Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position V3-042

Thompson 115kV

Revised PJM WebVersion
February, 2010
DOCS 578982v1

Introduction

This Revised Feasibility Study report supersedes the Feasibility Study Report issued on January 29, 2010. This Feasibility Study report provides the documentation of an assessment that has been performed by PJM Interconnection and the Transmission Owner (TO), FirstEnergy (FE), in response to a request made via Attachment N of the PJM Open Access Transmission Tariff by the Developer for the connection of an 84 MW (10.92 MW Capacity) Thompson PN (V3-042) Wind Farm Generation Project to the Penelec Transmission System. This will consist of 56 General Electric 1.5 MW wind turbine generators located in Wayne County Pennsylvania. The target in-service date is December 31, 2012.

This format of this report presents the analysis and associated results provided by the analysis of the PJM staff. Following that, and incorporating where relevant the results of PJM's analysis, is the results of the analysis performed by FirstEnergy. This includes the scope of all direct connections and attachment facilities, as well s the cost and schedule for their construction. FirstEnergy's work also includes the system protection and metering requirements.

PJM Analysis

Network Impacts

The queue V3-042 project was studied as an 84MW (10.9MW of which was capacity) injection into the 115kV PENELEC system at the Thompson facility. Project V3-042 was evaluated for compliance with reliability criteria for summer peak conditions in 2014. Potential network impacts were as follows:

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

No problems identified.

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)

No problems 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)

No problems identified.

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)

None.

Short Circuit

PJM has completed the short circuit analysis of the V3-042 queue project Thompson 115kV. One option was considered during this study: the option was a direct connection to the Thompson 115kV. PJM's analysis found no new breakers to be over-duty in the Penelec transmission area.

The study also showed no significant fault current contribution to the breakers which have already been identified as over-duty. This study was performed on the 100kV and above system.

A review and additional analysis will be performed by the Transmission Owner if required and will be included in the Impact Study Report.

Potential Congestion due to Local Energy Deliverability

(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 developer 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 below. There is no guarantee of full deliverability 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 identified overloaded element(s). As a result of the aggregate energy resources in the area, the following violations were identified:

1. The HOMER CT - SHELOCTA 230kV line (from bus 200767 to bus 200795 ckt 1) loads from 130.69% to 132.21% (DC power flow) of its emergency rating (841MVA) for the operational contingency ('B_PN345-SX-#6') as a result of V3-042. This project contributes approximately 12.8MW to cause this thermal violation.

2. The NO MESHO – MESH2REA 115kV line (from bus 200677 to bus 200825 ckt 3) loads from 115.32% to 126.83% (DC power flow) of its emergency rating (157MVA) for the operational contingency ('B_PN230-SX-#11') as a result of V3-042. This project contributes approximately 18.0MW to cause this thermal violation.

3. The N.MESHPN - OXBOW 230kV line (from bus 200706 to bus 200708 ckt 1) loads from 119.37% to 124.75% (DC power flow) of its normal rating (478MVA) for non-contingency conditions as a result of V3-042. This project contributes approximately 26.7MW to cause this thermal violation.

4. The N.MESHPN – OXBOW 230kV line (from bus 200706 to bus 200708 ckt 1) loads from 113.6% to 117.74% (DC power flow) of its emergency rating (608MVA) for the operational contingency ('PJM SUSQ-LACK 500_U4-05A') as a result of V3-042. This project contributes approximately 26.1MW to cause this thermal violation.

5. The OXBOW – LACK 230kV line (from bus 200708 to bus 208009 ckt 1) loads from 115.78% to 121.23% (DC power flow) of its normal rating (488MVA) for non-contingency conditions as a result of V3-042. This project contributes approximately 27.6MW to cause this thermal violation.

6. The OXBOW – LACK 230kV line (from bus 200708 to bus 208009 ckt 1) loads from 111.36% to 115.58% (DC power flow) of its emergency rating (617MVA) for the operational contingency ('PJM SUSQ-LACK 500_U4-05A') as a result of V3-042. This project contributes approximately 27.0MW to cause this thermal violation.

7. The MESH2REA – N.MESHPN 115/230kV transformer (from bus 200825 to bus 200706 ckt 3) loads from 96.24% to 105.85% (DC power flow) of its emergency rating (188MVA) for the operational contingency ('B_PN230-SX-#11') as a result of V3-042. This project contributes approximately 18.0MW to cause this thermal violation.

