Generation Interconnection Feasibility Study Report – Web Version 2

For

PJM Generation Interconnection Request Queue Position Z1-091

Lenox 34.5 kV Project

February 2014

Feasibility Study Report

Z1-091 Lenox 34.5kV Project

Introduction

This Feasibility/Impact Study report provides the documentation of an assessment that has been performed by PJM Interconnection and FirstEnergy (FE) in response to a request made by the Interconnection Customer (IC) for the connection of a 19.9MW (19.9MW Capacity) Lenox Generation Project to the Penelec Distribution System.

In compliance with the PJM Generation Interconnection Procedures, Interconnection Customer has submitted a "Generation Interconnection Feasibility Study Agreement" to PJM that identifies its plan to install 5 – 4.0 MW reciprocating engines to a common bus with a total capability of 19.9 MW (19.9 MW capacity).

Customer has chosen both a Primary Point of Interconnection (POI) and a Secondary Point of Interconnection to be studied. The primary POI is taken from a tap located at pole LK-247, which is sourced from the 34.5kV Oxbow ckt#00438-65 fed from Penelec's Lenox substation. The secondary POI is a direct feed into the 34.5kV bus at Penelec's Lenox substation via a dedicated substation breaker.

Part 1 of this report will detail the results for the Primary POI.

Part 2 of this report will detail the results for the Secondary POI. NOTE: the secondary POI will only receive a sensitivity analysis, no associated costs will be provided.

Part 1: Primary Point of Interconnection

Connection Facilities

Attachment 1 is an aerial overview that shows the position of the customer's generation facility relative to the location of their primary point of interconnection (POI), which is pole LK-247, and Penelec's Lenox substation. Attachment 2 is a conceptual single line diagram of the primary POI.

Interconnection Customer has requested a 34.5kV interconnection. The project was studied as an interconnection into the First Energy distribution system via a tap on the 34.5 kV Oxbow ckt#00438-65 @ Lenox substation taken at pole # LK-247. Procurement and construction of the 34.5 kV distribution line extending from the tap (primary POI) to the generating plant 34.5kV export bus is the responsibility of Interconnection Customer as this facility is on the customer's side of the primary point of interconnection (POI). Interconnection Customer will be responsible for acquiring all easements, properties and permits that may be required to construct both the project 34.5kV line and the attachment facilities. A summary of the Lenox Project direct connection facilities that will be required and their estimated cost are shown on Attachment 3.

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 #Z1-091 was studied as a 19.9 MW (Capacity 19.9 MW) injection at the Lenox 34.5 kV substation in the Penelec area. Project #Z1-091 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)

No problems found

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 N.MESHPN 230/115 kV transformer (from bus 200825 to bus 200706 ckt 3) loads from 105.58% to 108.29% (**DC power flow**) of its emergency rating (188 MVA) for the single line contingency outage of 'B_PN230-SX-#11'. This project contributes approximately 5.31 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

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

2. (PENELEC - PENELEC) The NO MESHO-MESH2REA 115 kV line (from bus 200677 to bus 200825 ckt 3) loads from 105.64% to 108.34% (**DC power flow**) of its emergency rating (188 MVA) for the single line contingency outage of 'B_PN230-SX-#11'. This project contributes approximately 5.31 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

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

3. (PENELEC - PENELEC) The N.MESHPN-OXBOW 230 kV line (from bus 200706 to bus 200708 ckt 1) loads from 116.43% to 117.32% (AC power flow) of its emergency rating (617 MVA) for the single line contingency outage of 'SUSQ 1'. This project contributes approximately 7.51 MW to the thermal violation.

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

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

4. (PENELEC - PL) The OXBOW-LACK 230 kV line (from bus 200708 to bus 208009 ckt 1) loads from 117.51% to 118.44% (AC power flow) of its emergency rating (624 MVA) for the single line contingency outage of 'PL100903'. This project contributes approximately 7.73 MW to the thermal violation.

```
CONTINGENCY 'PL100903'                    /* SUSQUEHANNA-SUSQ
GEN 1 230KV
  DISCONNECT BUS 208114
  END
```

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

5. (PENELEC - PL) The OXBOW-LACK 230 kV line (from bus 200708 to bus 208009 ckt 1) loads from 138.14% to 139.22% (AC power flow) of its normal rating (494 MVA) for non-contingency condition. This project contributes approximately 7.74 MW to the thermal violation.

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

6. (PENELEC - PENELEC) The N.MESHPN-OXBOW 230 kV line (from bus 200706 to bus 200708 ckt 1) loads from 145.96% to 147.03% (AC power flow) of its normal rating (478 MVA) for non-contingency condition. This project contributes approximately 7.51 MW to the thermal violation.

Please refer to Appendix 6 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)

None

Stability and Reactive Power Requirement

(Results of the dynamic studies should be inserted here)

Not applicable

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 N.MESHPN 230/115 kV transformer:
Replace N. Meshoppen #3 transformer. Estimated Cost: $4,250,900 including $984,500 in tax; Estimated Time: 14 months

2. (PENELEC - PENELEC) The NO MESHO-MESH2REA 115 kV line:
Same reinforcement as #1.

3, 6. (PENELEC - PENELEC) The N.MESHPN-OXBOW 230 kV line:

Rebuild line using 1622 ACSS conductor. Upgrade terminals at N. Meshoppen and Oxbow. Estimated Cost: $27,312,900 including $6,325,700 in tax; Estimated Time: 37 months

4, 5. (PENELEC - PL) The OXBOW-LACK 230 kV line:

PPL:

This overload can be mitigated by upgrading the bay equipment at Lackawanna to 3000 A at a cost of approximately $2M to achieve the required ratings (938 MVA Summer Emergency). This assumes that the FirstEnergy/Penelec upgrades the line to meet this rating as well. This upgrade may take approximately 18-24 months to complete.

Penelec:

Rebuild line using 1622 ACSS conductor. Upgrade terminals at Oxbow. Estimated Cost: $42,134,300 including $9,758,300 in tax; Estimated Time: 27 months

<u>Delivery of Energy Portion of Interconnection Request</u>

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.

Not Applicable

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 system upgrades.
Costs for affected Transmission owners other than FirstEnergy 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 (Detailed 34.5kV)

In order to identify any overloads or voltage conditions on the 34.5kV system near the Lenox-34.5kV (Z1-091) Project, FirstEnergy studied its own detailed model for the 2017 Penelec Summer Peak case. The Lenox-34.5kV (Z1-091) Project was modeled at both 19.9 MW output, and with the generator at unity power factor (see Attachment 5).

