

***Generation Interconnection  
Feasibility Study Report (Web Version)***

***For***

***PJM Generation Interconnection Request  
Queue Position V4-020***

***North Temple 230kV***

**January 2011**

## **Introduction**

This Feasibility Study report provides the documentation of an assessment performed by the transmission service providers, PJM Interconnection, the interconnected transmission owner, FirstEnergy (FE), and affected transmission owners, PPL and BG&E in response to a request made by the Interconnection Customer (IC) for the interconnection of a 650 MW Ontelaunee (V4-020) generation project to the Met-Ed Transmission System. This assessment was accomplished by: 1. Evaluating the reliability impact of the proposed facilities and connection on the interconnected transmission system by the performance of a power flow study; 2. Ensuring compliance with the NERC, ReliabilityFirst, PJM, FE, and any other applicable transmission owner Reliability Standards by identifying the system reinforcements that will need to be installed for an interconnection of the proposed project; 3. Coordinating and cooperating with the PJM staff and IC 4. Performing a Steady State, Short-Circuit and Dynamics Study as necessary; 5. Conducting all studies in accordance with the PJM Manuals and the all applicable transmission owner requirement documents that assure the assessment performed incorporates study assumptions, follows the documented system performance procedures, considers alternative connection and reinforcement plans, and jointly coordinates the study recommendations.

## **Network Impacts**

The queue V4-020 project was studied as a 650MW capacity injection into METED's system at the North Temple 230kV substation. Project V4-020 was evaluated for compliance with reliability criteria for summer peak conditions in 2014. Potential network impacts as identified in the PJM analysis were as listed below. There are additional overloads identified in the "FE-Power Flow Analysis." The Interconnection Customer will be responsible also for their associated reinforcements.

### **Generator Deliverability**

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

1. The North Temple - Riverview 69kV line (from bus 204607 to bus 204851 circuit 1) loads from 95.06% to 128.25% (DC power flow) of its emergency rating (109MVA) for the single contingency ('B\_ME230-SX-#16') as a result of V4-020. This project contributes approximately 36.2MW to cause this thermal violation.
2. The OCR - Conastone 230kV line (from bus 208048 to bus 220963 circuit 1) loads from 94.62% to 106.27% (DC power flow) of its emergency rating (531MVA) for the single contingency ('PJM17') as a result of V4-020. This project contributes approximately 61.9MW to cause this thermal violation.

### **Multiple Facility Contingency**

*(Double Circuit Tower Line contingencies only for the full energy output. Stuck breaker and bus fault contingencies will be performed for the Impact Study)*

3. The North Temple 230/69kV line (from bus 204508 to bus 204607 circuit 4) loads from 76.08% to 105.6% (DC power flow) of its emergency rating (260MVA) for the tower contingency ('C5\_ME230-DCT-#2') as a result of V4-020. This project contributes approximately 76.8MW to cause this thermal violation.

### **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)*

4. The Brunner Island - Yorkana 230kV line (from bus 207922 to bus 204515 circuit 1) loads from 108.32% to 116.49% (DC power flow) of its emergency rating (617MVA) for the single contingency ('PJM17') as a result of V4-020. This project contributes approximately 51.1MW to cause this thermal violation.

5. The Bagley13 - Raphael 230kV line (from bus 220999 to bus 220980 circuit 1) loads from 143.99% to 145.07% (DC power flow) of its emergency rating (674MVA) for the tower contingency ('CNSTN\_NWEST') as a result of V4-020. This project contributes approximately 7.3MW to cause this thermal violation.

### **New System Reinforcements**

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

1. The North Temple-Riverview 69kV line is a FirstEnergy facility. Details of this reinforcement were prepared by FirstEnergy and are discussed in the "FE Power Flow Analysis" portion of this report.

**This reinforcement is estimated to cost \$3,118,700 plus a portion of the \$70,000 cost for engineering oversight and commissioning.. Time for completion is 24 months from execution of ISA.**

2. The Otter Creek – Conastone 230kV line is a facility shared by PPL and BG&E. Their respective portions of this reinforcement are as follows:

#### **PPL portion**

PPL has recently submitted plans to PJM to rebuild the Otter Creek - Conastone 230kV line as part of a modernization project (submitted to PJM as supplemental project S0233). This project is tentatively scheduled to be complete by May 2013 (prior to this project's 2014 requested in-service date).

**Therefore the Interconnection Customer's responsibility for the cost to rebuild PPL's portion of the Otter Creek - Conastone 230kV line is \$0.**

### BG&E portion

This reinforcement will require the Interconnection Customer to rebuild the Otter Creek to Conastone 230 kV 4.7 mile line (2302) to the Pennsylvania border. New rating is 648N/802E MVA.

