#Z2-011 – Canton 34.5kV
Generation Interconnection

General

The Interconnection Customer (IC) is proposing to install a natural gas facility to be located in Bradford County, PA and has requested to be studied as a 19.9 MW Energy (19.9 MW Capacity) resource interconnecting into the Penelec area. The IC has proposed in-service date is for January 1, 2016. The IC has requested a backfeed date of August 1, 2015.

This Generation Interconnection Feasibility Study provides analysis results to aid the IC in assessing the practicality and cost of incorporating the facility into the PJM system. This study was limited to load flow analyses of probable contingencies. If the IC elects to pursue a System Impact Study, a more comprehensive analysis will be performed.

Point of Interconnection

Z2-011 will interconnect with the Penelec distribution system by tapping the West Leroy circuit approximately 2 miles from the Canton substation. PJM modeled this project as lumped equivalent load at the Grover 34.5kV substation.

Transmission Owner Scope of Work

To accommodate this interconnection, a 34.5kV tap, radio controlled switch, associated equipment, RTU programming, relaying support, and a transfer trip transmitter and sync check relaying will be installed. The costs for this upgrade are detailed in **Table 1** below. These costs include a CIAC Tax Gross-up column which may or may not be applicable. The single line is shown below in **Figure 1**.

The IC is required to construct all connection facilities in accordance with the Penelec published standards.

Table 1. Transmission Owner Work Cost Estimate

Description	Total Cost	Tax	Total with Tax
34.5kV tap, radio controlled switch, and associated equipment	$102,100	$30,500	**$132,600**
Install transfer trip transmitter and sync check relaying on the 34.5kV West Leroy line exit at the Canton 34.5kV substation.	$147,900	$44,600	**$192,500**
Engineering oversight and commissioning	$65,200	$19,700	**$84,900**
RTU programming for interconnection to the FirstEnergy SCADA and relay support for the generation installation.	$7,500	$2,500	**$10,000**
34.5kV recloser work at pole # CWL-30	$13,600	$3,900	**$17,500**
Total	**$336,300**	**$101,200**	**$437,500**

Anti-islanding protection

Meeting the protection requirements for anti-islanding protection will involve installation of a Direct Transfer Trip (DTT) system. Interconnection Customer, at their expense, shall provide overall system equipment design, and installation (except for the connection to Penelec equipment as covered below). The DTT system type shall be subject to FirstEnergy's approval.

The DTT system shall include transmitter equipment & receiver equipment. The transmitter equipment, so as to receive 34.5kV CB status at Penelec's Canton Substation and at Penelec's 34.5kV Line Recloser location, will be located in local proximity to each of these Penelec devices. Hardware, which will provide CB/Recloser status to the DTT transmitters, will be designed, provided by, and installed by FirstEnergy at Interconnection Customer's expense.

A receiver shall be located at Interconnection Customer's generation facility to receive the tripping signal. Tripping of Interconnection Customer's Canton generation CB would be required (via the DTT) for an open, or trip out, condition of any of the following Penelec CBs or Reclosers:

34.5kV West Leroy CB at Canton Substation

34.5kV West Leroy recloser at Penelec pole # CWL-30

Tripping of the Interconnection Customer's Canton generation CB would be required (via this DTT) for a loss of DTT communication channel between the transmitters and receiver, as well as for times of nonfunctional DTT transmitter/receiver terminals. Interconnection Customer's Canton generation CB will not re-connect to the Penelec system until full integrity of the DTT system is restored.

Maintenance and upkeep of the DTT system will be at Interconnection Customer'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

For abnormal 34.5kV operation of the Penelec system, which could cause Interconnection Customer's Canton generation facility to be electrically isolated from the Penelec 34.5kV system synchronous source, the Interconnection Customer's generator CB will disconnect and remain disconnected from the Penelec system until normal 34.5kV circuitry is restored.

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 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.

2. The installation of a Penelec provided 34.5kV interconnection metering instrument transformer. FE will provide the ratio and accuracy specifications based on the customer load and generation levels.

3. The installation of a Penelec provided revenue class meter for each unit to measure the power delivered in compliance with the FE standards.

4. 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.

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

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

7. The execution of a back-up service agreement to serve the customer load when the units are out-of-service. This assumes the intent of Interconnection Customer is to net the generation with the load.

8. Rough grade the property for the Z2-011 Interconnection 34.5kV 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.

9. The proposed Interconnection Customer facilities must be designed in accordance with the "Generator Interconnection Technical Requirement for Distribution Connection Facilities." Please use links in the Revenue Metering and SCADA Requirements section below to find this document.

Revenue Metering and SCADA Requirements

For PJM: IC 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.

For Penelec: 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

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.

Summary

The Canton (Z2-011) Project direct connection will require the facility and network upgrades defined in Table 1 above. As shown, the total estimated cost of the 34.5kV interconnection is **$336,300**. This cost does not include a CIAC (Contribution in Aid of Construction) Federal Income Tax Gross Up charge of **$101,200**. These costs do not include the upgrades required in the Network Impacts section of the report below.

Based on the scope of the FE direct connection, it is expected to take approximately **one (1.0) year** from the signing of a Connection Service Agreement to complete the installation required for the Canton (Z2-011) 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 a new Z2-011 Interconnecting tap pole and the associated equipment of the Penelec 34.5kV line to this site. It also assumes that Interconnection Customer will provide the property for the attachment tap pole 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 FE will allow all distribution system outages when requested.

