PJM Generator Interconnection

W3-066 Shawboro 230 kV

39 MW Capacity / 300 MW Energy

Feasibility Study Report

January 2011
DMS #628917v1

Introduction

This Feasibility Study has been prepared in accordance with the PJM Open Access Transmission Tariff, §36.2, as well as the Feasibility Study Agreement between Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is Virginia Electric and Power Company.

Preface

The intent of this Feasibility Study is to determine a plan, with preliminary cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by IC. As a requirement for interconnection, IC may be responsible for the cost of constructing Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM and the underlying system. All facilities required for interconnection of a generation interconnection project must be designed to meet ITO technical specifications.

The Feasibility Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. IC is responsible for its right of way, real estate, and construction permit issues.

General

Queue W3-066 is an IC 300 MW energy (39 MW Capacity) wind farm generation request. W3-066 will be located west of Shawboro, NC in the ITO area. The requested in-service date is December September 30, 2013. The project was studied with its primary interconnection point at Shawboro 230 kV substation. The project was studied with its secondary interconnection point between Shawboro and Sligo 230 kV. Project W3-066 was evaluated for compliance with reliability criteria for summer peak conditions in 2014.

Network Impacts: Primary Option - Shawboro 230 kV Substation

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 with full energy output. Stuck Breaker and Bus Fault contingencies will be applied during the Impact Study)

No problems identified.

Contribution to Previously Identified Overloads

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have % allocation of cost responsibility which will be calculated and reported for the Impact Study.)

No problems identified.

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

(Report Overdutied breakers here)

BUS NO	BUS	BREAKER	Rating Type	Duty Percent With w3-066	Duty Percent Without w3-066	Duty Percent Difference	Note
777	YADKIN 2&4 230.kV	23112	S	101.40%	99.60%	1.80%	New Over-duty

Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of the surrounding generation. Any potential problems identified below are likely to result in operational restrictions to the project under study. The 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. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which analyzes all overload conditions associated with the overloaded element(s) identified. As a result of the aggregate energy resources in the area, the following violations were identified.

1. The Poplar Chapel 115 kV-Everetts 115 kV line (from bus 314596 to bus 314573 ckt 1) loads from 166.80% to 167.88% (DC power flow) of its emergency rating (159 MVA) for the operational contingency 'V 2034'. This project contributes approximately 10.65 MW to the thermal violation.

   This overload will be resolved with project 99-2193 (RTEP b0325) which installs a 2nd 230-115kV Tx and 25 line upgrade at Everetts and project 99-2192 (RTEP b0342) which installed a 2nd 230-115kV Tx and 230 kV breakers at Trowbridge. This overload also assumes energy output from prior queues.

2. The Fredericksburg 230 kV-Cranes Corner 230 kV line (from bus 314137 to bus 314134 ckt 1) loads from 101.84% to 102.27% (DC power flow) of its emergency rating (637 MVA) for the operational contingency 'LN 568'. This project contributes approximately 16.80 MW to the thermal violation.

   This overload can be resolved by upgrading the existing 230 kV, 2104 line between Fredericksburg and Cranes Corner by replacing the wave trap at Fredericksburg Substation. The cost of this upgrade is estimated to be $50 thousand dollars (2011 dollars) and is expected to take 12 months to complete.

Network Impacts: Secondary Option - Tap on 230 kV Line #269

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 with full energy output. Stuck Breaker and Bus Fault contingencies will be applied during the Impact Study)

No problems identified.

Contribution to Previously Identified Overloads

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have % allocation of cost responsibility which will be calculated and reported for the Impact Study.)

No problems identified.

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

(Report Overdutied breakers here)

BUS NO	BUS	BREAKER	Rating Type	Duty Percent With w3-066	Duty Percent Without w3-066	Duty Percent Difference	Note
777	YADKIN 2&4 230.kV	23112	S	101.50%	99.60%	1.90%	New Over-duty

Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of the surrounding generation. Any potential problems identified below are likely to result in operational restrictions to the project under study. The 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. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which analyzes all overload conditions associated with the overloaded element(s) identified. As a result of the aggregate energy resources in the area, the following violations were identified.

1. The Fentress 230 kV-Thrasher 230 kV line (from bus 314466 to bus 314508 ckt 1) loads from 92.82% to 115.86% (DC power flow) of its emergency rating (637 MVA) for the operational contingency 'LN 271'. This project contributes approximately 146.77 MW to the thermal violation.

   This overload assumes energy output from prior queues. To resolve this overload would require upgrading the 230 kV line 279 between Fentress and Thrasher by reconductoring 5.7 miles of line and replacing a wave trap at Fentress Substation. The estimated cost for this upgrade is $6.3 Million dollars (2011 dollars).

2. The Fredericksburg 230 kV-Cranes Corner 230 kV line (from bus 314137 to bus 314134 ckt 1) loads from 101.83% to 102.26% (DC power flow) of its emergency rating (637 MVA) for the operational contingency 'LN 568'. This

project contributes approximately 16.84 MW to the thermal violation.

This overload can be resolved by upgrading the existing 230 kV, 2104 line between Fredericksburg and Cranes Corner by replacing the wave trap at Fredericksburg Substation. The cost of this upgrade is estimated to be $50 thousand dollars (2011 dollars) and is expected to take 12 months to complete.

