

***Generation Interconnection
Feasibility Study Report***

For

***PJM Generation Interconnection Request
Queue Position AB1-160***

Gold-Sabinsville 115kV

February 2016

Preface

The intent of the feasibility study is to determine a plan, with ballpark cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the Interconnection Customer. The Interconnection Customer may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: (1) Direct Connections, which are new facilities and/or facilities upgrades needed to connect the generator to the PJM network, and (2) Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system.

In some instances a generator interconnection may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection, may also contribute to the need for the same network reinforcement. The possibility of sharing the reinforcement costs with other projects may be identified in the feasibility study, but the actual allocation will be deferred until the impact study is performed.

The Feasibility Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. The project developer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

The conduct of light load analysis as required under the PJM planning process is not performed during the Generation Interconnection Feasibility Study phase of the PJM study process. Additional reinforcement requirements for this Interconnection Request may be defined during the conduct of the light load analysis which shall be performed following execution of the System Impact Study agreement.

General

The Interconnection Customer (IC), has proposed an uprate to a proposed wind generating facility located in Potter County, Pennsylvania. The increase is for 20 MW with 3.8 MW of this output being recognized by PJM as capacity. Note that this project is an increase to the Interconnection Customer's prior project, which will share the same property and connection point. The proposed in-service date for the AB1-160 project is December 2017. **This study does not imply a Pennsylvania Electric Company (Penelec) commitment to this in-service date.**

Point of Interconnection

AB1-160 will interconnect with the Penelec transmission system Gold-Sabinsville 115kV line.

Cost Summary

The AB1-160 project will be responsible for the following costs:

Description	Cost
Attachment Facilities	\$ 0
Direct Connection Network Upgrades	\$ 0
Non Direct Connection Network Upgrades	\$ 0
Total Costs	\$ 0

In addition, the AB1-160 project may be responsible for a contribution to the following costs:

Description	Cost	Tax (if applicable)	Total Cost
New System Upgrades	\$ 5,871,800	\$ 1,822,820	\$ 7,694,620
Previously Identified Upgrades	\$ 5,661,000	\$ 1,757,380	\$ 7,418,380
Total Costs	\$ 11,532,800	\$ 3,580,200	\$ 15,113,000

Cost allocations for these upgrades will be provided in the System Impact Study Report.

Attachment Facilities

No Attachment facilities are required to support this interconnection.

Direct Connection Cost Estimate

No Direct Connection facilities are required to support this interconnection.

Non-Direct Connection Cost Estimate

No Non-Direct Connection facilities are required to support this interconnection.

Interconnection Customer Requirements

1. An Interconnection Customer entering the New Services Queue on or after October 1, 2012 with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.
2. The Interconnection Customer may be required to install and/or pay for metering as necessary to properly track real time output of the facility as well as installing metering which shall be used for billing purposes. See Section 8 of Appendix 2 to the Interconnection Service Agreement as well as Section 4 of PJM Manual 14D for additional information.
3. The purchase and installation of a fully rated circuit breaker to protect the AB1-160 generator lead line. A single breaker must be used to protect this line; individual GSU transformer breakers cannot be used to protect this line.
4. 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.
5. The purchase and installation of a 115kV interconnection metering instrument transformer. FE will provide the ratio and accuracy specifications based on the customer load and generation levels.
6. The purchase and installation of a revenue class meter for each unit to measure the power delivered in compliance with the FE standards.
7. 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.

8. The establishment of dedicated communication circuits for SCADA report to the FE Transmission System Control Center.
9. A compliance with the FE and PJM generator power factor and voltage control requirements.
10. The execution of a back-up service agreement to serve the customer load supplied from the AB1-160 115kV interconnection substation when the units are out-of-service.
11. The rough grade of the property for the AB1-160 115kV interconnection substation and an access road for the delivery of equipment to this site.

Revenue Metering and SCADA Requirements

PJM Requirements

The Interconnection Customer will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Sections 24.1 and 24.2.