Network Impacts

The Queue Project Z2-011 was studied as a 19.9 MW (19.9 MW Capacity) injection into the Grover 34.5kVsubstation in the Penelec area. Project Z2-011 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project Z2-011 was studied with a commercial probability of 53%. 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)

No violations were identified.

Multiple Facility Contingency

(Double Circuit Tower Line contingencies only with full energy output. Stuck Breaker and Bus Fault contingencies will be applied during the Impact Study)

No violations were identified.

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.)

Item 1a. (PENELEC - PL) The 26OXBOW-LACK 230 kV line (from bus 200708 to bus 208009 ckt 1) loads from 100.14% to 101.65% (**DC power flow**) of its normal rating (494 MVA) for non-contingency condition. This project contributes approximately 7.45 MW to the thermal violation.

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

Item 1b. (PENELEC - PENELEC) The 26N.MESHPN-26OXBOW 230 kV line (from bus 200706 to bus 200708 ckt 1) loads from 101.81% to 102.93% (**DC power flow**) of its emergency rating (655 MVA) for the line fault with failed breaker contingency outage of 'PL100926'. This project contributes approximately 7.32 MW to the thermal violation.

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

Please refer to Appendix 2 for a table containing the generators having contribution to this flowgate.

Item 1c. (PENELEC - PL) The 26OXBOW-LACK 230 kV line (from bus 200708 to bus 208009 ckt 1) loads from 103.78% to 104.97% (**DC power flow**) of its emergency rating (624 MVA) for the line fault with failed breaker contingency outage of 'PL100926'. This project contributes approximately 7.41 MW to the thermal violation.

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

Please refer to Appendix 3 for a table containing the generators having contribution to this flowgate.

Item 1d. (PENELEC - PENELEC) The 26N.MESHPN-26OXBOW 230 kV line (from bus 200706 to bus 200708 ckt 1) loads from 106.98% to 108.51% (**DC power flow**) of its normal rating (478 MVA) for non-contingency condition. This project contributes approximately 7.35 MW to the thermal violation.

Please refer to Appendix 4 for a table containing the generators having contribution to this flowgate.

Item 1e. (PENELEC - NYISO) The 26E.SAYRE-N.WAV115 115 kV line (from bus 200676 to bus 130836 ckt 1) loads from 123.8% to 124.42% (**DC power flow**) of its emergency rating (128 MVA) for the single line contingency outage of 'B_PN230-SX-#8'. This project contributes approximately 1.66 MW to the thermal violation.

```
CONTINGENCY 'B_PN230-SX-#8'                             /* EAST TOWANDA -
HILLSIDE (ETH) 230 KV
 DISCONNECT BRANCH FROM BUS 200675 TO BUS 130763 CKT 1
 END
```

Please refer to Appendix 5 for a table containing the generators having contribution to this flowgate.

Item 1f. (PENELEC - PENELEC) The 26TOWANDA-26E.SAYRE 115 kV line (from bus 200674 to bus 200676 ckt 1) loads from 160.13% to 160.74% (**DC power flow**) of its emergency rating (131 MVA) for the single line contingency outage of 'B_PN230-SX-#8'. This project contributes approximately 1.66 MW to the thermal violation.

CONTINGENCY 'B_PN230-SX-#8' /* EAST TOWANDA - HILLSIDE (ETH) 230 KV
DISCONNECT BRANCH FROM BUS 200675 TO BUS 130763 CKT 1
END

Please refer to Appendix 6 for a table containing the generators having contribution to this flowgate.

Short Circuit

(Summary of impacted circuit breakers)

PJM has completed the short circuit analysis of the Z2-011 queue project **Canton 34.5kV**. One option was considered during this study: the primary option was a direct connection to Grover 34.5kV substation. PJM analysis found **no breakers** to be over duty in the PENELEC transmission area.

Light Load Analysis – 2018

Not required.

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)

For Items 1a and 1c, to mitigate the overloads on 26OXBOW-LACK 230kV line, the following mitigations were proposed:

- Penelec: No Penelec upgrades required. PPL owns the limiting equipment.
- PPL: This overload can be mitigated by upgrading the bay equipment at Lackawanna to 3000A at an approximate cost of **$2,000,000** to achieve the required ratings (938 MVA SE). This assumes that FirstEnergy/Penelect upgrades the line to meet this rating as well. This upgrade will take approximately **18 – 24 months** to complete.

For Items 1b and 1d, to mitigate the overload on 26N.MESHPN-26OXBOW 230kV line, Penelec has proposed to replace 1033 AAC bus conductor at North Meshoppen substation with 1033 ACSS high temperature conductor on the Oxbow terminal. The upgrade is estimated to cost **$40,700** (add an extra **$12,100** in tax on top of cost if applicable for a total cost of **$52,800**)

and take approximately **12 months** to complete. This overload has been caused by a prior project.

In Item 1e, to mitigate the overload on 26E.SAYRE-N.WAV115 115kV line, there is an operating procedure that governs this line. This overload has been caused by a prior project. This violation will be further analyzed during the System Impact Study.

In Item 1f, to mitigate the overload on 26TOWANDA-26E.SAYRE 115kV line, Penelec has proposed to open the East Sayre – North Waverly 115kV line. This overload has been caused by a prior project. This violation will be further analyzed during the System Impact Study.

Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of the surrounding generation. Any potential problems identified below are likely to result in operational restrictions to the project under study. The Interconnection Customer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Transmission Interconnection request.

Note: 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 analyzes all overload conditions associated with the overloaded element(s) identified. As a result of the aggregate energy resources in the area, the following violations were identified.

As a result of the aggregate energy resources in the area, no violations were identified.