FirstEnergy Analysis

Power Flow Analysis

Consistent with the PJM analysis, a Power Flow study was conducted by FirstEnergy to determine the reliability impact of the proposed V3-042 Thompson 115 kV Project on the FE Transmission System. 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 V3-042 Thompson 115 kV Project Power Flow Analysis that was performed was completed using a 2014 summer peak load base case power flow provided by the PJM staff. This base case included a detailed representation of the Penelec transmission system in the area of the proposed Thompson 115 kV substation. A simulation of all possible contingencies within the NERC and FE Planning Standards that are impacted by the V3-042 Thompson 115 kV Project was conducted to test for criteria compliance.

The results from the study Power Flow Analysis showing a comparison of the FE and PJM contingency study results is detailed on Attachment 4. At the time of this analysis, the Q72 project had been withdrawn from the PJM Queue. The FE analysis is shown for two separate scenarios; scenario 1 is with the Q72 Project generator off line, and scenario 2 is with both the Q72 generator off line and the Q72 required reinforcements removed. **As shown, the**

conclusion from this analysis is that there are no new upgrades required for the Thompson PN (V3-042) 115 kV Project.

However, similar to those revealed by the PJM analysis and stated above, the FE findings show that there are criteria violations which will have an impact on network congestion and local energy deliverability. The facilities impacted include Keystone - Shelocta 230kV line, North Meshoppen – Mehoopany 115kV line, North Meshoppen - Oxbow 230kV line, Oxbow – Lackawanna 230kV line, and the Mehoopany – North Meshoppen 115/230kV transformer 3. The Developer will therefore be subject to generation curtailment in order to mitigate these violations.

Short Circuit and Dynamics Analysis

A short circuit analysis was performed by PJM as reported above. FE may elect to perform a short circuit study for inclusion in the Impact Study report.

System Protection Analysis

An analysis was conducted to assess the impact of the V3-042 Thompson 115 kV 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:

Tiffany Substation

- V3-042 115kV line exit -- One line exit relay panel –
  - primary protection over PLC utilizing SEL321 (DCB)
  - backup using existing SEL311B
  - 1 communication panel with 9780 DTT transmitter over PLC to V3-018 generation at generation sub and also ring bus breakers at V3-042 interconnection sub for breaker open at Tiffany

V3-042 Interconnection Substation

- Three Line Relay panels and One PLC panel for Tiffany 115kV line
- One Fiber Panel for Windfarm line exit
- Tiffany exit
  - primary protection over PLC utilizing SEL321 (DCB)
  - backup using existing SEL311B, 9780 DTT receiver to trip V3-042 generation and 2 ring bus breakers for breaker open at Tiffany sub
- Thompson exit
  - primary protection using SEL387 for Thompson TR OA diff
  - SEL311B Thompson backup.
- V3-042 Generation exit
  - dual SEL311L over fiber channel, DTT-Contact from Receiver will also transmit DTT using RFL9745 over fiber channel to V3-042 Generation Sub
  - SEL352 BF/SC relaying required (one per breaker).

V3-042 Generation Substation

- V3-042 Interconnection line exit
  - One line exit panel and One Fiber Panel for V3-042 line exit
  - dual SEL311L relays, 9745 DTT receivers to trip V3-018 generation.

Thompson Substation

- Remove HU and replace with SEL387 TRF OA diff

Assumption

The V3 interconnection sub and the Thompson sub are assumed physically adjacent to one another. Therefore the ground grids for the V3 interconnection sub and the Thompson sub shall be tied together to eliminate ground potential rise problems between substations.

Metering

The Developer will be required to comply with all FE Revenue Metering Requirements for Generation Interconnection Customers. These FE requirements are detailed on Attachment 7 of this report.

Compliance Issues

The Developer will be responsible for meeting all FE criteria as defined in the FE Requirements for Transmission Connected Facilities document. While the voltage analysis is not performed for the feasibility study, any voltage criteria violations that would require the plant to provide reactive power, that determination of reactive power requirements will be determined in the system impact study, which will include the low voltage ride through analysis.

