

***Generation Interconnection
Feasibility Study Report***

For

***PJM Generation Interconnection Request
Queue Position Z1-069***

Gold – Sabinsville 115kV Project

March 2014

Feasibility Study Report

Gold – Sabinsville 115kV Project

Introduction

This Feasibility Study report provides the documentation of an assessment that has been performed by FirstEnergy (FE) in response to a request made by the Interconnection Customer (IC) for the connection of a 70 MW (14.7 MW Capacity) Wind Generation Project (the Project) to the Penelec Transmission System. The IC has proposed commercial operation date of December, 2016 for the Project.

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 70 MW Wind Generation Project with a total capability of 70 MW (14.7 MW Capacity) on a property that is adjacent to the Gold – Sabinsville segment of the Niles Valley – Potter 115kV line (see Attachment 1). For purposes of this report, it has therefore been designated as the Gold – Sabinsville 115kV (Z1-069) Project to reflect its interconnection voltage and its proximity to the Gold – Sabinsville 115kV line.

The interconnection of the Project for will be accomplished by constructing a new 115kV 3 breaker ring bus and looping the Niles Valley - Potter 115kV line into the new station between Gold and Sabinsville substations. The new 115kV 3 breaker ring bus will be approximately 7.76 miles from Sabinsville substation. The IC will be responsible for acquiring all easements, properties and permits that may be required to construct both the new 115kV 3 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 3 breaker ring bus site. A summary of the Project direct connection facilities and their estimated costs are shown on Attachment 3. The one-line for is shown in Attachment 2.

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 #Z1-069 was studied as a 70.0 MW (Capacity 13.3 MW) injection as a tap of the Gold – Sabinsville 115 kV line in the Penelec area. Project #Z1-069 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)

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.

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. (PENELEC - PENELEC) The E.TWANDA-CNYO&G 230 kV line (from bus 200675 to bus 200924 ckt 1F) loads from 105.2% to 106.84% (**DC power flow**) of its emergency rating (549 MVA) for the line fault with failed breaker contingency outage of 'PL100926'. This project contributes approximately 9.0 MW to the thermal violation.

CONTINGENCY 'PL100926' /* SUSQUEHANNA 230KV
TIE CB TO SUSQ G1
DISCONNECT BRANCH FROM BUS 208113 TO BUS 208114 CKT 1
DISCONNECT BRANCH FROM BUS 208113 TO BUS 234250 CKT 1
DISCONNECT BUS 208117
END

Please refer to Appendix 1 for a table containing the generators having contribution to this flowgate.

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)

1. (PENELEC - PENELEC) The E.TWANDA-CNYO&G 230 kV line:

Re-conductor 230 kV line with 1033 ACSS conductor. Upgrade terminal equipment at East Towanda. Replace switch at Canyon. Estimated Cost: \$14,269,200 including \$3,304,800 in tax; Estimated Time: 33 months

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 overloaded conditions associated with the overloaded element(s) identified.

1. (PENELEC - PENELEC) The EV DRIVE P47-SOUTH TR 115 kV line (from bus 200885 to bus 200673 ckt 1) loads from 94.0% to 102.08% (**DC power flow**) of its emergency rating (149 MVA) for the single line contingency outage of 'B_PN345-SX-#8B'. This project contributes approximately 12.03 MW to the thermal violation.

CONTINGENCY 'B_PN345-SX-#8B' /* FUTURE
MAINESBRG - WATERCURE ROAD 345 KV
DISCONNECT BRANCH FROM BUS 200930 TO BUS 130757 CKT 1
END

2. (PENELEC - PENELEC) The E.TWANDA-CNYO&G 230 kV line (from bus 200675 to bus 200924 ckt 1F) loads from 102.05% to 103.91% (**DC power flow**) of its normal rating (488 MVA) for non-contingency condition. This project contributes approximately 9.06 MW to the thermal violation.

