

***Generation Interconnection
Feasibility Study Report***

For

***PJM Generation Interconnection Request
Queue Position AC2-077***

Sabinsville 34.5 kV

July 2017

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.

General

The Interconnection Customer (IC), has proposed a natural gas generating facility located in Sabinsville, PA. The installed facilities will have a total capability of 20 MW with 20 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is May 31, 2018. **This study does not imply a Pennsylvania Electric Company (or “Penelec”) commitment to this in-service date.**

Point of Interconnection

AC2-077 will interconnect with the Pennsylvania Electric Company (or “Penelec”) distribution system along the Wellsboro 34.5kV circuit at pole # SO-263.

Cost Summary

The AC2-077 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	\$ 112,300
Direct Connection Network Upgrades	\$ 0
Non Direct Connection Network Upgrades	\$ 481,600
Total Costs	\$ 593,900

In addition, the AC2-077 project may be responsible for a contribution to the following costs:

Description	Total Cost
New System Upgrades	\$ 0
Previously Identified Upgrades	\$ 9,954,400
Total Costs	\$ 9,954,400

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

Attachment Facilities

The total preliminary cost estimate for the Attachment work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Activity Cost	Tax (if applicable)	Total Cost
Region Line Tap on Wellsboro 34.5 kV line AC2-077 Point of Interconnection including costs associated with 34.5 kV Metering Package.	\$ 112,300	\$ 47,600	\$ 159,900
Total Attachment Facility Costs	\$ 112,300	\$ 47,600	\$ 159,900

Direct Connection Cost Estimate

No Direct Connection Facilities are required to support this interconnection request.

Non-Direct Connection Cost Estimate

The total preliminary cost estimate for the Non-Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Activity Cost	Tax (if applicable)	Total Cost
Sabinsville SS. Install sync check and anti-islanding relaying.	\$ 240,800	\$ 99,500	\$ 340,300
Wellsboro SS. Install sync check and anti-islanding relaying.	\$ 240,800	\$ 99,500	\$ 340,300
Total Non-Direct Connection Facility Costs	\$ 481,600	\$ 199,000	\$ 680,600

Notes:

- Detailed Engineering & Construction Estimates TBD via Facility Study
- The above estimates do not include 1) property costs and site development up to rough grade which is to be provided by the developer, and 2) generation SCADA to be provided by the developer.

Transmission Owner Scope of Work

It was proposed that the project be studied as an interconnection into the First Energy distribution system as a tap on the 34.5 kV Wellsboro circuit. Interconnection Customer has submitted a "Generation Interconnection Feasibility Study Agreement" to PJM and a proposed single line diagram (see Attachment 7) that identifies their proposal.

Interconnection Customer is responsible for constructing all of the facilities on its side of the point of interconnection, on the line to the generating plant. Interconnection Customer will also be responsible for the modifications at the tap that are required due to connecting the facility.

The proposed interconnection facilities must be designed in accordance with the FirstEnergy "Requirements for Transmission Connected Facilities" document and "Technical Requirements for the Interconnection of Customer-Owned generation to the FirstEnergy Distribution System" document.

The 34.5kV interconnection point will require the installation of a Penelec installed/owned radio controlled switch (which will act as the disconnect point between First Energy and the generator interconnection) and a new disconnect switch situated just beyond the tap point (POI).

Interconnection metering is also required for this generation connection. The 34.5 kV revenue quality metering equipment shall be designed, furnished and installed by FirstEnergy. The Interconnection Customer will be responsible for designing, furnishing and installing a SCADA RTU in their generation substation and obtaining the telecommunication circuits from the RTU to the Penelec Data Center. The connection to the Penelec Data Center will be to provide MW, MVAR and 34.5kV voltage at Interconnection Customer generation substation. Please reference the FirstEnergy Metering Requirements for Interconnection Customers, for more details on the metering requirements for FirstEnergy. This document can be found on the FE website at:

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

Transmission Owner Schedule

Based on the scope of the FE direct connection, it is expected to take approximately one (1) year from the signing of a Construction Service Agreement to complete the direct connect installation required for the Sabinsville 34.5kV (AC2-077) Project. Based on the scope of the FE transmission network upgrades, it is expected to take approximately 18 months from the signing of a Construction Service Agreement to complete the transmission network upgrades installation required for the Sabinsville 34.5kV (AC2-077) Project. This assumes that the IC 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 facility upgrades, and that all system outages will be allowed when requested.