19.9 MW Energy Output
No overload/voltage issues identified

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. The study also showed no significant fault current contribution to the breakers which are near the over-duty limit. A dynamics analysis will be performed as part of the Impact study.

System Protection Analysis

An analysis was conducted to assess the impact of the Lenox-34.5kV (Z1-091) 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 diagram, as depicted in Attachment 2, shows the IC constructing a generation facility called Lenox 34.5 kV at the customer's Site, to tap the Penelec 34.5kV Oxbow circuit at pole LK-247.

Meeting the protection Technical Requirement, referenced below, will include (but not be limited to) FirstEnergy designed & installed modifications, at the IC's expense, to Penelec's 34.5kv Oxbow circuit breaker (CB) at Lenox Substation, specifically to install 34.5kV system voltage and synchronism checking equipment on the noted CB. This work may include adding line potential transformers and associated protective relays and/or relay programming at the location.

Also, meeting the protection Technical Requirement will involve installation of a Direct Transfer Trip (DTT) system, designed and provided by the IC. The DTT system type shall be subject to FirstEnergy's approval. The DTT system shall include transmitter & receiver equipment. The transmitter equipment, so as to receive 34.5kV CB status at Penelec's Lenox Substation, will be located in local proximity to this Penelec equipment. Hardware to provide Penelec's equipment status to the DTT transmitter will be designed and installed by FirstEnergy, at the IC's expense. The receiver equipment shall be located at the Lenox 34.5 kV generation facility to receive the tripping signal.

- Tripping of the Lenox 34.5 kV generator would be required (via this DTT) for an open, or trip out, condition of Penelec's 34.5kv Oxbow CB at Lenox Substation.
- Tripping of the Lenox 34.5 kV generator would be required (via this DTT) for an open, or trip out, condition of Penelec's 34.5kV #1 Transformer at Lenox Substation.
- Tripping of the Lenox 34.5 kV generator would be required for a loss of DTT communication channel between the transmitters and receiver, as well as for times of nonfunctional DTT transmitter/receiver terminals. Lenox 34.5 kV generator will remain disconnected from the Penelec system until full integrity of the DTT system is restored.

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

It is to be understood, for any abnormal 34.5kV operation of the Penelec system that will cause Lenox 34.5 kV generation facility to be electrically isolated from Penelec's Lenox Substation via the normal 34.5kV circuit, the Lenox 34.5 kV generator will disconnect, and remain disconnected, from the Penelec system until the normal 34.5kV circuit is restored.
Notes

The proposed interconnection Owners/developers facilities must be designed in accordance with the Generator Interconnection Technical Requirement for Distribution Connection Facilities document located at either of the following links:

www.firstenergycorp.com/feconnect

www.pjm.com/planning/design-engineering/to-tech-standards.aspx

Additional Note: F.E.'s policy, (as noted in F.E. (Engineering Practices)) EP(# 02-280 C 3.11)

Generator owner 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).

Generator owner 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.

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 a power factor between 0.95 leading (absorbing MVARs) and 0.95 lagging (producing MVARs) to assure that voltage deviation will be less than 1.0 volt as measured at the POI under all Gen operating conditions.

Interconnection Customer must also meet all PJM, ReliabilityFirst and NERC reliability criteria and operating procedures required for standards compliance. For example, the Developer 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 from the PJM and FE power flow analysis show that there are FE criteria violations that are directly attributable to the capacity of the Lenox-34.5kV (Z1-091) Project. Furthermore, there are violations affecting thermal overload on network branches in which the capacity of the Lenox-34.5kV (Z1-091) Project is a contributor. In accordance with the Generation Interconnection procedures defined in the PJM Open Access Transmission Tariff and PJM Manuals, Interconnection Customer is responsible for network upgrades, and Attachment 4 has the details of the FE upgrades only. 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 Facilities Study. The Interconnection Customer will be responsible for the actual cost of the direct connection that is implemented. In addition, Interconnection Customer is responsible to provide the distribution line between the tap at pole # LK-247 and the Z1-091 generating substation, as Interconnection Customer will own this distribution line. FE herein reserves the right to return to any previously identified issues in this document and, upon appropriate justification, request additional monies to complete any reinforcements to the distribution system.

Generation Connection Requirements

The proposed interconnection facilities must be designed in accordance with Attachment 7, FirstEnergy's "Technical Requirements for the Interconnection of Parallel-Operated Generation to the FirstEnergy Distribution System" and must also meet IEEE 1547.

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

IC Requirements

In addition to the FE facilities, the IC 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 34.5 kV 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 the IC is to net the generation with the load.

8. The rough grade of the property for the Z1-091 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

Summary

The Lenox 34.5kV Project direct connection will require the FirstEnergy facility upgrades defined in Attachment 3. As shown, the total estimated cost of the 34.5 kV interconnection direct connection requirements is $433,943. This cost includes a CIAC (Contribution in Aid of Construction) Federal Income Tax Gross Up charge of $100,728.

In addition, the Lenox 34.5kV Project will require network upgrades to the FE system as defined in Attachment 4. As shown, the total estimated cost of the FE upgrades is $73,698,100. This cost includes a CIAC (Contribution in Aid of Construction) Federal Income Tax Gross Up charge of $17,068,500. The PPL upgrade will cost approximately $2,000,000 and will take 18 to 24 months to complete. Hence the total cost estimate $75,698,100. This estimate will likely be reduced once the cost allocations are determined. PJM is responsible for determining the cost allocations at the Impact Study Phase.

Based on the scope of the FE direct connection and all of the upgrades, it is expected to take approximately 37 months from the signing of a Construction Service Agreement to complete the installation required for the Lenox-34.5kV 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 Z1-091 Interconnecting tap pole and the associated equipment of the Penelec 34.5 kV line to this site. It also assumes that the IC 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.

Part 2: Secondary Point of Interconnection

Connection Facilities

The Secondary Point of Interconnection is a direct feed into the 34.5kV bus at Penelec's Lenox substation via a dedicated substation breaker. Once again, Attachment 1 provides an aerial overview that shows the position of the customer's generation facility relative to the location of their secondary point of interconnect (POI), which is with a dedicated breaker at Penelec's Lenox substation. Attachment 8 is a conceptual single line diagram of secondary POI.

The IC has requested a 34.5kV interconnection. The project was studied as an interconnection into the First Energy distribution system via a dedicated circuit breaker tapped directly into the 34.5kV bus at Penelec's Lenox substation.

