criteria for summer peak conditions in 2017. Potential network impacts were as follows:

Generator Deliverability

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

None

Light Load Analysis

Light Load Studies to be conducted during later study phases (applicable to wind, coal, nuclear, and pumped storage projects).

Multiple Facility Contingency

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

None

Short Circuit

(Summary form of Cost allocation for breakers will be inserted here if any)

None

Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

None

Steady-State Voltage Requirements

(Results of the steady-state voltage studies should be inserted here)

To be determined

Stability and Reactive Power Requirement

(Results of the dynamic studies should be inserted here)

To be determined

New System Reinforcements

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

None

Contribution to Previously Identified System Reinforcements

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

None

Delivery of Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.
Only the most severely overloaded conditions are listed. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed, which will study all overload conditions associated with the overloaded element(s) identified.

None

Interconnected Transmission Owner's Analysis Results

The following was generated by FirstEnergy (Pennsylvania Electric Company or "Penelec") the Interconnected Transmission Owner, based upon its analysis, as well as that of PJM, for mitigation of the project's impacts on the transmission and lower voltage system as applicable.

Power Flow Analysis

A Power Flow study was conducted to determine the reliability impact of the proposed Warrior Ridge – MacLane 46kV (Z1-042) 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 Power Flow Analysis was performed using a 2017 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 Warrior Ridge - MacLane 46kV line. A simulation of all possible contingencies within the NERC and FE Planning Standards that are impacted by the Project was conducted to test for criteria compliance. The direct connection of the Project to the Penelec transmission system was studied at both the Primary and Secondary POI. Additionally, FE performed an analysis of the 46kV subtransmission system in the area of the proposed project location.

The results from the study Power Flow Analysis showing a comparison of the FE and PJM Transmission contingency study results are detailed on Attachment 4. Also shown are the results of FE analysis of the 46kV subtransmission system. Please note that the Attachment displays the Power Flow Analysis results for both the Primary and Secondary POI. As shown, the conclusion from this analysis is that there are new upgrades required for the Project.

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 FE. The findings show that no circuit breakers are newly over dutied with the addition of the Project to the FE transmission system. The study also showed no significant fault current contribution to the breakers which are near the over-duty limit.

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 6 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. FE will also perform a light load analysis of the 46kV subtransmission system during the system impact study.

The 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.

The IC has requested a non-standard GSU transformer winding configuration. This transformer winding configuration is in violation of FE's Requirements for Transmission Connected Facilities document and will not be accepted. The FE standard winding configuration is a grounded wye winding on the high (transmission) side and a delta winding on the low (generator) side, as shown on the drawing in Attachment 2.

FE Facility Upgrades and Costs

The results from the PJM and FE Power Flow Analysis (Attachment 4) show that there are FE criteria violations that are directly attributable to the output of the Project. Therefore in accordance with the RTEP procedures defined in the PJM Open Access Transmission Tariff and PJM Manuals, the IC is responsible for network upgrades. 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. Interconnection Customer 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.

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 a fully rated plant circuit breaker. A single breaker must be installed that will trip the entire plant.

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 supervisory control and data acquisition (SCADA) equipment to provide information in a compatible format to the FE Transmission System Control Center.

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

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

6. The execution of a back-up service agreement to serve the customer load supplied from the Z1-042 46kV interconnection substation when the units are out-of-service. This assumes the intent of the IC is to net the generation with the load.

7. The rough grade of the property for the Z1-042 46kV 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 Warrior Ridge – MacLane 46kV (Z1-042) Project direct connection for the Primary POI will require the facility upgrades defined in Attachment 3. As shown, the total estimated cost of the 46kV three breaker ring bus substation is $4,319,916. This cost includes a CIAC (Contribution in Aid of Construction) Federal Income Tax Gross Up charge of $987,002. This tax may or may not be charged based on whether or not this project meets the eligibility requirements of IRS Notice 88-129. The Project will require network upgrades to the FE system as defined in Attachment 5. As shown, the total estimated cost of the upgrades is $5,891,000. This cost includes a CIAC (Contribution in Aid of Construction) Federal Income Tax Gross Up charge of $1,364,700.

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 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 Z1-042 46kV interconnection substation. It also assumes that the IC will provide the property for the Z1-042 46kV 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 3
Direct Connection Requirements

Estimate No.	Description	Total with Tax	Tax	Total Cost
PN-S-732-1	**Z1-042 Interconnect SS.** Install new 46kV three breaker ring bus substation for interconnect to PJM Z1-042 project.	$3,312,100	$767,100	$2,545,000
PN-S-732-2	**Lewistown SS.** Install a DTT transmitter to the new Z1-042 interconnect substation for anti-islanding for new developer generation.	$164,000	$38,000	$126,000
PN-S-732-3	**Logan SS.** Install a DTT transmitter to the new Z1-042 interconnect substation for anti-islanding for new developer generation.	$164,000	$38,000	$126,000
PN-S-732-4	**Huntingdon SS.** Install a DTT transmitter to the new Z1-042 interconnect substation for anti-islanding for new developer generation.	$164,000	$38,000	$126,000
PN-S-732-5	**Warrior Ridge SS.** Install a DTT transmitter to the new Z1-042 interconnect substation for anti-islanding for new developer generation.	$164,000	$38,000	$126,000
	Construct 46kV Line Loop to New Station	$84,400	$19,600	$64,800
	Install 46kV Metering in Customer's Substation	$95,816	$8,502	$87,314
EOC	Engineering Oversight and Commissioning	$171,600	$39,800	$131,800
Total		**$4,319,916**	**$987,002**	**$3,332,914**