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 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.
4. The installation of a Penelec provided 34.5 kV interconnection metering instrument transformer. FE will provide the ratio and accuracy specifications based on the customer load and generation levels.
5. The installation of a Penelec provided revenue class meter for each unit to measure the power delivered in compliance with the FE standards.
6. 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.
7. The establishment of dedicated communication circuits for SCADA report to the FE Transmission System Control Center.
8. A compliance with the FE and PJM generator power factor and voltage control requirements.
9. The execution of a back-up service agreement with the electric distribution company to serve the customer load supplied from the AC2-077 generation project interconnection point when the units are out-of-service. This assumes the intent of Interconnection Customer is to net the generation with the load.
10. The rough grade of the property for the AC2-077 Interconnection 34.5 kV tap pole and an access road for the delivery of equipment to this site. The above requirements are in addition to any metering and telecommunications required by PJM as specified in PJM Manuals M-01 and M-14D

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>

FirstEnergy Revenue Metering Requirements

The FE operating company (Penelec) shall provide, own, operate, test, and maintain the revenue metering equipment at the Interconnection Customer’s (IC) expense. The revenue metering equipment includes, but is not limited to, current transformers, voltage transformers, secondary wires, meter socket, bidirectional revenue meter, and associated devices. The IC shall mount the instrument transformers unless otherwise agreed to by Penelec. The instrument transformers and meter socket shall be installed in a location that is readily accessible to authorized Penelec representatives. Penelec will provide the IC access to bidirectional kWh and kVARh pulses from the Penelec meter at the IC’s expense if requested. The IC shall, at its expense, install, own, operate, test, and maintain any metering and telemetry equipment that may be required to provide real-time meter data to FE or PJM.

Network Impacts

The Queue Project AC2-077 was evaluated as a 20.0 MW (Capacity 20.0 MW) injection at the Sabinsville 34.5 kV substation in the PenElec area. Project AC2-077 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC2-077 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
B2-TIE-345-104_B	CONTINGENCY 'B2-TIE-345-104_B' /* MAINESBURG - WATERCURE ROAD (NYSEG) 345KV LINE DISCONNECT BRANCH FROM BUS 920750 TO BUS 130757 CKT 1 /* AA2-300 TAP WATRC345 345 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)

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)

#	Contingency		Affected Area	Facility Description	Bus		Circuit	Power Flow	Loading %		Rating		MW Contribution	Ref
	Type	Name			From	To			Initial	Final	Type	MVA		
1	N-1	B2-TIE-345-104_B	PENELEC	26EVERT DR-26SOUTH TR 115 kV line	200885	200673	1	DC	122.89	124.59	ER	242	4.12	1
2	N-1	B2-TIE-345-104_B	PENELEC	26MAINESBURG-26EVERT DR 115 kV line	200929	200885	1	DC	155.98	158.28	ER	179	4.13	2

Note: Please see Attachment 3 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.

None.

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)

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
#1	Everts Drive – South Troy 115 kV	<p>In order to mitigate the overloads of facilities above, the following reinforcements are required:</p> <ul style="list-style-type: none">• Rebuild the East Towanda – Everts Drive 115 kV circuit from Everts Drive to South Troy, approximately 3.2 miles, with 795 ACSS conductor. Total Cost with Tax: \$7,476,200; Tax: \$2,192,300; Total Cost: \$5,283,900• Revise the relay settings and replace the line drops on the South Troy exit. Total Cost with Tax: \$63,200; Tax: \$18,600; Total Cost: \$44,600• Estimated Time: 18 months		\$ 5,328,500

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
#2	Everts Drive – Mainesburg 115 kV	In order to mitigate the overloads of facilities above, the following reinforcements are required: <ul style="list-style-type: none"> • At the Mainesburg substation, replace the 636 ACSR line drops with 636 ACSS. Total Cost with Tax: \$33,900; Tax: \$10,100; Total Cost: \$23,800 • Re-conductor 8.7 miles of 636 ACSR with 636 ACSS high temperature conductor from Everts Drive to Mainesburg. Total Cost with Tax: \$6,511,500; Tax: \$1,909,400; Total Cost: \$4,602,100 • Estimated Time: 12 months 		\$ 4,625,900
Total New Network Upgrades				\$ 9,954,400

Attachment 1. Penelec System Protection Analysis

An analysis was conducted to assess the impact of the Sabinsville 34.5 kV (AC2-077) Project on the system protection requirements in the area. The results of this review show that the following relay additions will be required:

Proposed single line diagrams show Interconnection Customer (Developer) constructing a generation facility they call “**Sabinsville 34.5kV**” tapping Penelec’s Sabinsville-34.5kV Wellsboro Circuit at pole SO-263.

The 34.5kV interconnection proposal will require Developer to meet applicable "Technical Requirements" as outlined in First Energy’s document titled “Technical Requirements for the Interconnection of Customer-Owned Generation to the FirstEnergy Distribution System”.

Protection requirements are included in the "Technical Requirements" document.

Meeting the protection requirements for this application will include (but not be limited to):

Voltage and synch check

FirstEnergy designed, provided, & installed, at Developer’s expense, modifications to add 34.5kV system line protection, voltage and synchronism checking equipment on the following Penelec circuit breakers (CBs). This work may include adding line potential transformers, and adding associated protective relays and/or relay programming at Sabinsville Substation.

34.5kV Transformer CB at Sabinsville Substation

34.5kV Wellsboro CB at Sabinsville Substation

Anti-islanding protection

Also, meeting the protection requirements includes anti-islanding protection via installation of a Direct Transfer Trip (DTT) system. Developer, at their expense, shall provide overall system equipment design, procurement and installation (except for the connection to Penelec equipment as covered below). The DTT system type shall be subject to FirstEnergy's acceptance.