The Developer 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 FE power flow analysis (Attachment 4) show that there are no FE criteria violations that are directly attributable to the capacity of the Thompson PN (V3-042) 115 kV Project. However, there are five violations affecting network congestion and local energy delivery that the V3-042 Thompson 115 kV Project will impact. Note that the FE and PJM study results differ somewhat due to the differences in the study process and power flow programs utilized. However, the overall conclusions reached by the FE and PJM staff are the same. In accordance with the RTEP procedures defined in the PJM Open Access Transmission Tariff and PJM Manuals, the Developer is not responsible for network upgrades. The direct connection costs however 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 System Impact Study. The Developer will be responsible for the

actual cost of the direct connection that is implemented. In addition, the Developer is responsible to provide the transmission line between V3-042 interconnecting substation and the V3-042 generating substation, as the Developer will own this transmission line. FE herein reserves the right to return to any issues in this document and, upon appropriate justification, request additional monies to complete any reinforcements to the transmission system.

Direct Connection/Attachment Facilities

The direct connection of this project will be accomplished by the construction of a new 115 kV 3 breaker ring bus and the looping of the Tiffany - Thompson (TFT) 115 kV line to it. Procurement and construction of the 115 kV transmission line connecting the 3 breaker ring bus to the Wind Farm 115 kV export bus is the responsibility of the Developer as this facility is not owned by FirstEnergy Corp. The Developer will be responsible for acquiring all easements, properties and permits that may be required to construct both the project connection 3 breaker ring bus and the attachment facilities. The Developer will also be responsible for the rough grade of the property and an access road to the proposed 3 breaker ring bus site. A summary of the V3-042 Thompson 115 kV Project direct connection facilities that will be required and their estimated costs are shown on Attachment 3.

Developer Requirements

In addition to the FE facilities, The Developer 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 purchase and installation of a 115 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 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 supplied from the Thompson 115kV substation when the units are out-of-service. This assumes the intent of the Developer is to net the generation with the load.

8. The rough grade of the property for the V3-042 Interconnection 115 kV Substation and an access road for the delivery of equipment to this site.

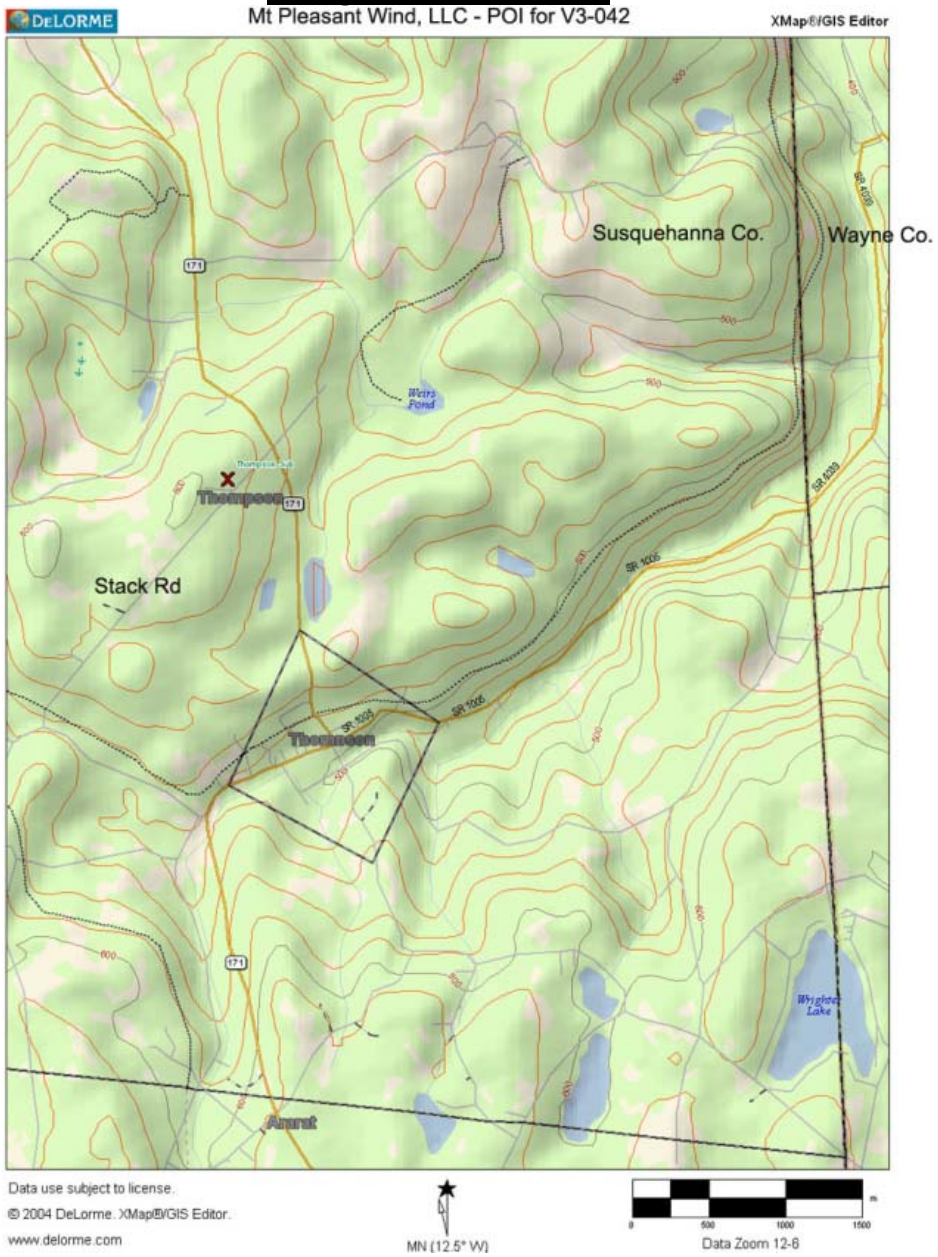
The above requirements are in addition to any metering required by PJM.