Penelec Requirements

The Interconnection Customer will be required to comply with all FE Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "FirstEnergy Requirements for Transmission Connected Facilities" document located at the following links:

<http://www.firstenergycorp.com/feconnect>

<http://www.pjm.com/planning/design-engineering/to-tech-standards.aspx>

Network Impacts

The Queue Project AB1-160 was evaluated as a 20.0 MW (Capacity 3.8 MW) injection tapping the Sabinsville-N036 115kV line (Z1-069 POI) in the Penelec area. Project AB1-160 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AB1-160 was studied with a commercial probability of 53% using a 2019 Summer Peak case. Potential network impacts were as follows:

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
APS_B_G698	CONTINGENCY 'APS_B_G698' / 200663 TWOMILE 115 235234 01POTTER 115 1 OPEN BRANCH FROM BUS 200663 TO BUS 235234 CKT 1 END
B_PN115-SX-#58A	CONTINGENCY 'B_PN115-SX-#58A' /* FUTURE MANSFIELD-MAINESBRG 115 KV DISCONNECT BRANCH FROM BUS 200672 TO BUS 200929 CKT 1F /* MANSFIEL 115.00 MAINESBRG115.00 END
B_PN230-SX-#25	CONTINGENCY 'B_PN230-SX-#25' /* FOREST - GLADE 230 KV DISCONNECT BRANCH FROM BUS 200581 TO BUS 200593 CKT 1 END
B_PN345-SX-#6	CONTINGENCY 'B_PN345-SX-#6' /* HANDSOME LAKE - WAYNE (WHL) 345 KV - (PJM-PN33A) DISCONNECT BRANCH FROM BUS 200826 TO BUS 200595 CKT 1 END
B_PN345-XF-#275	CONTINGENCY 'B_PN345-XF-#275' /* FUTURE MAINEBURG 345-115 XFMR DISCONNECT BRANCH FROM BUS 200930 TO BUS 200929 CKT 2F END
C2_PN230-SB-8C1	CONTINGENCY 'C2_PN230-SB-8C1' /* FUTURE GLADE 230 KV STUCK CB - CB5 (WARREN #1/FOREST) DISCONNECT BRANCH FROM BUS 200581 TO BUS 200593 CKT 1 OPEN BRANCH FROM BUS 200593 TO BUS 200811 CKT 1 /* GLADE - WARREN #1 230KV END
C2_PN345-SB-8A1	CONTINGENCY 'C2_PN345-SB-8A1' /* FUTURE MAINESBURG 345KV SB OPEN BRANCH FROM BUS 200930 TO BUS 200929 CKT 2F /* MAINESBURG 345/115KV XFMR OPEN BRANCH FROM BUS 200930 TO BUS 130757 CKT 1 /* MAINESBURG - WATERCURE ROAD 345KV OPEN BUS 203426 /* MAINESBURG FSS END

Contingency Name	Description
C2_PN345-SB-8B1_A	CONTINGENCY 'C2_PN345-SB-8B1_A' /* FUTURE MAINESBURG 345KV SB OPEN BRANCH FROM BUS 200930 TO BUS 200929 CKT 2F /* MAINESBURG 345/115KV XFMR OPEN BRANCH FROM BUS 200930 TO BUS 920780 CKT 1F /* MAINESBURG - RENOVO 345KV OPEN BUS 203426 /* MAINESBURG FSS END
C5_PN230-TW-#2A	CONTINGENCY 'C5_PN230-TW-#2A' /* 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 END

Generator Deliverability

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

None.

Multiple Facility Contingency

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

#	Contingency		Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution	Ref
	Type	Name			From	To	Circuit		Initial	Final	Type	MVA		
1	LFFB	C2_PN345-SB-8A1	PENELEC	26EVERT DR-26SOUTH TR 115 kV line	200885	200673	1F	DC	99.73	102.88	ER	242	7.61	1
2	LFFB	C2_PN345-SB-8B1_A	PENELEC	26EVERT DR-26SOUTH TR 115 kV line	200885	200673	1F	DC	99.73	102.88	ER	242	7.61	

Note: Please see Attachment 2 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper table in the Attachment.