The DTT system shall include transmitter equipment & receiver equipment, and communication channel. The transmitter equipment, so as to receive 34.5kV CB status at Penelec's Substation, will be located, by Developer, in local proximity to Penelec devices. Hardware, which will provide CB status to the DTT transmitters, will be designed, provided by, and installed by FirstEnergy, at Developer’s expense.

The receiver equipment shall be located at Developer’s generation facility to receive signals from the transmitter equipment. Tripping of Developer’s generation CB would be required (via the DTT) for an open, or trip out, condition of any* of the following Penelec CBs:

34.5kV Transformer CB at Sabinsville Substation

34.5kV Wellsboro CB at Sabinsville Substation

*this project will require a trip matrix programmed in the DTT receiver equipment at the Developer Generation location. The matrix will be based on specific trip combination of the above 34.5kV devices as sensed by the DTT transmitter equipment at each location.

Additionally, tripping of the Developer's generation CB would be required (via this DTT equipment) for a loss of DTT communication channel between any of the transmitters and receiver, as well as for times of nonfunctional DTT transmitter/receiver terminals. Developer's generation CB will not re-connect to the Penelec system until full integrity of the DTT system is restored. Real Time DTT communication channel status will be continually transmitted to FE's distribution control center (DCC). Developer's design is to include the ability for FE's DCC to trip the Developer's generation CB for DTT communication channel, or other, problems, should automatic tripping of the CB fail to be implemented within a reasonable time following occurrence of problems.

Maintenance and upkeep of the DTT system will be at Developer's expense.

Due to the considerable distance between the above equipment DTT locations, as well as potential reliability issues of using DTT telephone line communication channels, First Energy recommends the use of a DTT system with a fiber optic dedicated communication channel between the transmitters and receiver.

General Concerns

It is to be understood, for abnormal operation of the Penelec system, which could cause Developer's generation facility to be electrically isolated from the Penelec system synchronous source via the tripping of an interconnecting primary voltage line or device not monitored by the DTT system, Developer will, via Penelec's direction, be required to disconnect the generation from Penelec's system and remain disconnected (**units are required to be OFF LINE**), until the Penelec system normal circuitry is restored. These abnormal condition will be reviewed by Penelec system operators as to the need for the generation facility to be disconnected.

Requirements for Owner's/Developer's generation IPP Facility

The proposed interconnection Owner's/Developer's facilities must be designed in accordance with the document titled FirstEnergy **Distribution Engineering Practices Interconnection of Customer-Owned Generation to the FirstEnergy Distribution System** dated 11/17/14 located at the following link:

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

The document is referred to as engineering practice EP(# 02-280) with section 4 part C specifically referencing the "interconnection technical requirements". Certain protection requirements are shown.

Additionally, Owner/Developer is responsible to provide adequate protection (for their equipment) under any distribution system operating condition' - which includes 'Separation from supply' (i.e. tripping of F.E. circuit breakers) and 'Re-synchronizing the generation after electric restoration of the supply' (i.e. reclosing of F.E. circuit breakers).

Owner's/Developer's protection must be designed to coordinate with the reclosing practices of FirstEnergy line protective devices. The generator must cease to energize the FirstEnergy circuit to which it is connected prior to reclosing of any (FE) automatic reclosing devices.

Owners/Developer's electrical protection and control schematics shall be provided to FE for consideration. FE may request modifications, if required, to meet the technical requirements.

Attachment 2. Flowgate Details

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 26EVERT DR-26SOUTH TR 115 kV line (from bus 200885 to bus 200673 ckt 1) loads from 122.89% to 124.59% (**DC power flow**) of its emergency rating (242 MVA) for the single line contingency outage of 'B2-TIE-345-104_B'. This project contributes approximately 4.12 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
200887	26ARMNA MT	1.75
203261	26BLOSSBCT	0.41
931571	AC2-077	4.12
916201	Z1-069 C	0.48
916351	Z1-091	-1.62
921932	AA2-081	5.04

Bus Number	Bus Name	Full Contribution
LTF	AA2-300	124.1
LTF	AA2-800	14.45
922932	AB1-082 OP	2.19
LTF	AB1-100	82.52
923442	AB1-160 C	0.7
927001	AC1-187 C	2.13

Appendix 2

(PENELEC - PENELEC) The 26MAINESBURG-26EVERT DR 115 kV line (from bus 200929 to bus 200885 ckt 1) loads from 155.98% to 158.28% (**DC power flow**) of its emergency rating (179 MVA) for the single line contingency outage of 'B2-TIE-345-104_B'. This project contributes approximately 4.13 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
203261	26BLOSSBCT	0.41
931571	AC2-077	4.13
916201	Z1-069 C	0.48
916351	Z1-091	-1.62
921932	AA2-081	5.04
LTF	AA2-300	124.1

Bus Number	Bus Name	Full Contribution
LTF	AA2-800	14.45
922932	AB1-082 OP	2.2
LTF	AB1-100	82.56
923442	AB1-160 C	0.7
927001	AC1-187 C	2.13