Summary

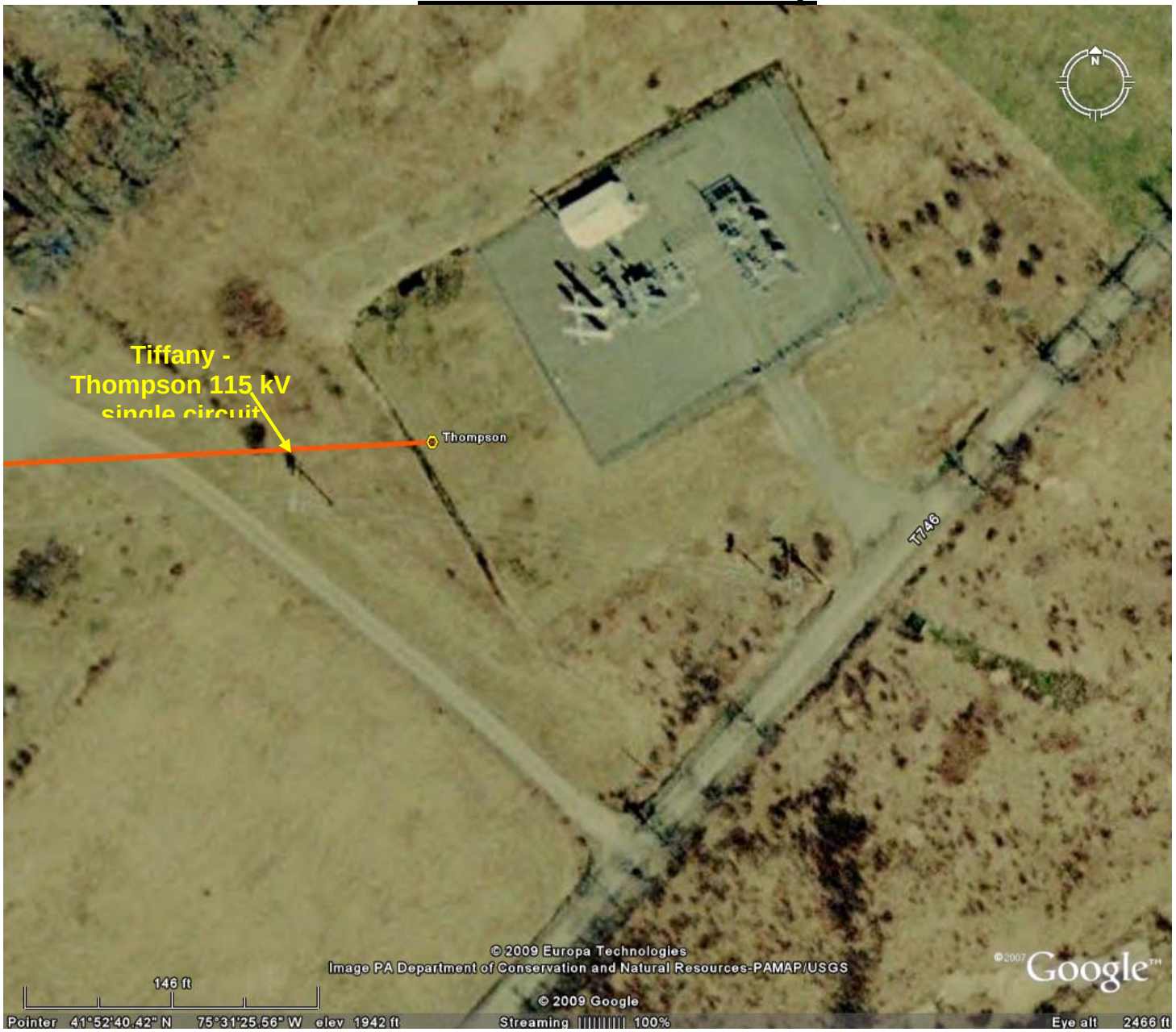
The Thompson PN (V3-042) Project direct connection will require the facility upgrades defined in Attachment 3. As shown, the total estimated cost of the new three breaker ring bus substation and attachment lines is $4,552,300. The Thompson PN (V3-042) Project does not have any network upgrades.

