Generation Interconnection Feasibility Study Report Web Version

For

PJM Generation Interconnection Request Queue Position Z2-038

Frostburg-Ridgeley 138 kV Generation Project

August 2014

Feasibility Study Report – Web Version

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Introduction

This Feasibility Study report provides the documentation of an assessment that has been performed by PJM Interconnection LLC and FirstEnergy (FE) in response to a request made by Interconnection Customer for the connection of a 19.9 MW (7.6 MW Capacity) generation project to the Frostburg – Ridgeley 138 kV line, PJM queue number Z2-038, on the Potomac Edison transmission system. This assessment was accomplished by:

1. Evaluating the reliability impact of the proposed facilities and connection on the interconnected transmission and subtransmission systems 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 conducting meetings and issuing this report as a part of the Regional Transmission Expansion Planning ("RTEP") study process;
4. Performing a Steady State, Short-Circuit and Dynamics study as necessary;
5. Conducting all studies in accordance with the PJM Manuals and the FE "Requirements for Transmission Connected Facilities" document to assure that the assessment performed incorporates study assumptions, follows the documented system performance procedures, considers alternative connection and reinforcement plans, and jointly coordinates the study recommendations.

Connection Facilities

In compliance with the RTEP protocol, Interconnection Customer has submitted a "Form of Generation Interconnection Feasibility Study Agreement" to PJM that identifies its plan to construct the Frostburg – Ridgeley 138 kV (Z2-038) Generation Project ("Z2-038") with PV cells. The installed facilities will have a total generating capability of 19.9 MW, of which, 7.6 MW will be recognized by PJM as a capacity resource.

The proposed point of interconnection ("POI") for the Z2-038 generation project will be located on the Frostburg – Ridgeley 138 kV line. Attachment 1 provides the proposed location for the POI. The direct connection of Z2-038 will be accomplished by building a 3 breaker ring bus substation on the Frostburg – Ridgeley 138 kV line. Attachment 2 shows a conceptual one-line diagram of the proposed connection of Z2-038 to the Potomac Edison transmission system. The Interconnection Customer will be responsible for constructing all of the facilities on its side of the POI including the attachment line.

Interconnection Customer may not install above ground equipment within any FE right-of-way unless permission to do so is expressly granted by FE. The FE facilities required to be upgraded for the Direct Connection of the generation project and the associated cost estimate are shown in Attachment 3.

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 Z2-038 was studied as a 19.9 MW (Capacity 7.6 MW) injection as a tap of the Ridgeley – Frostburg 138 kV substation in the APS area. Project Z2-038 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project Z2-038 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Analysis - 2018

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

None

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

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

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. (AP - AP) The 01GARRET-01ALBRIG 138 kV line (from bus 235469 to bus 235120 ckt 1) loads from 101.13% to 103.02% (**DC power flow**) of its emergency rating (191 MVA) for the single line contingency outage of 'B_PN115-LX-#198_A'. This project contributes approximately 3.62 MW to the thermal violation.

CONTINGENCY 'B_PN115-LX-#198_A' /* SOMERSET-ROCKWOOD & ROCKWOOD #1 XF
DISCONNECT BRANCH FROM BUS 200744 TO BUS 200746 CKT 1
DISCONNECT BRANCH FROM BUS 200746 TO BUS 200773 CKT 1
END

Light Load Analysis - 2018

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

System Reinforcements

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

Short Circuit

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

The analysis determined that no FE transmission circuit breakers will exceed their interrupting capability with the interconnection of the Z2-038 generation project.

Stability and Reactive Power Requirement

(Results of the dynamic studies should be inserted here)

To be performed, if required, in the System Impact Study Phase.

Interconnected Transmission Owner's Analysis Results

The following was prepared by FirstEnergy 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. It includes the costs and schedules for any system upgrades.

Power Flow Analysis

A power flow study was conducted to determine the reliability impact of the proposed Z2-038 generation project on the FE transmission system. This study was completed using a 2017 summer peak power flow model that contain a detailed representation of the Potomac Edison transmission network in the area of the proposed Z2-038 generation project. The findings and the recommendations from this analysis are based on a contingency review that was performed to identify the facility loadings and/or voltage conditions that violate the ReliabilityFirst, PJM, or FE Planning Criteria and are attributable to this project. Note that in accordance with PJM RTEP study procedures, the Z2-038 generation project under study and earlier active queue projects are considered to be in-service. All active queue projects after the Z2-038 project are considered not in-service.

As shown in Attachment 2, the Z2-038 generation project was studied with a connection to the Frostburg – Ridgeley 138 kV line using a new 3 breaker ring bus. The results of the FE analysis show that there are no network upgrades required for the deliverability of the Z2-038 capacity generation to the FE transmission system. However, the PJM and FE findings show that there are criteria violations which will have an impact on network congestion and local energy deliverability in the PJM Energy Deliverability case as detailed in Attachment 4. As a result, the Z2-038 generation project has the option to upgrade the criteria violation or be subject to generation curtailment in order to mitigate these violations.