**The estimated cost to perform this work is \$19,000,000, and will require 60 months to complete after signing of an ISA.**

3. The North Temple 230/69kV line (from bus 204508 to bus 204607 circuit 4) overload may be relieved by the Northkill sub-regional PJM Regional Transmission Expansion Planning (RTEP) upgrade. (Network Upgrade No. b0653)

### 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)*

4. The Brunner Island – Yorkana 230kV line overload is on a PPL facility. The reinforcement requires the Interconnection Customer to upgrade the PPL portion of the Brunner Island - Yorkana 230 kV line, approximately 0.64 miles of 13.23 mile circuit. The proposed upgrade will consist of re-conductoring approximately 0.64 miles of 1033 kcmil ACSR, (current ratings 498/617 MVA Summer Normal/Emergency based on conductor temp @ 125 deg C) with new 1590 kcmil ACSR (new ratings 653/793 MVA Summer Normal/Emergency, conductor operating temperature @ 125 deg C). This estimate assumes that temporary facilities will need to be built in order to keep the line in-service.

**The cost estimate for this upgrade including substation terminal equipment is \$1,700,000. This will require 30 months after signing the ISA.**

5. The Bagley13 - Raphael 230kV line (from bus 220999 to bus 220980 circuit 1) is a BG&E facility. Its overload mitigation requires that the Interconnection Customer rebuild the 6 mile Raphael Road to Bagley 230 kV circuit to a double circuit rated 659 MVA normal / 800 MVA emergency on each circuit.

**The estimated cost is \$7,000,000, and is estimated to take 60-72 months after execution of ISA (CPCN still required).**

### Short Circuit

See the “FE Short Circuit and Dynamics Analysis” section later in this report.

## **FE Power Flow Analysis**

A Power Flow study was conducted to determine the reliability impact of the proposed Ontelaunee (V4-020) Project on the FE Transmission System. This study was completed using a 2014 summer peak load power flow that contained a detailed representation of the Met-Ed transmission networks in the area of the proposed Ontelaunee (V4-020) Project. The findings and the recommendations from this analysis are based on a contingency review that was performed to identify the facility loadings and/or voltage conditions that violate the ReliabilityFirst, PJM or FE Planning Criteria and are either directly attributable to this project or for which it will have a shared responsibility. As a part of this review, a simulation of all possible contingencies within the NERC and FE Planning Standards that are impacted by the Ontelaunee (V4-020) Project was conducted.

The results from the Power Flow Analysis reveal three criteria violations. The North Temple - Lyons (1031) 230 kV line, the North Temple - Riverview 69 kV line (this was identified earlier in this report) and Riverview - Car Tech (836) 69 kV lines were each found to exceed their emergency ratings for contingency events. The resolution to the North Temple - Lyons 230 kV overload is to add a North Temple 230 kV breaker between the North Temple - Northkill 230 kV line and the 230/69 kV Bank 6 attachments. This will prevent the North Temple - Northkill 230 kV line from being outaged as a part of a North Temple - Hosensack 230 kV line fault and North Temple stuck breaker event. A resolution of the North Temple - Riverview (836) 69 kV line overload is to construct a second parallel line. This new line will utilize the existing 69 kV structures that are designed for double circuit operation. The Berkley - Riverview (797) 34.5 kV line that is currently strung on one side of these structures will be moved to new poles. The resolution to the Riverview - Car Tech (836) 69 kV line criteria violation is to reconductor this circuit with 795 ACSR conductor.

## **FE Short Circuit and Dynamics Analysis**

A short circuit analysis was conducted by PJM and confirmed by the FE System Protection staff. This analysis showed that no FE circuit breaker will exceed its interrupting capability with the implementation of the Ontelaunee (V4-020) Project. Therefore no breaker reinforcements will be required.

In accordance with the RTEP Impact Study process, the PJM staff is responsible for the performance of a dynamic analysis for the Ontelaunee (V4-020) Project. The results of these studies will be included in the PJM Impact Study report if this project proceeds.

## **FE Connection Facilities**

IC has submitted a "Form of Generation Interconnection Feasibility Study Agreement" to PJM that identifies its plan to construct a 2 x 1 gas fired Combined Cycle Generation Project with a total capability of 650 MW on a property adjacent to the existing Ontelaunee 230 kV plant. The

new units will be connected to the North Temple 230 kV substation by a single attachment line to be constructed by the IC. The proposed in-service date for the Ontelaunee (V4-020) Project is June 1, 2014.

The North Temple 230 kV substation will be expanded by two breakers to a seven breaker ring bus configuration that includes a relocation of the breaker 070112 and its associated switches. In addition, the double circuit dead end structure for the Ironwood Tap (1001) and North Lebanon (1071) 230 kV lines will be moved as a part of this plan. To mitigate the potential for a contingency overload of the North Temple 230 kV circuit breakers 103112 and 100312, these facilities will also be replaced. Note that there is a gas pipeline and railroad line adjacent to the North Temple 230 kV substation that requires its expansion to be offset from a normal design.

The IC will be responsible to construct, own and operate the radial 230 kV attachment line to the North Temple substation. The IC will also be responsible for acquiring all easements, properties and permits that may be required to expand the North Temple substation for the construction of the project connection facilities.