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)

#	Contingency		Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution	Ref
	Type	Name			From	To	Circuit		Initial	Final	Type	MVA		
3	LFFB	C2_PN230-SB-8C1	PENELEC	26FARM VLY-26RIDGWAY 115 kV line	200668	200582	1	DC	139.81	141.17	ER	160	2.17	2
4	DCTL	C5_PN230-TW-#2A	PENELEC	26FARM VLY-26RIDGWAY 115 kV line	200668	200582	1	DC	105.05	106.42	ER	160	2.18	

#	Contingency		Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution	Ref
	Type	Name			From	To	Circuit		Initial	Final	Type	MVA		
5	N-1	APS_B_G698	PENELEC	26MANSFIEL-26MAINESBURG 115 kV line	200672	200929	1F	DC	118.26	120.31	ER	179	3.68	3
6	Non	Non	PENELEC	26MANSFIEL-26MAINESBURG 115 kV line	200672	200929	1F	DC	121.1	122.6	NR	140	2.1	

Note: Please see Attachment 2 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper table in the Attachment.

Short Circuit

(Summary of impacted circuit breakers)

None.

Potential Congestion due to Local Energy Deliverability

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.

Note: Only the most severely overloaded conditions are listed below. 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 shall study all overload conditions associated with the overloaded element(s) identified.

#	Contingency		Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution	Ref
	Type	Name			From	To	Circuit		Initial	Final	Type	MVA		
7	N-1	B_PN115-SX- #58A	PENELEC	26TWO MILE-26FARM VLY 115 kV line	200663	200668	1	DC	156.29	165.67	ER	191	17.92	
8	N-1	B_PN230-SX- #25	PENELEC	26FARM VLY-26RIDGWAY 115 kV line	200668	200582	1	DC	101.82	102.37	ER	160	1.95	

#	Contingency		Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution	Ref
	Type	Name			From	To	Circuit		Initial	Final	Type	MVA		
9	N-1	B_PN115-SX-#58A	PENELEC	26GOLD-26TENGASVM 115 kV line	200669	200923	1	DC	91.41	98.72	ER	245	17.92	
10	N-1	APS_B_G698	PENELEC	26SABINSVI-26NILES VA 115 kV line	200670	200671	1	DC	93.95	105.58	ER	172	20	
11	N-1	APS_B_G698	PENELEC	26NILES VA-26MANSFIEL 115 kV line	200671	200672	1	DC	80.97	91.78	ER	185	20	
12	N-1	APS_B_G698	PENELEC	26MANSFIEL-26MAINESBURG 115 kV line	200672	200929	1F	DC	197.55	208.37	ER	179	19.36	
13	Non	Non	PENELEC	26MANSFIEL-26MAINESBURG 115 kV line	200672	200929	1F	DC	162.24	170.13	NR	140	11.05	
14	N-1	B_PN345-XF-#275	PENELEC	26EVERT DR-26SOUTH TR 115 kV line	200885	200673	1F	DC	97.88	101.04	ER	242	7.65	
15	N-1	B_PN115-SX-#58A	PENELEC - AP	26TENGASVM-01POTTER 115 kV line	200923	235234	1	DC	88.35	95.66	ER	245	17.92	
16	N-1	APS_B_G698	PENELEC	26MAINESBURG 345/115 kV transformer	200929	200930	2F	DC	104.21	109	ER	323	15.45	
17	N-1	B_PN345-SX-#6	AP - AP	01ARMSTRONG 345/138 kV transformer	235129	235121	1F	DC	99.91	100	ER	650	1.38	
18	N-1	B_PN115-SX-#58A	AP - PENELEC	01POTTER-26TWOMILE 115 kV line	235234	200663	1	DC	131.64	138.95	ER	245	17.92	
19	N-1	B_PN115-SX-#58A	PENELEC	Z1-069 TAP-26GOLD 115 kV line	916200	200669	1	DC	145.64	157.05	ER	157	17.92	
20	N-1	APS_B_G698	PENELEC	Z1-069 TAP-26SABINSVI 115 kV line	916200	200670	1	DC	109.55	122.29	ER	157	20	