Based on the scope of the FE direct connection, it is expected to take a minimum of two (2) years from the signing of a Connection Service Agreement to complete the installation required for the Thompson PN (V3-042) 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 V3-042 Interconnecting substation and the loop of the Penelec 115 kV lines to this site. It also assumes that the Developer will provide the property for the attachment substation 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 PJM will allow all transmission system outages when requested.

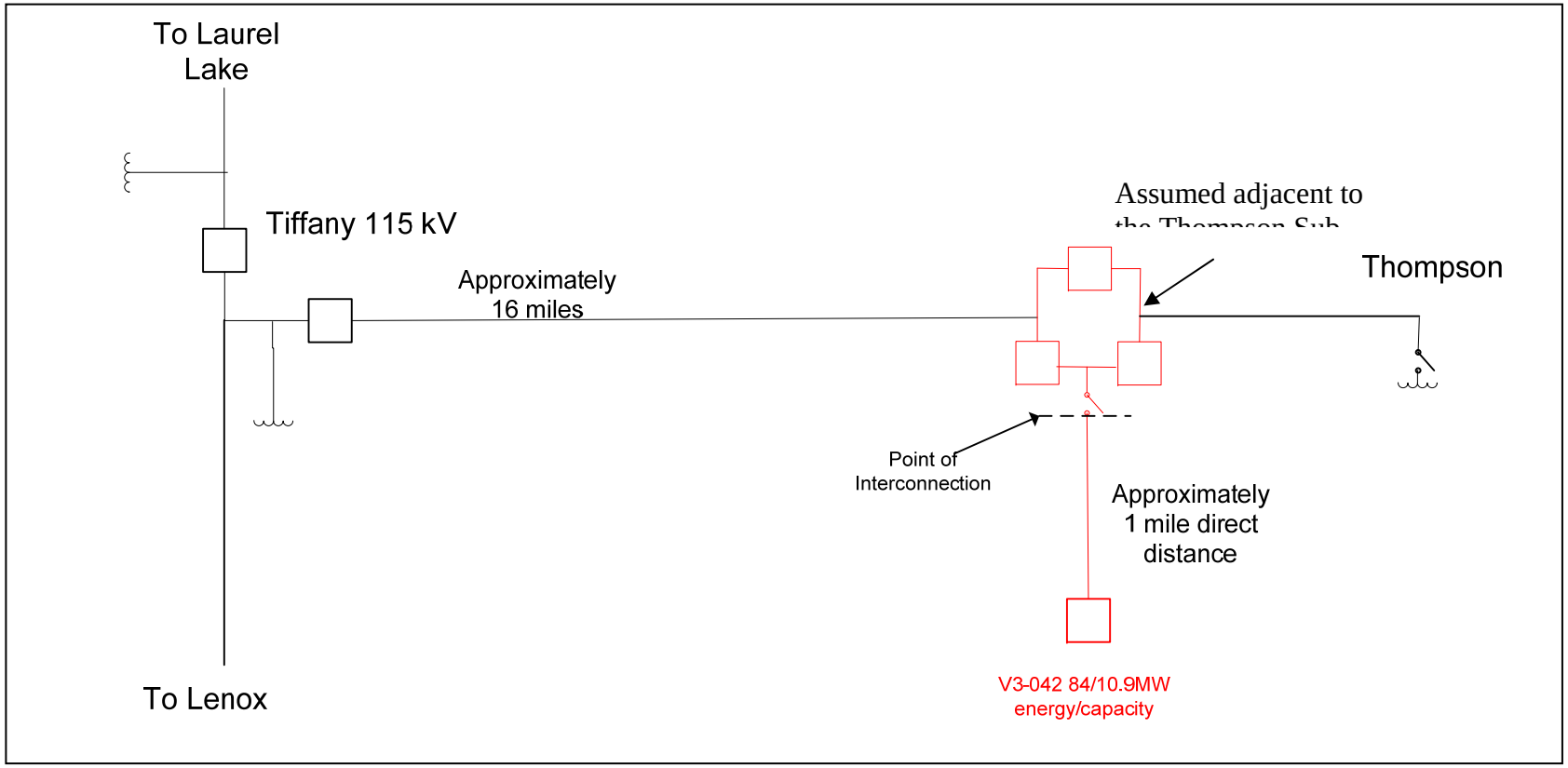
Attachment 1A
V3-042 Thompson RTEP Project
Project Location