Power Flow Analysis (New Project Upgrades and Contributions)

A Power Flow study was conducted to determine the reliability impact of the proposed Lenox-34.5kV (Z1-091) Project on the FE Bulk Transmission System (greater than 100 kV). 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 Lenox-34.5kV (Z1-091) Project Power Flow Analysis was completed using a 2017 summer peak load base case power flow provided by the PJM staff. This base case included an equivalent representation of the Penelec 34.5kV distribution system modeled as lumped equivalent load at the Lenox 115 kV substation. The Lenox—34.5kV Project was modeled as an injection into the Lenox 34.5 kV substation via a tap on the 34.5 kV Oxbow circuit. A simulation of all possible contingencies within the NERC and FE Planning Standards that are impacted by the Lenox-34.5kV (Z1-091) Project was conducted to test for criteria compliance. A simulation of all possible contingencies within the NERC and FE Planning Standards that are impacted by the Lenox-34.5kV (Z1-091) Project was conducted to test for criteria compliance. The conclusion from this analysis is that there are new bulk electric system network upgrades required for the Lenox-34.5kV (Z1-091) Project. Furthermore, there are findings of previously identified criteria violations from other generation or transmission interconnection projects in which Lenox-34.5kV (Z1-091)) Project contributes.

Power Flow Analysis (Detailed 34.5kV)

In order to identify any overloads or voltage conditions on the 34.5kV system near the Lenox-34.5kV (Z1-091) Project, FirstEnergy studied its own detailed model for the 2017 Penelec Summer Peak case. The Lenox-34.5kV (Z1-091) Project was modeled at both 19.9 MW output, and with the generator at unity power factor.

19.9 MW Energy Output
No overload/voltage issues identified

Short Circuit and Dynamics Analysis

No problems were identified. A circuit breaker analysis was completed for the Z1-091 study. No overdutied breakers were found to be directly attributable to the Z1-091 project.

Note that stability studies will be conducted by the PJM staff should this project proceed to the Facilities Study stage of the Generation Interconnection process.

System Protection Analysis

An analysis was conducted to assess the impact of the Lenox-34.5kV (Z1-091) 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 diagram for secondary point of interconnection (as shown in attachment 8) shows the IC constructing a dedicated 34.5kV line to connect their Lenox 34.5kV generation to Penelec's Lenox substation 34.5kV bus.

In association with the new 34.5kV line exit equipment (circuit breaker (CB), disconnect switches, arresters etc) at Lenox substation, will be a First Energy corporate group designed distribution line relay panel, for installation inside the Lenox substation control house.

This panel will provide control of the new 34.5kV line exit CB at Lenox substation and this CB will provide isolation of the Lenox 34.5kV generation facility for abnormal utility system conditions.

This panel will provide sensing of line faults occurring on the 34.5kV line between Lenox substation and Lenox 34.5kV generation facility, and will provide trip initiation to the CB at Lenox substation, as well as appropriate closing/reclosing of the CB into the new line.

Existing Lenox substation protection (i.e. bus differential schemes, operational conditions requiring tripping of the CB) will interface with this relay panel and not directly with Lenox 34.5kV generation facility equipment.

Additionally:

This panel will follow current FE corporate group specifications/design methods for a distribution line installation and to include the following **extra protection**:

- 34.5kV line potential sensing (requiring a line potential transformer installation to the new line at Lenox substation)

- Protection against CB closing out of phase into Lenox 34.5kV generation facility, using a synch check/dead line closing relay.

- Trip & LO initiation to the CB at Lenox substation for the condition of 'open' 34.5kV No.1 transformer CB at Lenox substation.

Modified protective relay existing settings may be required for 34.5kV protection at Lenox substation, based on power flows, fault levels, and generation capabilities.

Notes

The proposed interconnection Owners/developer's facilities must be designed in accordance with the *Generator Interconnection Technical Requirement for Distribution Connection Facilities* document located at either of the following links:

www.firstenergycorp.com/feconnect

www.pjm.com/planning/design-engineering/to-tech-standards.aspx

Additional Note: F.E.'s policy, (as noted in F.E. (Engineering Practices)) EP(# 02-280 C 3.11)

Generator owner 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).

Generator owner 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.

Attachment 3

Lenox--34.5kV (Z1-091) Project

Direct Connection Requirements

Network Upgrade	Description	Total with Tax	Tax	Total Cost
PN-S-749A	Add sync check relaying to 34.5kV Oxbow line breaker (including one PT on each side of breaker). Add DTT transmitter on this exit to send breaker status to developer substation.	$233,100	$54,000	$179,100
EOC	Engineering, Oversight, and Commissioning	$85,800	$19,900	$65,900
	34.5kV tap, radio controlled switch, and associated equipment.	$105,043	$24,328	$80,715
	RTU programming for connection to the FirstEnergy SCADA and relay support for the generation installation	$10,000	$2,500	$7,500
Total		$433,943	$100,728	$333,215

The above estimates do not include:

1. Property costs and site development up to rough grade, which is to be provided by the developer.

2. Generation SCADA that is to be provided by the developer.

Attachment 4
Lenox-34.5kV (Z1-091) Project (Primary POI)
FE Network Facility Reinforcement Conceptual Cost Estimates

North Meshoppen: Replace #3 230/115kV Transformer

Estimate No.	Description	Total with Tax	Tax	Total Cost
PN-S-742	Replace No. 3 Transformer and remove 115kV reactor. @ North Meshoppen	$4,250,900	$984,500	$3,266,400
Total		$4,250,900	$984,500	$3,266,400

North Meshoppen – Oxbow 230kV: Rebuild line and upgrade terminals

Estimate No.	Description	Total with Tax	Tax	Total Cost
PN-S-746	**North Meshoppen SS.** Upgrade terminal equipment	$274,100	$63,500	$210,600
PN-S-747	**Oxbow SS.** Upgrade terminal equipment	$109,400	$25,400	$84,000
PN-T-202	**North Meshoppen – Oxbow:** Rebuild and reconductor the 10.6 mile North Meshoppen-Oxbow 230kV line with 1622 kcmil ACSS.	$26,929,400	$6,236,800	$20,692,600
Total		$27,312,900	$6,325,700	$20,987,200

Oxbow – Lackawanna 230kV: Rebuild line and upgrade terminal

Estimate No.	Description	Total with Tax	Tax	Total Cost
PN-S-748	**Oxbow SS.** Upgrade terminal equipment	$109,400	$25,400	$84,000
PN-T-203	**Oxbow – Lackawanna:** Rebuild and reconductor the 16.3 mile Lackawanna-Oxbow 230kV line with 1622 kcmil ACSS conductor.	$42,024,900	$9,732,900	$32,292,000
Total		$42,134,300	$9,758,300	$32,376,000

Attachment 5

Lenox--34.5kV (Z1-091) Project

FE Contingency Analysis Results --Primary Point of Interconnection

Detailed 34.5kV Analysis						
			FirstEnergy Results		PJM Results	
Outage Description	Overloaded Elements	N/4 Hr - Rating	MVA Flow	% Rating	MVA Flow	% Rating
	No Problems					

Attachment 6

FirstEnergy Revenue Metering Requirements for Generation Interconnection Customer

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.