Attachment 4
FE Contingency Analysis Results

Refer to PJM analysis for Transmission System

Primary POI 46kV Analysis

Overloaded Element	Contingency Description	Rating	% Loading	MW Contribution	Reinforcement
Warrior Ridge – WRH Tap 46kV Line	Warrior Ridge – Tyrone North – Williamsburg 46kV Line	25	132.0%	46	Replace relay at Warrior Ridge.
Warrior Ridge – WRH Tap 46kV Line	Warrior Ridge – Miller REC 46kV Line	25	124.3%	46	Replace relay at Warrior Ridge
Warrior Ridge – WRH Tap 46kV Line	Base Case	25	115.8%	46	Replace relay at Warrior Ridge
Belleville – Center Union 46kV Line	Base Case	32	115.1%	46	Reconductor line with 477 ACSR
Center Union – Warrior Ridge 46kV Line	Base Case	17	198.5%	46	Replace relay and meter at Warrior Ridge.
Belleville Tap – Belleville 46kV Line	Base Case	32	129.6%	46	Reconductor line with 477 ACSR.
Huntingdon – OC1 Tap 46kV Line	Warrior Ridge – Tyrone North – Williamsburg 46kV Line	24	137.2%	46	Replace relay at Huntingdon.
Huntingdon – OC1 Tap 46kV Line	Warrior Ridge – Miller REC 46kV Line	24	129.2%	46	Replace relay at Huntingdon.
Huntingdon – OC1 Tap 46kV Line	Base Case	24	120.4%	46	Replace relay at Huntingdon.
Z1-042 Tap – Belleville Tap 46kV Line	Base Case	31	143.8%	46	Reconductor line with 477 ACSR.

Secondary POI 46kV Analysis

Overloaded Element	Contingency Description	Rating	% Loading	MW Contribution
Warrior Ridge – WRH Tap 46kV Line	Belleville – MacLane 46kV Line	25	134.0%	46
Warrior Ridge – WRH Tap 46kV Line	Warrior Ridge – Tyrone North – Williamsburg 46kV Line	25	132.0%	46
Warrior Ridge – WRH Tap 46kV Line	Warrior Ridge – Miller REC 46kV Line	25	124.3%	46
Warrior Ridge – WRH Tap 46kV Line	Base Case	25	115.8%	46
Belleville – Center Union 46kV Line	Belleville – MacLane 46kV Line	32	129.3%	46
Belleville – Center Union 46kV Line	Base Case	32	115.1%	46
Center Union – Warrior Ridge 46kV Line	Belleville – MacLane 46kV Line	17	225.3%	46
Center Union – Warrior Ridge 46kV Line	Base Case	17	198.5%	46
Huntingdon – OC1 Tap 46kV Line	Belleville – MacLane 46kV Line	24	139.3%	46
Huntingdon – OC1 Tap 46kV Line	Warrior Ridge – Tyrone North – Williamsburg 46kV Line	24	137.2%	46
Huntingdon – OC1 Tap 46kV Line	Warrior Ridge – Miller REC 46kV Line	24	129.2%	46
Huntingdon – OC1 Tap 46kV Line	Base Case	24	120.4%	46

Attachment 5
FE Network Facility Reinforcement Conceptual Cost Estimates

Warrior Ridge: Upgrade relay on WRH Line

Estimate No.	Description	Total with Tax	Tax	Total Cost
PN-S-752	Replace Relay on the WRH Line Exit. @ Warrior Ridge	$97,700	$22,700	$75,000
Total		$97,700	$22,700	$75,000

Belleville – Center Union: Reconductor Line

Estimate No.	Description	Total with Tax	Tax	Total Cost
	Belleview - Center Union. Reconductor approximately 13.8 miles with 477 ACSR conductor.	$4,652,600	$1,077,600	$3,575,000
Total		$4,652,600	$1,077,600	$3,575,000

Warrior Ridge: Upgrade Center Union Terminal

Estimate No.	Description	Total with Tax	Tax	Total Cost
PN-S-755	Replace Relay and Meter Center Union REC exit. @ Warrior Ridge	$119,300	$27,700	$91,600
Total		$119,300	$27,700	$91,600

Belleville – Belleville Tap: Reconductor Line

Estimate No.	Description	Total with Tax	Tax	Total Cost
	Belleview - Belleview Tap. Reconductor approximately 0.97 miles with 477 ACSR conductor.	$327,100	$75,800	$251,300
Total		$327,100	$75,800	$251,300

Huntingdon: Upgrade OC1 line relaying

Estimate No.	Description	Total with Tax	Tax	Total Cost
PN-S-753	Replace relay on OC1 Tap line. @ Huntingdon	$97,700	$22,700	$75,000
Total		$97,700	$22,700	$75,000

Z1-042 Tap – Belleville Tap: Reconductor Line

Estimate No.	Description	Total with Tax	Tax	Total Cost
	Z1-042 - Belleview Tap. Reconductor approximately 1.77 miles with 477 ACSR conductor.	$596,600	$138,200	$458,400
Total		$596,600	$138,200	$458,400

Attachment 6
FE Revenue Metering Requirements

The FirstEnergy Revenue Metering Requirements may be found in the FirstEnergy Requirements for Transmission Connected Facilities document located at the following links:

www.firstenergycorp.com/feconnect
www.pjm.com/planning/design-engineering/to-tech-standards.aspx