### **FE System Protection Analysis**

An analysis was conducted to assess the impact of the Ontelaunee (V4-020) Project on the system protection requirements in the area. The results of this review show that the following relay additions and upgrades will be required:

#### **Direct Connection Requirements**

Three-phase, dual-winding potential devices required at the V4-020 line exit.

All new relays to be connected to SEL-2020 with GPS time sync.

Dual independent fiber optic cables are required between the North Temple substation and the new V4-020 site for primary and backup line protection.

Add IDM with 32 analog and 64 digital channels and upgrade existing DFR to be compatible with new IDM.

New V4-020 line protection to include:

- SEL-387L with fiber optic interface, for primary line protection
- SEL-311L with fiber optic interface, for backup line protection
- (2) SEL-352 for breaker failure protection
- SATEC meter

#### **System Upgrade Requirements**

230-69 kV #6 Transformer protection

- Remove TPU transformer differential relay
- Add SEL-387 for transformer overall differential protection
- Add SEL-387 for transformer high-side lead protection.

New 69 kV line protection

- SEL-311A
- SEL-311B
- SEL-352
- SATEC meter

Due to the magnitude of this project, only high level costs have been developed for this Feasibility Study. A detailed system protection analysis will be deferred to the Facilities Study if this project proceeds. However, the system upgrade information reported include a generic cost estimate for the system protection upgrades that will required to support the Ontelaunee (V4-020) Project.

### **Metering**

IC will be required to comply with all FE Revenue Metering Requirements for Generation Interconnection Customers.

### **Compliance Issues**

IC will be responsible for meeting all FE criteria as defined in the FE Requirements for Transmission Connected Facilities document. This includes the provision of a reactive power capability sufficient to maintain a composite power delivery for the facility at the interconnection point at a power factor from .95 leading (absorbing MVARs) to .90 lagging (producing MVARs).

IC will also be required to meet all PJM, ReliabilityFirst and NERC reliability criteria and operating procedures 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**

There are three criteria violations that are directly attributable to the Ontelaunee (V4-020) Project. The total estimated cost for the upgrades is shown to be \$4,771,400. However; in accordance with the procedures defined in the PJM Open Access Transmission Tariff and PJM Manuals the PJM staff will determine the IC cost allocation that will be assessed.

Note that all cost data contained in this document should be considered as only ballpark estimates produced without a detailed engineering review. The applicant will be responsible for the actual cost of construction. FirstEnergy herein reserves the right to return to any issues in

this document and, upon appropriate justification, request additional monies to complete any connections to the transmission system.

### **IC Requirements**

IC will 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 purchase and installation of a 230 kV interconnection metering instrument transformer. FE will provide the ratio and accuracy specifications based on the customer load and generation levels.
3. The purchase and installation of a revenue class meter for each Ontelaunee unit to measure the power delivered in compliance with the FE standards.
4. A compliance with the FE and PJM generator power factor and voltage control requirements.
5. The execution of a back-up service agreement to serve the customer load supplied from the North Temple 230 kV substation when the Ontelaunee (V4-020) Project units are out-of-service. This assumes the intent of IC is to net the generation with the load.
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. The RTU, the communications channel and all related equipment will be furnished and maintained by the IC. The RTU must communicate with the FirstEnergy EMS via DNP 3.0 protocol.
7. The following status and metering points will be required:
  - a. Interconnection breaker position.
  - b. Generator real and reactive power output measured at the high-side of the generator step-up transformer.
  - c. Generator voltage at the point of interconnection.

The above requirements are in addition to any metering required by PJM.

## Summary

The Direct Connection of the Ontelaunee generation project to the North Temple 230 kV substation will require the FE attachment facilities and facility upgrades. 4. The total estimated cost of these upgrades is \$6,232,700.

In addition, there are Network Upgrades required to maintain a reliability of the FE and PJM transmission systems. The total estimated cost of these upgrades is \$4,771,400 for the FirstEnergy upgrades. That brings the total for First Energy work to \$11,004,100.

The network upgrades for BG&E as shown in the Network Impacts section of this report are estimated to cost a total \$26,000,000.

Similarly, the network upgrades required by PPL as shown in the Network Impacts section of this report are estimated to cost \$1,700,000.

Therefore, the total cost of the Attachment /Direct Connection and network facility upgrades attributable to the Ontelaunee (V4-020) Project is \$38,704,100. PJM will be responsible for determining the allocation of this total to IC as part of the Impact Study Report.

FirstEnergy assumes that the IC will construct all facilities to the point of interconnection at the North Temple 230 kV substation. A further assumption is that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the defined direct connection and network upgrades, and that PJM will allow all transmission system outages when requested.

Note that all cost data contained in this document should be considered as only ballpark estimates produced without a detailed engineering review. Also, the FE findings were made from a conceptual review of this project. A more detailed review of the connection and network facilities and their cost will be identified in the Impact Study. The Interconnection Customer will be responsible for the actual cost of construction.