Short Circuit and Dynamics Analysis

In accordance with the RTEP process, a short circuit analysis was conducted by PJM and confirmed by the FE Protection staff. The analysis determined that no FE transmission circuit breakers will exceed their interrupting capability with the interconnection of the Z2-038 generation project.

In accordance with the RTEP Study process, the results of a dynamic analysis for the Z2-038 generation project will be included in the System Impact Study stage of the RTEP process.

System Protection Analysis

An analysis was conducted to assess the impact of the generation project on the system protection requirements in the area. The review has identified the following direct connect tie line protection requirements:

- 138 kV Tie Line Relaying
- 138 kV Breaker Failure Relaying
- DC Power
- Communications
- Anti-islanding/Transfer-trip

Attachment 5 shows the specific power and protection equipment requirements.

Metering

Interconnection Customer will be required to comply with all FE revenue metering requirements for generation interconnection customers. The FE revenue metering requirements may be found in the FE "Requirements for Transmission Connected Facilities" document located at the following links:

http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx

Compliance Issues

The proposed interconnection facilities must be designed in accordance with the FE "Requirements for Transmission Connected Facilities" document located at:

http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx

Interconnection Customer will also be responsible for following the requirements of the FE "Approved Vendors and Contractors" document which is also located at the above link.

Interconnection Customer will also be required to meet all PJM, ReliabilityFirst and NERC reliability criteria and operating procedures for standards compliance. For example, Interconnection Customer will need to properly locate and report the over and under voltage and over and under frequency system protection elements for its units as well as the submission of the generator model and protection data required to satisfy the PJM and ReliabilityFirst audits. Failure to comply with these requirements may result in a disconnection of service if the violation is found to compromise the reliability of the FE system.

FE Facility Upgrades and Costs

The results of the FE power flow analysis for the Z2-038 generation project show that there are no FE criteria violations directly attributable to the capacity of the Project. Therefore in accordance with the RTEP procedures defined in the PJM Open Access Transmission Tariff and PJM Manuals, the Z2-038 generation project is not responsible for any network upgrades. However, the PJM and FE findings show that there are criteria violations which will have an impact on network congestion and local energy deliverability in the PJM Energy Deliverability case. As a result, the Z2-038 generation project has the option to upgrade the criteria violation or be subject to generation curtailment in order to mitigate these violations.

The direct connection requirements for the Z2-038 generation project to the Potomac Edison transmission system is detailed in Attachment 3.

The associated one-line with the generation project direct connection is shown in Attachment 2.

Note that all cost estimates contained in this document were produced without a detailed engineering review and are therefore subject to change. 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 metering, disconnect switches and high-side breakers for each unit, as Interconnection Customer will own this equipment. 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 or subtransmission systems.

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 fully rated 138 kV circuit breaker on the high side of the Z2-038 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 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 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 Z2-038 generation project metering point when the units are out-of-service. This assumes the intent of Interconnection Customer is to net the generation with the load.

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

Summary

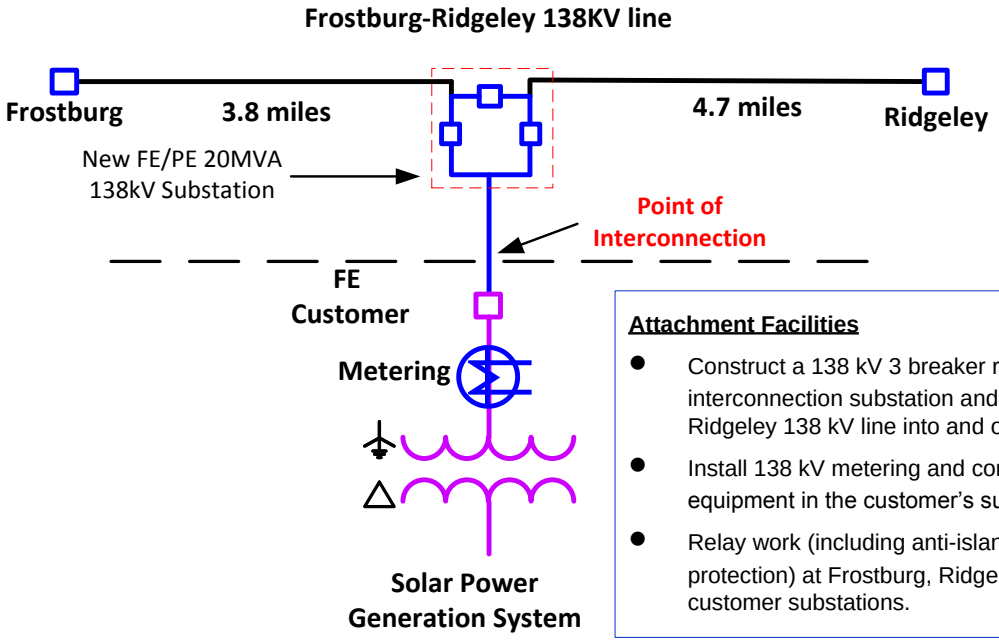
The Interconnection Customer generation project direct connection will require the facility upgrades defined in Attachment 3. As shown in Attachment 3, the estimated cost of the new Z2-038 Direct Connection facilities (substation, breaker, disconnects, CTs, VTs, etc.) is $5,219,900. This cost includes a Federal Income Tax Gross Up charge of $ 1,080,700. This tax may or may not be charged based on whether or not this project meets the eligibility requirements of IRS Notice 88-129. Power flow results for the Z2-038 generation project shows that no facility upgrades in the FE service territory are required.