Attachment 7

Applicability

- This document defines the technical requirements for the interconnection of parallel-operated generation and related equipment to the FirstEnergy distribution system. For purposes of this document the term "generation" includes rotating and inverter-derived generating sources.

- These requirements apply to customer-owned generation used to offset energy usage and to distributed generation exporting energy on a wholesale basis.

- This document also applies to standby generator schemes with a make-before-break transition provided that the duration of parallel operation is 100 milliseconds or more.

- These requirements apply to new generator interconnections as well as existing facilities being upgraded or expanded.

Purpose

- The purpose of this document is to ensure the safety of FirstEnergy employees and the public, to protect FirstEnergy equipment from damage and to ensure the reliability of service to FirstEnergy customers.

Applicable Standards

- Generator facilities must comply with all requirements of the latest version of the IEEE 1547, "Standard for Interconnecting Distributed Resources with Electric Power Systems[1]."
- Inverter systems must comply with all requirements of the latest version of the UL1741, "Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources[2]."
- Generator facilities and equipment must comply with all applicable national, state, and local construction codes and all operation and maintenance-related safety codes, such as the National Electrical Code (NEC), the National Electrical Safety Code (NESC), and the Occupational Safety and Health Administration (OSHA) regulations.
- Generator interconnections are subject to applicable Federal or State interconnection rules and regulations depending upon interconnection type.

Relaying and Protection

- The generator owner is responsible for providing adequate protection to FirstEnergy facilities for conditions arising from the operation of generation

[1] IEEE Standard 1547-2003, "IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems," July 28, 2003.
[2] Underwriters Laboratory U.L. 1741, "Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources," May 7, 1999.

under all FirstEnergy distribution system operating conditions. The generator owner is also responsible for providing adequate protection to their facility under any distribution system operating condition whether or not their generator is in operation. Conditions may include but are not limited to:

Loss of a single phase of supply

Distribution system faults

Equipment failures

Abnormal voltage or frequency

Lightning and switching surges

Excessive harmonic voltages

Excessive negative sequence voltages

Separation from supply

Synchronizing generator to the distribution system

Re-synchronizing the generation after electric restoration of the supply.

- The generator must connect to the FirstEnergy system through an interrupting device, which has adequate fault interruption, and withstand capability, and adequate continuous current and voltage rating in accordance with latest IEEE C37 standards. Three-phase generators shall use an interrupting device that interrupts all three phases simultaneously. The tripping control of the circuit interrupting device shall be powered independently of the utility AC source in order to permit operation upon loss of the FirstEnergy supply.

- Non-certified inverters rated 300 kW or larger and rotating machines rated 300 kW or larger will require the use of utility grade relays at the point of interconnection. Utility-grade relays are also required where multiple generators are connected to the FirstEnergy system through a single point of interconnection and the aggregate generation is 2000 kW or larger. For purposes of this policy, utility-grade relays are defined as follows:

Relays comply with the latest IEEE Standard, C37.90, "Relays and Relay Systems Associated with Electric Power Apparatus."

Relays have appropriate test plugs/switches for testing the operation of the relay without unwiring or disassembly.

Relays have targets to indicate relay operation.

Relays have ability to record and store fault events.

- The generator protection and controls 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 re-closure of any automatic reclosing devices.

- The generator shall cease to energize the FirstEnergy distribution system for faults on the circuit to which it is connected. The generator shall not reconnect to the FirstEnergy system following a trip from a system protection device, until the FirstEnergy system has been re-energized for a minimum of five minutes.

- The generator protection and controls shall be designed to prevent the generator from being connected to a de-energized FirstEnergy circuit.

Voltage Control & Flicker

- The generator shall be capable of paralleling with the FirstEnergy system without causing a voltage fluctuation at the point of common coupling (PCC) greater than 5% of the prevailing voltage level of the FirstEnergy system at the PCC.

- The generator must have adequate protection and controls to ensure the requirements for frequency, voltage, and phase angle shown in Table 1 are met prior to paralleling with the FirstEnergy system.

Table 1: Paralleling requirements for generators connecting to the distribution system.

Rating of Generator (kVA)	Frequency Difference (Hz)	Voltage Difference (%V)	Phase angle Difference (degrees)
0 - 500	0.3	10	20
500 - 1500	0.2	5	15
> 1500	0.1	3	10

- The generator shall not be a source of excessive harmonic voltage and current distortion and/or voltage flicker. Limits for harmonic distortion (including inductive telephone influence factors) will be as published in the latest issues of IEEE 519, "Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems[3]." Flicker occurring at the point of common coupling serving other FirstEnergy customers shall remain below the Border Line of Visibility curve shown in fig. 10-3 of the IEEE 519 Standard. (A.k.a. the GE Flicker Curve). Flicker occurring at the secondary of a service transformer serving a sole DG customer shall remain below the Borderline of Irritability curve.

- When there is reasonable cause for concern due to the nature of the generation and its location, FirstEnergy may require the installation of a monitoring system to permit ongoing assessment of compliance with these criteria. The monitoring system, if required, will be installed at the generator owner's expense. Situations where high harmonic voltages and/or currents originate from the distribution system are to be addressed in the Interconnection

[3] IEEE Standard 519-1992, "IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems," Second printing June 15, 2004

Agreement.

- If high voltage, low voltage, or objectionable voltage flicker arises due to the operation, frequent tripping, and/or frequent starting and stopping of the generator, the generator owner may be required to disconnect its generation equipment from the FirstEnergy system until the problem has been fully investigated and resolved.