New System Reinforcements

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

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
#1, #2	Everts Drive – South Troy 115kV Line	Everts Drive - South Troy 115kV line. Rebuild 3.2 miles of 636 ACSR with 1033 ACSS high temperature conductor.		\$ 5,871,800
Total New Network Upgrades				\$ 5,871,800

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)

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
#3, #4	Farmers Valley – Ridgway 115kV Line	Farmers Valley SS. & Ridgway SS. Upgrade Ridgway line equipment for new line rating. Adjust Remote Relay Settings at Farmers Valley and Ridgway 115 kV substations. Farmers Valley - Ridgway 115kV Reconductor. Reconductor 5.5 miles, from structure #234 to Farmers Valley Substation, with 336 kcmil ACSS, replacing the existing 336 kcmil ACSR.		\$ 5,537,100
#5, #6	Mansfield	Mansfield SS. Reconductor Mainesburg 115-kV Line drops & bus with 795 AAC.		\$ 123,900
Total New Network Upgrades				\$ 5,661,000

Attachment 1. Single Line Diagram

Attachment 2. Flowgate Details

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 26EVERT DR-26SOUTH TR 115 kV line (from bus 200885 to bus 200673 ckt 1F) loads from 99.73% to 102.88% (DC power flow) of its emergency rating (242 MVA) for the line fault with failed breaker contingency outage of 'C2_PN345-SB-8A1'. This project contributes approximately 7.61 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
200887	26ARMNA MT	1.15
203261	26BLOSSBCT	0.52
200888	P-047 E	54.27
292391	T-121 C	5.12
292392	T-121 E	20.49
297050	V2-019 E	0.34
916201	Z1-069 C	5.06

Bus Number	Bus Name	Full Contribution
916202	Z1-069 E	21.57
919971	AA2-081	9.52
920241	AA2-120 OP	137.06
930411	AB1-082 OP	4.25
931091	AB1-160 C	1.45
931092	AB1-160 E	6.16
931291	AB1-179	7.79

Appendix 2

(PENELEC - PENELEC) The 26FARM VLY-26RIDGWAY 115 kV line (from bus 200668 to bus 200582 ckt 1) loads from 139.81% to 141.17% (DC power flow) of its emergency rating (160 MVA) for the line fault with failed breaker contingency outage of 'C2_PN230-SB-8C1'. This project contributes approximately 2.17 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
236828	01GRAYMONT	-0.27
200642	26SENECA#1	2.51
200643	26SENECA#2	2.34
200644	26SENECA#3	0.33
292391	T-121 C	3.96
292392	T-121 E	15.83
LTF	Z1-019	17.45
916201	Z1-069 C	1.45
916202	Z1-069 E	6.17

Bus Number	Bus Name	Full Contribution
916311	Z1-087	5.23
919971	AA2-081	1.51
920241	AA2-120 OP	13.06
930411	AB1-082 OP	3.28
LTF	AB1-100	11.29
931091	AB1-160 C	0.41
931092	AB1-160 E	1.76
931291	AB1-179	2.09

Appendix 3

(PENELEC - PENELEC) The 26MANSFIEL-26MAINESBURG 115 kV line (from bus 200672 to bus 200929 ckt 1F) loads from 118.26% to 120.31% (DC power flow) of its emergency rating (179 MVA) for the single line contingency outage of 'APS_B_G698'. This project contributes approximately 3.68 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
203261	26BLOSSBCT	0.99
292391	T-121 C	23.24
916201	Z1-069 C	12.88
916541	Z1-110	1.97
917072	Z2-011	1.97
918871	AA1-106	1.97

Bus Number	Bus Name	Full Contribution
919971	AA2-081	19.27
920241	AA2-120 OP	242.03
930411	AB1-082 OP	19.27
931091	AB1-160 C	3.68
931291	AB1-179	19.27