Attachment 1B
V3-042 Thompson RTEP Project
Nearest Tower for Loop



Attachment 2
V3-042 Thompson RTEP Project
Conceptual 115 kV Interconnection Substation Configuration



Attachment 3

Thompson PN 115kV (V3-042) Feasibility Study

Direct Connection Requirements

FE UpgradeID	Description	Total Cost
PN-T-55	Thompson-Tiffany 115kV, Loop to Mt Pleasant Wind LLC Wind Farm (PJM V3-042): Loop, approx. 1000' in length, consists of two 3-way dead-end structures, four tangent structures and rebuild of adjacent H-frame structures (remove outside suspension assemblies and install 138kV horiz. post insulators). (ISD 12/31/2012)	$152,400
	Engineering Oversight and Commissioning Support of the Interconnection Customer 34.5/115kV substation including support of protective relay installation	$63,900
PN-S-391-1	V3-042 Interconnect Sub: Install new 115 kV 3 position ring bus. (ISD 10/1/2012)	$3,836,800
PN-S-391-2	Tiffany Sub: Line relay upgrade to support new 115kV V3-042 interconnect substation. (ISD 10/1/2012)	$416,900
PN-S-391-3	Thompson Sub: Relay upgrade to support new 115kV V3-042 interconnect substation. (ISD 10/1/2012)	$82,300
	TOTAL	$4,552,300

Attachment 4

Thompson PN 115kV (V3-042) Feasibility Study

FE Contingency Analysis Results

Identified New Project Upgrades

					Q72 Gen only removed		Q72 in Place		Q72 Gen and Reinforcement removed	
					FirstEnergy Results		PJM Results		FirstEnergy Results	
PJM #	FE Contingency	Outage Description	Overloaded Element	N/4-Hr Rating	MVA Flow	% Rating	MVA Flow	% Rating	MVA Flow	% Rating

Contributions To Previously Identified Overloads

					FirstEnergy Results		PJM Results		FirstEnergy Results	
PJM #	FE Contingency	Outage Description	Overloaded Element	N/4-Hr Rating	MVA Flow	% Rating	MVA Flow	% Rating	MVA Flow	% Rating