- The operation of the generator equipment must not result in harmonic currents or voltages at the point of common coupling that will interfere with FirstEnergy's metering accuracy and/or proper operation of facilities and/or with the loads of other FirstEnergy customers. Such adverse effects may include, but are not limited to heating of wiring and equipment, overvoltage, communication interference, harmonic resonance, etc.

- DC injection from inverters shall be maintained at or below 0.5% of full rated inverter output current into the point of common coupling.

- The generated voltage shall follow, not attempt to oppose or regulate, changes in the prevailing voltage level provided by FirstEnergy at the point of common coupling, unless otherwise mutually agreed to by the generator owner and FirstEnergy.

- The generator must not interfere with the operation of FirstEnergy voltage regulating equipment including voltage regulators and line capacitors such that the service voltage to other FirstEnergy customers falls outside the limits specified in ANSI C84.1[4], Range A.

- Voltage unbalance at the point of common coupling caused by the generator equipment under any condition shall not exceed 3% (ratio of maximum deviation from average voltage to the average voltage).[5]

- A generator connected to an area network system shall not cause tripping of network protectors due to reversal of power flow.

Response to abnormal voltage

- The protection functions of the interconnection system shall detect the effective (RMS) or fundamental frequency value of each phase-to-phase voltage, except where the transformer connecting the generator to the FirstEnergy system is a grounded wye-wye configuration, or single-phase installation, the phase-to-neutral voltage shall be detected.

- When any voltage is in a range given in Table 2 the generator shall cease to

[4] ANSI C84.1-2006, American National Standard for Electrical Power Systems and Equipment—Voltage Ratings (60 Hertz)
[5] ANSI C84.1-2006, Annex C, Polyphase Voltage Unbalance, Paragraph C.2

energize the FirstEnergy system within the clearing time as indicated. Clearing time is the time between the start of the abnormal condition and the generator ceasing to energize the utility system.

- For generators 30 kW or larger, different settings may be used for the under/over voltage trip levels or time delays if approved by FirstEnergy. Field-adjustable set points shall be protected against unauthorized adjustment.

Table 2: Interconnection System Response to Abnormal Voltages

Voltage Range (% of Base Voltage) [1]	Clearing time [2]
V < 50 %	0.16 Seconds
50 % ≤ V < 88 %	2.00 Seconds
110% < V < 120 %	1.00 Seconds
V ≥ 120 %	0.16 Seconds

[1] Base voltages are the nominal system voltages stated in ANSI C84.1-1995.
[2] For generators ≥ 30 kW times may be extended if approved by FirstEnergy.

- Voltages shall normally be detected at the PCC to eliminate the effects of voltage drop or transformer connections between the PCC and the point of generator interconnection. However, under any of the following conditions the voltages may be detected at the point of generator interconnection:

  The aggregate capacity of the generator system connected to a single PCC is less than or equal to 30 kW,

  The interconnection equipment is certified to pass a non-islanding test for the system to which it is to be connected,

  The aggregate generator capacity is less than 50% of the total local electric power system minimum annual integrated electrical demand for a 15 minute time period, and export of real or reactive power by the generator to the FirstEnergy system is not permitted.

Response to abnormal frequency

- When the system frequency is in a range given in Table 3, the generator shall cease to energize the FirstEnergy system within the clearing time as indicated. Clearing time is the time between the start of the abnormal condition and the generator ceasing to energize the FirstEnergy system.

- For generators greater than 30 kW, the frequency and time delay set points shall be field adjustable. Field-adjustable set points shall be protected against unauthorized adjustment.

Table 3: Interconnection Response to Abnormal Frequency		
Generator Size	Frequency Range (Hz)	Clearing time
≤ 30 kW	> 60.5	0.16 Sec
	< 59.3	0.16 Sec
> 30 kW	> 60.5	0.16 Sec
	< 59.3 [1]	0.25 Sec [2]
	< 57.0	0.16 Sec

[1] < {59.8 – 57.0 Hz} Allowable setting under approval from FirstEnergy.

[2] {0.16 to 300 Sec} Allowable setting under approval from FirstEnergy.

Islanding Protection

- The generator protection and controls must be able to detect an island condition and disconnect the generator from the FirstEnergy system within two seconds of the formation of an island. The anti-islanding requirement can be satisfied by using any of the following methods, subject to the approval of FirstEnergy.

  Direct Transfer Trip Scheme,

  Use of frequency relays and voltage relays,

  The generator's protection package or the inverter is certified to pass an anti-islanding test (certified to comply with IEEE 1547),

  Non-exporting customer generator with reverse power relaying applied at the point of interconnection.

Direct Transfer Trip (DTT) Scheme

- FirstEnergy will make the determination if a DTT scheme is required on a case-by-case basis. A DTT scheme will typically be required when both of the following are true:

  The generator is any of the following types; a synchronous machine, a non-certified inverter, or a self-excited induction generator, each capable of sustaining a load when separated from the utility system;

  The minimum circuit load on the line section connected to the generator following the opening of any automatic sectionalizing devices is not greater than 3 times the aggregate generation capacity.

- The DTT scheme design, equipment and type of communication channel shall be proposed by the generator owner and submitted to FirstEnergy for review and acceptance.

- The DTT scheme must be designed to automatically trip and separate the generator from the FirstEnergy distribution system upon loss of communication channel. The generator shall not reconnect to the system until the communication channel is proven to functioning normally.

- Responsibilities for purchase, installation and ownership of DTT equipment will be as follows:

  The generator owner shall own and provide a direct-transfer trip receiver(s) at their facility to receive tripping signals originating from a FirstEnergy location(s).

  The generator owner shall bear the costs to purchase and install the required DTT transmitting and associated relaying equipment at the required FirstEnergy location(s). FirstEnergy will perform or coordinate the installation of the equipment at the cost of the generator owner. FirstEnergy will own and be responsible to maintain and perform periodic maintenance and testing of this equipment.

  The generator owner is responsible for the design, installation and maintenance of a dedicated communication channel(s) between the FirstEnergy location(s) and the generation owner's facility, including any rental, license and attachment fees for the communications channel.

  When DTT equipment needs replacement due to age or continued unreliable performance, the generator owner is responsible for purchase and installation costs of the new equipment. This must be established in the Interconnection agreement with the generator owner.

- If the generator owner wishes to install communications cables or equipment on FirstEnergy poles, the generator owner will be responsible to secure a license agreement or pole attachment agreement for those attachments, and assume typical licensed attachment responsibilities in terms of make-ready work costs and annual attachment fees. Cable attachment will be in the communications space on the poles.