3. (PENELEC - PENELEC) The N.MESHPPN-OXBOW 230 kV line (from bus 200706 to bus 200708 ckt 1) loads from 116.79% to 118.72% (**DC power flow**) of its emergency rating (617 MVA) for the single line contingency outage of 'SUSQ 1'. This project contributes approximately 11.93 MW to the thermal violation.

CONTINGENCY 'SUSQ 1'
REMOVE MACHINE 1 FROM BUS 208918
END

4. (PENELEC - PL) The OXBOW-LACK 230 kV line (from bus 200708 to bus 208009 ckt 1) loads from 127.96% to 130.17% (**DC power flow**) of its normal rating (494 MVA) for non-contingency condition. This project contributes approximately 12.12 MW to the thermal violation.

5. (PENELEC - PENELEC) The N.MESHPN 230/115 kV transformer (from bus 200825 to bus 200706 ckt 3) loads from 132.99% to 133.97% (**DC power flow**) of its emergency rating (188 MVA) for the single line contingency outage of 'B_PN230-SX-#11'. This project contributes approximately 4.53 MW to the thermal violation.

```
CONTINGENCY 'B_PN230-SX-#11'                /* EAST TOWANDA - N
MESHOPPEN (ETP) 230 KV & N MESHOPPEN BK 4
DISCONNECT BRANCH FROM BUS 200675 TO BUS 200924 CKT 1F
DISCONNECT BRANCH FROM BUS 200924 TO BUS 200706 CKT 1F
DISCONNECT BRANCH FROM BUS 200706 TO BUS 200677 CKT 4
END
```

6. (PENELEC - PENELEC) The NO MESH0-MESH2REA 115 kV line (from bus 200677 to bus 200825 ckt 3) loads from 132.99% to 133.97% (**DC power flow**) of its emergency rating (188 MVA) for the single line contingency outage of 'B_PN230-SX-#11'. This project contributes approximately 4.53 MW to the thermal violation.

```
CONTINGENCY 'B_PN230-SX-#11'                /* EAST TOWANDA - N
MESHOPPEN (ETP) 230 KV & N MESHOPPEN BK 4
DISCONNECT BRANCH FROM BUS 200675 TO BUS 200924 CKT 1F
DISCONNECT BRANCH FROM BUS 200924 TO BUS 200706 CKT 1F
DISCONNECT BRANCH FROM BUS 200706 TO BUS 200677 CKT 4
END
```

7. (PENELEC - PENELEC) The N.MESHPN-OXBOW 230 kV line (from bus 200706 to bus 200708 ckt 1) loads from 133.29% to 135.53% (**DC power flow**) of its normal rating (478 MVA) for non-contingency condition. This project contributes approximately 11.93 MW to the thermal violation.

Interconnected Transmission Owner's Analysis Results

The following was generated 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 FirstEnergy system upgrades only.

Costs for affected Transmission owners other than FirstEnergy, if applicable, are included and reported in the "New System Reinforcements" and "Contribution to Previously Identified System Reinforcements" sections of the "PJM Interconnection Study Results" above.

Power Flow Analysis

A Power Flow study was conducted to determine the reliability impact of the proposed Gold – Sabinsville 115kV (Z1-069) 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 Gold - Sabinsville 115kV 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 conclusion from this analysis is that there are upgrades required for the Project.

Short Circuit and Dynamics Analysis

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.

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 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 capacity 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 direct connection costs are detailed in Attachment 3.

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 circuit breaker on the high side of the Z1-069 115/34.5kV 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 Z1-069 115kV interconnection substation when the units are out-of-service. This assumes the intent of the IC is to net the generation with the load.
9. The rough grade of the property for the Z1-069 115kV 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 Gold – Sabinsville 115kV (Z1-069) Project direct connection for the Primary POI will require the facility upgrades defined in Attachment 3. As shown, the total estimated cost of the 115kV three breaker ring bus substation is \$6,324,400. This cost includes a CIAC (Contribution in Aid of Construction) Federal Income Tax Gross Up charge of \$1,189,600. 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 also require network upgrades to the FE system as defined in Attachment 5. As shown, the total estimated cost of those upgrades is \$14,269,200. This cost includes a CIAC (Contribution in Aid of Construction) Federal Income Tax Gross Up charge of \$3,304,800. PJM is responsible for determining the cost allocation of the upgrades.