Potential Congestion due to Local Energy Deliverability

					FirstEnergy Results		PJM Results		FirstEnergy Results	
PJM #	FE Contingency	Outage Description	Overloaded Element	N/4-Hr Rating	MVA Flow	% Rating	MVA Flow	% Rating	MVA Flow	% Rating
--	B_PN345-SX-#6	HANDSOME LAKE - WAYNE (WHL) 345 KV - (PJM-PN33A)	KEYSTONE - SHELOCTA 230kV line	721 / 841	1135	134.9			1141	135.7
1	B_PN345-SX-#6	HANDSOME LAKE - WAYNE (WHL) 345 KV - (PJM-PN33A)	HOMER CT - SHELOCTA 230kV line	721 / 841	1125	133.8	1112	132.2	1131	134.5
2	B_PN230-SX-#11	EAST TOWANDA - N MESHOPPEN (ETP) 230 KV & N MESHOPPEN BK 4	NO MESHO – MESH2REA 115kV line	111 / 143	143	100	199	139.2	125	87.4
3	Base Case	Normal	N.MESHPN - OXBOW 230kV line	478 / 608	514	107.5	596	124.8	439	91.9
--	b_PN230-XF-#133A	LEWISTOWN 230/115KV BANK #3 FAULT	N.MESHPN - OXBOW 230kV line	478 / 608	618	101.7			548	90.2
4	PJM SUSQ-LACK 500_U4-05A	SUSQHANA - LACK (U4-005 TAP) 500kV	N.MESHPN - OXBOW 230kV line	478 / 608	598	98.3	716	117.7	522	85.9
5	Base Case	Normal	OXBOW – LACK 230kV line	488 / 617	508	104	592	121.2	432	88.6
6	PJM SUSQ-LACK 500_U4-05A	SUSQHANA - LACK (U4-005 TAP) 500kV	OXBOW – LACK 230kV line	488 / 617	594	96.3	713	115.6	517	83.8
7	B_PN230-SX-#11	EAST TOWANDA - N MESHOPPEN (ETP) 230 KV & N MESHOPPEN BK 4	MESH2REA – N.MESHPN 115/230kV transformer #	143 / 188	--	--	199	105.9	--	--

Attachment 5
V3-042 Thompson RTEP Project
FE Network Facility Reinforcement Conceptual Cost Estimates

None Required

Attachment 6
V3-042 Thompson RTEP Project
FE Network Facility Reinforcement Conceptual One Line Diagrams

None Required

Attachment 7

FirstEnergy Revenue Metering Requirements for Generation Interconnection Customer

Interconnection Customer shall install, own, operate, test and maintain the necessary revenue quality Metering Equipment. This includes current transformers, voltage transformers, mounting structures, wiring, meters, communication circuits, and associated devices. The Metering Equipment must meet the specifications listed in the FirstEnergy and regional transmission organization (RTO) connection documents. The FirstEnergy "Requirements for Transmission Connected Facilities" are located at: http://www.firstenergycorp.com/feconnect

The Metering Equipment shall be located at the generation facility on the high voltage side of the generator step-up transformers or facility main step-up transformer and/or station service power transformers. Power flows to and from the facility shall be compensated to the Point of Interconnection.

FirstEnergy will provide revenue quality Metering Equipment for a station service power supply at a generation facility if the supply is from the local FirstEnergy distribution system.

The revenue quality Metering Equipment shall be capable of collecting and storing bidirectional billing data. The billing data shall be stored in intervals specified by FirstEnergy, typically fifteen minutes or thirty minutes. The Interconnection Customer must provide FirstEnergy with remote access to the billing data in the Metering Equipment via a dedicated voice-grade analog telephone circuit. The Interconnection Customer shall provide FirstEnergy with contact information for the person or persons responsible for meter programming and Metering Equipment maintenance.

The Interconnection Customer shall consult with FirstEnergy regarding the revenue quality metering system design and provide the following information:

- Facility one line and revenue metering installation drawings (schematics, wiring diagrams, etc.)
- Estimated power flows to and from the facility at all revenue metering points
- Current transformer and voltage transformer specifications, including manufacturer, type, nameplate drawings, and certified accuracy test reports
- Revenue meter specifications including manufacturer, type, model number, and accuracy
- Revenue meter program information including but not limited to billing data recorder channel assignments, recorder pulse weights (Ke), and read-only password for access to interval data by the FirstEnergy billing data collection system (MV-90)
- Revenue meter telephone number
- Revenue meter loss compensation data (if applicable)

The Interconnection Customer shall provide FirstEnergy with prior notification of any modifications at the facility that will affect the revenue meter measurements, including substation reconfigurations and meter program changes.

The revenue metering system at each location shall be tested for accuracy by the Interconnection Customer once every two years. The Interconnection Customer shall give reasonable notice to FirstEnergy of the time when the testing is scheduled so that FirstEnergy may have representatives present. FirstEnergy and the RTO shall have the right to audit the revenue metering equipment and/or related documents. The Interconnection Customer shall be given a reasonable period of time to comply with any requests associated with an audit.

Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position V3-042

Thompson 115kV

January 2010
DOCS 577548v1

General

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