- When a DTT tripping signal originates from a FirstEnergy substation breaker, the preferred location for DTT transmitter and associated equipment is within the FirstEnergy substation control room or approved outdoor enclosure within the substation perimeter if a control room is not available.

- FirstEnergy will establish a demarcation point for any DTT communication cables leaving the substation property. FirstEnergy will perform or coordinate the installation of the cable and conduit up to the demarcation point including the box enclosure. FirstEnergy will determine the enclosure location. All material and installation costs will be borne by the generator owner. The generator owner will be responsible to install cable and conduit originating from their end up to the demarcation point. Details of the planned installation including any trenching must be approved by FirstEnergy.

- The generator owner may be responsible to compensate FirstEnergy for any labor expenses involved with troubleshooting or testing of the DTT communications or protection system. This requirement is to be contractually addressed in the Interconnection Agreement with the generator owner.

Disconnect Switch Requirements

- FirstEnergy requires that a disconnect device with a visibly open means be provided, installed, and paid for by the generator owner, which is readily accessible to and lockable by FirstEnergy personnel, in order to safely disconnect the generator from the FirstEnergy system.[6]

- The disconnect device may be installed either at the primary voltage level or secondary voltage level at the discretion of FirstEnergy. The generator disconnect device must be clearly labeled to show its intended function.

Interconnection Transformer Requirements

- All generation must be isolated from the FirstEnergy primary distribution system by a transformer in order to properly integrate the grounding scheme of the generator to the grounding scheme of the distribution system.

- The grounding scheme of the interconnection transformer shall not cause overvoltages on the un-faulted phases during ground-fault conditions that exceed the rating of equipment connected to the FirstEnergy distribution system.

- The ground source contribution current of the interconnection transformer shall not disrupt the coordination of the overcurrent devices of the distribution circuit whether or not the generator is in operation.

Maintenance Requirements

- The generator owner shall maintain all equipment associated with the generator system, including DTT communications equipment, according to good utility practices and according to equipment manufacturer's recommendations and keep it in proper working condition.

- The generator owner shall keep a written log and test records showing the periodic testing of such equipment. These records must be available to FirstEnergy upon request.

Acceptance Testing

- Test results or equipment pre-certification shall be supplied by the generator owner, that verify, to the satisfaction of FirstEnergy, compliance with the IEEE 1547 Standard, Section 5 "Interconnection Test Specifications and Requirements."

- The generator owner must provide FirstEnergy the opportunity to perform an

[6] Exception: In New Jersey, an outdoor disconnect switch is not a requirement for Level 1 interconnections per NJ Net metering regulations. See NJ Administrative Code, NJAC 14:8-4.1 et seq.(2008)

inspection prior to interconnection to verify correct protective settings and wiring connections.

- Acceptance testing shall be performed on all generators and generating equipment not pre-certified by a nationally recognized testing laboratory as suitable for utility interconnection meeting the intent of these technical requirements. A qualified third party testing organization shall perform these tests at the expense of the generator owner.

- Acceptance testing of the protective schemes, where required, must be completed on new or modified installations.

Communications and Control

- FirstEnergy may require the generator owner to provide a listing of two or more persons and their telephone numbers such that the FirstEnergy dispatching office can contact the generator owner for emergency switching operations 24 hours a day. This is a necessary safety requirement.

- For generators rated 2000 kVA or larger, individually or in aggregate, who are exporting energy on a wholesale basis, will require the generator owner to furnish a SCADA remote terminal unit (RTU) which will interface with the FirstEnergy energy management system (EMS). The RTU, the communications channel and all related equipment will be furnished and maintained by the generator owner. The RTU must communicate with the FirstEnergy EMS via DNP 3.0 protocol. The following control, status, and metering points will be required:

  Tripping control of generator or interconnection breaker.

  Generator real and reactive power output measured at the high-side of the generator step-up transformer.

  Generator voltage at the point of interconnection.

  Indication that a direct-transfer trip operation has occurred where DTT is used.

- Where tripping control of generator breaker is required, the tripping command originating from the FirstEnergy dispatching office must also activate a closing lockout function which must be manually reset before the generator breaker can be re-connected to the system.

Metering Requirements

- Metering instrument transformers are to be protected from the distribution system by a fuse or other protective device such that failure of an instrument transformer does not cause a distribution protection device to open.

- In the case of an existing retail customer that is adding generation their facility, the retail billing meter will need to be replaced with a bi-directional meter. A review of the wiring and current transformers may need to be performed to verify the ampacity ratings are sufficient for the size of the generator. Cost responsibilities for meter replacement are defined in the retail net metering tariffs.

- Wholesale generation facilities must comply with the metering requirements of the appropriate RTO.

- Wholesale generation facilities must comply with the FirstEnergy requirements specified in the document entitled "FirstEnergy Revenue Metering Requirements For Generation Facilities Connected 46 kV and Lower."

- Generators with an aggregate capacity of 1000 kVA or larger may require the installation of an interval metering system, which will transfer metering data to the FirstEnergy MV-90 system[7]. The meter will be provided by FirstEnergy. The generator owner will be responsible to provide at their cost a dedicated communications channel, which will interface with FirstEnergy's MV-90 system.

- Cost responsibilities associated with the purchase, installation, and testing and of revenue metering equipment will be determined on a case-by-case basis under the direction of the FirstEnergy Corporate Metering Department and in accordance with the rules found in filed tariffs. These details are to be addressed in the facilities study.

- Metering equipment must meet the specifications of FirstEnergy and the appropriate RTO.

Definitions

Area Network System - A type of electric distribution system served by multiple transformers interconnected in an electrical network circuit, which is generally used in large metropolitan areas that are densely populated, in order to provide highly reliable service. Area network has the same meaning as the term "distribution secondary grid network" found in institute of electrical and electronics engineers (IEEE) standard 1547.

Certified Equipment – Equipment which has been submitted by a manufacturer to an OSHA-approved nationally recognized testing laboratory, and has been tested and listed by the laboratory for continuous interactive operation with an electric distribution system in compliance with the applicable codes and standards listed in the IEEE 1547 and UL 1741 Standards.

Flicker – A variation of input voltage sufficient in duration to allow visual observation of a change in electric light source intensity.

Harmonic Distortion – Continuous distortion of the normal sine wave; typically caused by nonlinear loads or by inverters.

[7] MV-90 is FirstEnergy's system for collecting interval metering data.