Based on the extent of the FE primary Direct Connection and system upgrades required to support the Z2-038 generation project, it is expected to take a minimum of 20 months from the date of a fully executed Interconnection Construction Service Agreement to complete the installation. This includes the requirement for Interconnection Customer to make a preliminary payment to FE which funds the first three months of engineering design that is related to the construction of the Direct Connection facilities. It further assumes that Interconnection Customer will provide all rights-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 all system outages will be allowed when requested.

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

Attachment 1
Frostburg – Ridgeley 138 kV
(Z2-038) Generation Project
Project Location

Attachment 2
Frostburg – Ridgeley 138 kV
(Z2-038) Generation Project
Interconnection Customer
Proposed Interconnection Single Line Diagram



Attachment Facilities

- Construct a 138 kV 3 breaker ring bus interconnection substation and loop the Frostburg-Ridgeley 138 kV line into and out of the substation.
- Install 138 kV metering and commission protection equipment in the customer's substation.
- Relay work (including anti-islanding/transfer-trip protection) at Frostburg, Ridgeley, and the Z2-038 customer substations.

Attachment 3
Frostburg – Ridgeley 138 kV
(Z2-038) Generation Project
Primary Direct Connection Requirements

Estimate No.	Description	Total with Tax	Tax	Total Cost
PE-S-179	**Z2-038 Interconnection SS.** Construct a 3 breaker ring bus interconnection substation including property, grading, ground grid, fence, foundations, control building, breakers and all associated facilities.	4,383,700	907,400	3,476,300
PE-S-180	**Ridgeley SS.** Relay work associated with Z2-038 Interconnection.	8,800	1,900	6,900
PE-S-181	**Frostburg SS.** Relay work associated with Z2-038 Interconnection.	8,800	1,900	6,900
PE-S-182	**Z2-038 Customer Station SS.** Install metering and commission protection equipment	160,700	33,300	127,400
PE-T-30	**Hazelton-Ridgeley 138kV, Loop to 3-Breaker Ring Bus for PJM Z2-038.** Install a loop, approx. 200' in length, from the Frostburg-Ridgeley section of the Hazelton-Ridgeley 138kV line to the proposed 3-breaker ring bus interconnecting substation for PJM Z2-038.	499,500	103,400	396,100
EOC FE-7 No OTB	Engineering Oversight and Commissioning - FE Construction (No-OTB) - FE-7	158,400	32,800	125,600
	Totals	**5,219,900**	**1,080,700**	**4,139,200**

Attachment 4
Frostburg – Ridgeley 138 kV
(Z2-038) Generation Project
PJM Contingency Analysis Results

Table 1: Overloads Identified by PJM Energy Deliverability Study

Outage Description	Overloaded Element	Rating (MVA)	CTG Flow (MVA)	% 4-Hr Rating
'B_PN115-LX-#198_A' Somerset-Rockwood ckt 1 & Rockwood #1 transformer	Garrett to Albright 138 kV line	191	196.8	**103.02**

Attachment 5
Frostburg – Ridgeley 138 kV
(Z2-038) Generation Project
Detailed Protection Requirements

Z2-038 GENERAL PROTECTION REQUIREMENTS

At the new Z2-038 three breaker ring bus switchyard, two fiber optic pilot channels for relay communication will be required between the new FE three breaker ring bus switchyard and the location of the 138 kV high side breaker for the generation station GSU transformer. Two line differential relays will provide redundant protection for this interconnection line, and will also serve as redundant communication channels for breaker failure transfer trip.

Directional Comparison Blocking schemes will be employed on the 138 kV lines to Frostburg and Ridgeley. A non-pilot step distance backup scheme will be utilized on these lines.

Exiting power line carrier based relay communication at Ridgeley, Frostburg, Finzel, and Hazleton will be used. No new equipment at these locations will be required.

At Ridgeley, the existing power line carrier frequencies for the blocking scheme pilot channel and for the anti-islanding scheme transmitter will need to be changed. Frequencies at Frostburg, Finzel, and Hazleton will remain unchanged.

Relay settings will need to be changed at Ridgeley, Frostburg, Finzel, Hazleton, and possibly other nearby stations for proper coordination as determined during the relay setting calculation process.