Based on the scope of the direct and non-direct connection for the Primary POI, it is expected to take a minimum of 33 months 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 Z1-069 115kV direct connection interconnection substation. It also assumes that the IC will provide the property for the Z1-069 115kV 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 Project Location

Attachment 2

Substation Configuration

Attachment 3 Direct Connection Requirements

Estimate No.	Description	Total with Tax	Tax	Total Cost
PN-S-728	Sabinsville SS. Modify drawing references and nameplates.	\$15,000	\$3,500	\$11,500
PN-S-733	Z1-069 Interconnect SS. Install new 115kV three breaker ring bus substation for interconnect to PJM Z1-069 project.	\$5,707,000	\$1,047,900	\$4,659,100
PN-S-740	Niles Valley SS. Modify drawing references and nameplates.	\$15,000	\$3,500	\$11,500
PN-T-200	Gold – Sabinsville 115kV. Install a loop, approx. 200' in length, consisting of two 3-way dead-end structures and rebuild of adjacent H-frame structures (rebuild outside suspension assemblies by installing 138kV horizontal post insulators).	\$415,800	\$94,900	\$320,900
EOC	Engineering Oversight and Commissioning	\$171,600	\$39,800	\$131,800
Total		\$6,324,400	\$1,189,600	\$5,134,800

Attachment 4

FE Contingency Analysis Results

Refer to PJM load flow analysis.

Attachment 5

FE Network Facility Reinforcement Conceptual Cost Estimates

East Towanda – Canyon 230kV

Estimate No.	Description	Total with Tax	Tax	Total Cost
PN-S-744	East Towanda: Upgrade terminal equipment	\$32,100	\$7,500	\$24,600
PN-S-745	Canyon: Upgrade terminal equipment	\$103,600	\$24,000	\$79,600
PN-T-201	East Towanda – Canyon 230kV: Reconductor the 12.3 mile East Towanda – Canyon 230kV line with 1033 kcmil ACSS.	\$14,133,500	\$3,273,300	\$10,860,200
Total		\$14,269,200	\$3,304,800	\$10,964,400

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

Appendices

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact.

It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

Appendix 1

(PENELEC - PENELEC) The E.TWANDA-CNYO&G 230 kV line (from bus 200675 to bus 200924 ckt 1F) loads from 105.2% to 106.84% (**DC power flow**) of its emergency rating (549 MVA) for the line fault with failed breaker contingency outage of 'PL100926'. This project contributes approximately 9.0 MW to the thermal violation.

CONTINGENCY 'PL100926'

/* SUSQUEHANNA 230KV

TIE CB TO SUSQ G1

DISCONNECT BRANCH FROM BUS 208113 TO BUS 208114 CKT 1

DISCONNECT BRANCH FROM BUS 208113 TO BUS 234250 CKT 1

DISCONNECT BUS 208117

END

Bus Number	Bus Name	Full Contribution
200887	ARMNA MT P47	0.14
203261	BLOSSBCT	0.14
200857	LAURHILL	13.83
203283	MANOR	0.01
294573	P-028 E	-13.47
200888	P-047 E	15.04
296914	R-092 C	1.
296915	R-092 E	4.
200715	SHAWVL 1	9.79
200722	SHAWVL 2	9.91
200665	SHAWVL 3	14.47
292391	T-121 C	1.5
292392	T-121 E	6.01
889011	U2-015 C	-0.85
889012	U2-015 E	-5.7
297050	V2-019 E	< 0.01
901902	W1-111 E	1.33
907481	X1-109	10.14
910522	X3-003 E	-2.25
X3-050	X3-050	13.22
Y2-044	Y2-044	10.99
914131	Y2-055	3.3
Y2-068	Y2-068	65.5
Y2-082	Y2-082	33.2
915642	Y3-104 E	2.35

Z1-019	Z1-019	79.61
916261	Z1-069 C	1.89
916262	Z1-069 E	7.11