Inverter – A device or system that changes direct current power to alternating current power. Inverters that are self-commutating can be configured for stand-alone service. Inverters that are line-commutated cannot be configured for stand-alone service.

Point of Common Coupling – The point at which the generator facility is connected to the shared portion, or potentially shared portion of the FirstEnergy system. The IEEE 1547 standard establishes this point as the location where voltage and harmonic limits are measured and applied.

Regional Transmission Organization (RTO) – An independent, FERC-approved organization of sufficient regional scope, which coordinates the interstate movement of electricity under FERC-approved Tariffs by operating the transmission system and competitive wholesale electricity markets, and ensuring reliability and efficiency through expansion planning and interregional coordination.

Single Phasing Condition – Occurs when one or two phases of the three phase supply line are disconnected.

Unintentional Island - An unplanned condition where one or more generator's and a portion of the FirstEnergy system remain energized solely through the point of interconnection.

Attachment 8
Lenox-34.5kV (Z1-091) Project
Conceptual 34.5 kV Secondary Point of Interconnection

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 N.MESHPN 230/115 kV transformer (from bus 200825 to bus 200706 ckt 3) loads from 105.58% to 108.29% (**DC power flow**) of its emergency rating (188 MVA) for the single line contingency outage of 'B_PN230-SX-#11'. This project contributes approximately 5.31 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

Bus Number	Bus Name	Full Contribution
200887	ARMNA MT P47	0.07
203261	BLOSSBCT	0.06
203283	MANOR	< 0.01
200851	MEHOOP3	0.81
293270	N-036 C	0.62
294572	P-028 C	0.41
293416	V3-042 C	2.33
907991	X1-078	11.72
907481	X1-109	3.4
X3-021	X3-021	12.56
X3-050	X3-050	7.81
913191	Y1-047 OP1	5.79
913441	Y1-069 OP1	3.69
Y2-044	Y2-044	6.17
Y2-049	Y2-049	11.12
914151	Y2-060	1.32
Y2-068	Y2-068	35.49
Y2-082	Y2-082	18.03
915771	Y3-092	19.88
Z1-019	Z1-019	47.68
916251	Z1-033	10.19
916061	Z1-038	5.51
916261	Z1-069 C	0.95
Z1-070A	Z1-070A	2.42
Z1-070B	Z1-070B	10.23

916421	Z1-091	5.31

Appendix 2

(PENELEC - PENELEC) The NO MESHO-MESH2REA 115 kV line (from bus 200677 to bus 200825 ckt 3) loads from 105.64% to 108.34% (**DC power flow**) of its emergency rating (188 MVA) for the single line contingency outage of 'B_PN230-SX-#11'. This project contributes approximately 5.31 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

Bus Number	Bus Name	Full Contribution
200887	ARMNA MT P47	0.07
203261	BLOSSBCT	0.06
203283	MANOR	< 0.01
200851	MEHOOP3	0.81
293270	N-036 C	0.62
294572	P-028 C	0.41
293416	V3-042 C	2.33
907991	X1-078	11.72
907481	X1-109	3.4
X3-021	X3-021	12.56
X3-050	X3-050	7.81
913191	Y1-047 OP1	5.79
913441	Y1-069 OP1	3.69
Y2-044	Y2-044	6.17
Y2-049	Y2-049	11.12
914151	Y2-060	1.32
Y2-068	Y2-068	35.49
Y2-082	Y2-082	18.03
915771	Y3-092	19.88
Z1-019	Z1-019	47.68
916251	Z1-033	10.19
916061	Z1-038	5.51
916261	Z1-069 C	0.95
Z1-070A	Z1-070A	2.42
Z1-070B	Z1-070B	10.23

916421	Z1-091	5.31

Appendix 3

(PENELEC - PENELEC) The N.MESHPN-OXBOW 230 kV line (from bus 200706 to bus 200708 ckt 1) loads from 116.43% to 117.32% (AC power flow) of its emergency rating (617 MVA) for the single line contingency outage of 'SUSQ 1'. This project contributes approximately 7.51 MW to the thermal violation.

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

Bus Number	Bus Name	Full Contribution
200887	ARMNA MT P47	0.19
203261	BLOSSBCT	0.18
94106	GRAYMONT	0.01
200828	HNSMLK 1	0.11
200829	HNSMLK 2	0.11
200830	HNSMLK 3	0.11
200831	HNSMLK 4	0.11
200832	HNSMLK 5	0.11
200838	HOMER C2	1.26
200839	HOMER C3	1.33
200849	LAKVU GN	0.01
203283	MANOR	0.02
200851	MEHOOP3	1.02
293270	N-036 C	1.64
294572	P-028 C	0.52
200649	PENNTECH	0.14
290085	Q-036 C	0.02
290113	Q-063 C	0.05
296914	R-092 C	1.18
291011	S-103	0.18
200662	SCRUB GR	0.16
200642	SENECA#1	0.66
200643	SENECA#2	0.61
200644	SENECA#3	0.09
200715	SHAWVL 1	11.24
200722	SHAWVL 2	11.39
200665	SHAWVL 3	16.57
200666	SHAWVL 4	16.39

292391	T-121 C	1.97
292078	V1-034	0.2
293416	V3-042 C	3.62
903651	W3-099 C OP1	1.
907991	X1-078	30.81
907481	X1-109	10.97
X3-050	X3-050	19.17
913191	Y1-047 OP1	7.23
Y2-044	Y2-044	15.16
914131	Y2-055	4.29
914151	Y2-060	1.64
Y2-068	Y2-068	91.45
Y2-082	Y2-082	46.19
Y3-032	Y3-032	12.63
915331	Y3-062 C	0.19
Y3-083	Y3-083	12.72
915771	Y3-092	52.69
Z1-019	Z1-019	116.38
916251	Z1-033	26.82
916061	Z1-038	6.97
916261	Z1-069 C	2.51
916381	Z1-087	3.41
916421	Z1-091	7.51

Appendix 4

(PENELEC - PL) The OXBOW-LACK 230 kV line (from bus 200708 to bus 208009 ckt 1) loads from 117.51% to 118.44% (AC power flow) of its emergency rating (624 MVA) for the single line contingency outage of 'PL100903'. This project contributes approximately 7.73 MW to the thermal violation.

```
CONTINGENCY 'PL100903'                    /* SUSQUEHANNA-SUSQ GEN 1 230KV
  DISCONNECT BUS 208114
  END
```

Bus Number	Bus Name	Full Contribution
200887	ARMNA MT P47	0.19
203261	BLOSSBCT	0.18
94106	GRAYMONT	0.01
200828	HNSMLK 1	0.11
200829	HNSMLK 2	0.11
200830	HNSMLK 3	0.11
200831	HNSMLK 4	0.11
200832	HNSMLK 5	0.11
200838	HOMER C2	1.27
200839	HOMER C3	1.34
200849	LAKVU GN	0.01
203283	MANOR	0.02
200851	MEHOOP3	1.05
293270	N-036 C	1.66
294572	P-028 C	0.53
200649	PENNTECH	0.14
290085	Q-036 C	0.02
290113	Q-063 C	0.05
296914	R-092 C	1.19
291011	S-103	0.18
200662	SCRUB GR	0.16
200642	SENECA#1	0.66
200643	SENECA#2	0.62
200644	SENECA#3	0.09
200715	SHAWVL 1	11.32
200722	SHAWVL 2	11.47
200665	SHAWVL 3	16.69

200666	SHAWVL 4	16.5
292391	T-121 C	1.99
292078	V1-034	0.2
293416	V3-042 C	3.72
903651	W3-099 C OP1	1.01
907991	X1-078	31.58
907481	X1-109	11.08
X3-050	X3-050	19.44
913191	Y1-047 OP1	7.48
913241	Y1-057 C	< 0.01
914061	Y2-042	12.22
Y2-044	Y2-044	15.37
914131	Y2-055	4.33
914151	Y2-060	1.7
Y2-068	Y2-068	90.87
Y2-082	Y2-082	46.14
Y3-032	Y3-032	12.69
915331	Y3-062 C	0.19
Y3-083	Y3-083	12.78
915771	Y3-092	52.95
Z1-019	Z1-019	118.05
916251	Z1-033	27.47
916061	Z1-038	9.89
916261	Z1-069 C	2.54
916381	Z1-087	3.44
916421	Z1-091	7.73

Appendix 5

(PENELEC - PL) The OXBOW-LACK 230 kV line (from bus 200708 to bus 208009 ckt 1) loads from 138.14% to 139.22% (AC power flow) of its normal rating (494 MVA) for non-contingency condition. This project contributes approximately 7.74 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
200887	ARMNA MT P47	0.19
203261	BLOSSBCT	0.18
94106	GRAYMONT	0.01
200828	HNSMLK 1	0.11
200829	HNSMLK 2	0.11
200830	HNSMLK 3	0.11
200831	HNSMLK 4	0.11
200832	HNSMLK 5	0.11
200838	HOMER C2	1.28
200839	HOMER C3	1.35
200849	LAKVU GN	0.01
203283	MANOR	0.02
200851	MEHOOP3	1.05
293270	N-036 C	1.67
294572	P-028 C	0.53
200649	PENNTECH	0.14
290085	Q-036 C	0.02
290113	Q-063 C	0.05
296914	R-092 C	1.19
291011	S-103	0.18
200662	SCRUB GR	0.16
200642	SENECA#1	0.67
200643	SENECA#2	0.62
200644	SENECA#3	0.1
200715	SHAWVL 1	11.38
200722	SHAWVL 2	11.54
200665	SHAWVL 3	16.78
200666	SHAWVL 4	16.6
292391	T-121 C	2.
292078	V1-034	0.2

293416	V3-042 C	3.73
903651	W3-099 C OP1	1.02
907991	X1-078	31.29
907481	X1-109	11.1
X3-021	X3-021	32.53
X3-050	X3-050	19.5
913191	Y1-047 OP1	7.49
913241	Y1-057 C	< 0.01
914061	Y2-042	12.23
Y2-044	Y2-044	15.42
914131	Y2-055	4.35
914151	Y2-060	1.7
Y2-068	Y2-068	92.94
Y2-082	Y2-082	46.94
Y3-032	Y3-032	12.84
915331	Y3-062 C	0.19
Y3-083	Y3-083	12.93
915771	Y3-092	53.51
Z1-019	Z1-019	118.39
916251	Z1-033	27.24
916061	Z1-038	9.9
916261	Z1-069 C	2.55
Z1-070A	Z1-070A	6.33
Z1-070B	Z1-070B	26.75
916381	Z1-087	3.46
916421	Z1-091	7.74

Appendix 6

(PENELEC - PENELEC) The N.MESHPN-OXBOW 230 kV line (from bus 200706 to bus 200708 ckt 1) loads from 145.96% to 147.03% (AC power flow) of its normal rating (478 MVA) for non-contingency condition. This project contributes approximately 7.51 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
200887	ARMNA MT P47	0.19
203261	BLOSSBCT	0.18
94106	GRAYMONT	0.01
200828	HNSMLK 1	0.11
200829	HNSMLK 2	0.11
200830	HNSMLK 3	0.11
200831	HNSMLK 4	0.11
200832	HNSMLK 5	0.11
200838	HOMER C2	1.26
200839	HOMER C3	1.33
200849	LAKVU GN	0.01
203283	MANOR	0.02
200851	MEHOOP3	1.02
293270	N-036 C	1.64
294572	P-028 C	0.52
200649	PENNTECH	0.14
290085	Q-036 C	0.02
290113	Q-063 C	0.05
296914	R-092 C	1.18
291011	S-103	0.18
200662	SCRUB GR	0.16
200642	SENECA#1	0.66
200643	SENECA#2	0.61
200644	SENECA#3	0.09
200715	SHAWVL 1	11.24
200722	SHAWVL 2	11.39
200665	SHAWVL 3	16.57
200666	SHAWVL 4	16.39
292391	T-121 C	1.97
292078	V1-034	0.2

293416	V3-042 C	3.62
903651	W3-099 C OP1	1.
907991	X1-078	30.81
907481	X1-109	10.97
X3-021	X3-021	32.01
X3-050	X3-050	19.17
913191	Y1-047 OP1	7.23
Y2-044	Y2-044	15.16
Y2-049	Y2-049	28.3
914131	Y2-055	4.29
914151	Y2-060	1.64
Y2-068	Y2-068	91.45
Y2-082	Y2-082	46.19
Y3-032	Y3-032	12.63
915331	Y3-062 C	0.19
Y3-083	Y3-083	12.72
915771	Y3-092	52.69
Z1-019	Z1-019	116.38
916251	Z1-033	26.82
916061	Z1-038	6.97
916261	Z1-069 C	2.51
Z1-070A	Z1-070A	6.23
Z1-070B	Z1-070B	26.32
916381	Z1-087	3.41
916421	Z1-091	7.51