ITO Analyses

ITO assessed the impact of the proposed queue project, W3-066, interconnection of 39.0 MW of Capacity and 300 MW of energy on the ITO transmission system. The system was assessed using the summer 2014 RTEP Case provided to ITO by PJM, where the proposed generation capacity was injected at either primary option, 230 kV at ITO's Shawboro Substation, or secondary option, ITO's 230 kV line 269 between Fentress and Shawboro Substations. This analysis did include the impacts of the generation capacity for all higher order queue generators within the ITO transmission system. When performing a generation analysis, ITO's main analysis will be load flow study results under single contingency (both normal and stressed system conditions) and import/export system conditions. ITO criterion considers a transmission facility overloaded if it exceeds 94% of its emergency rating under normal and stressed system conditions. For import/export studies ITO considers a transmission facility overloaded if it exceeded 100% of its emergency rating. A full listing of ITO's planning criteria and interconnection requirements can be found in the ITO's *Facility Connection Requirements* which are publicly available at: http://www.dom.com.

Primary Option: Shawboro 230 kV Substation

As part of its generation impact analysis ITO routinely evaluates the impact that a proposed new generation resource will have under maximum generation conditions and stressed system conditions. For the W3-066 evaluation three different assessments were conducted.

1) The first being when local generation including the proposed W3-066 facility is operated at their maximum capability. The result of this study is shown below.

   No problems indentified for 39.0 MW Capacity or 300 MW energy from W3-066.

2) The second being a stressed system condition where the largest generator in the area is unavailable. With the W3-066 generator geographically located in Eastern Virginia, Surry Unit #2 is considered the most critical generating unit in the area. The impact of W3-066 was studied with the outage of Surry Unit #2. The result of this study is shown below.

No problems indentified for 39.0 MW Capacity from W3-066.

The results of 300 MW energy from W3-066 are shown below in Table A.

Table A: Stressed System Conditions for W3-066 Energy

Overloaded Element	Cont Loading (MVA)	Rating	Cont Loading (%)	Contingency Label
314137 6FREDBRG 230 314138 6MINE RD 230 1	754.1	797.0	94.6	314212 6FRRIVER 230 314222 6HANOVER 230 1
314137 6FREDBRG 230 314138 6MINE RD 230 1	741.6	797.0	93.0	314218 6ELMONT 230 314222 6HANOVER 230 1

As shown above in Table A, the impact of the W3-066 generator energy under single contingency conditions results in the thermal overload of one 230 kV line section and almost overloads the same line for a different contingency.

3) The third being import and export conditions into and out of the ITO system. Any new facility that is interconnected with the ITO system should not significantly decrement First Contingency Incremental Transfer Capability between utilities. This analysis will be performed during the System Impact Study.

Light load analysis will be necessary during the System Impact Study to determine the effects of energy level generation on the ITO system during light load conditions. System upgrades may be necessary to resolve problems identified in this analysis.

Optional Merchant Network Upgrades

The results of these studies, as indicated above in Table A, shows an overload on one 230 kV line section for the full energy output of the wind facility. In order to resolve this thermal violation, the IC must sumbit a Merchant Transmission queue request for the following work to be completed prior to adding the generation energy of W3-066 in the primary location.

Upgrade the existing 230 kV, 2090 line between Fredericksburg and Mine Rd by replacing two 230 kV line switches at Mine Rd Substation. The cost of this upgrade is estimated to be $50 thousand dollars (2011 dollars) and is expected to take 12 months to complete.

Non-Direct Connection Network Upgrades

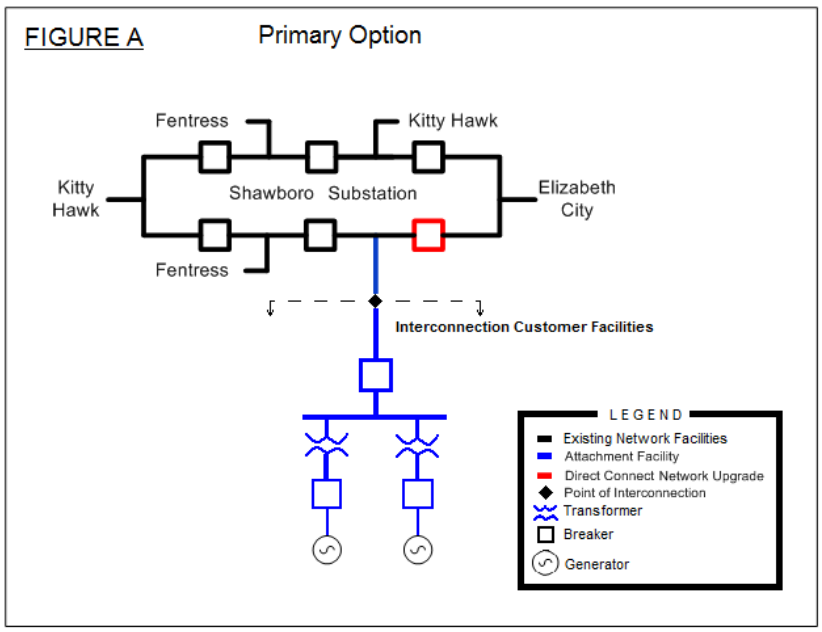
The 40 kA breaker 23112 at Yadkin 230 kV will be overdutied as a result of W3-066 for the primary option. The estimated cost to replace this breaker with a 50kA breaker is $214,000 and will take about nine months to complete including equipment order time.

Attachment Facilities

The proposed layout and Attachment Facilities are illustrated below in Figure A. The interconnection arrangement shown assumes the proposed W3-066 facility 5 miles from Shawboro Substation. The Attachment Facilities interconnection costs are estimated to be $15 million dollars (2011 dollars). This cost includes metering, protection equipment and 230 kV line work to directly connect the proposed facility with the 230 kV at Shawboro Substation. This work will take an estimated time of 36 to 48 months to engineer and construct. This includes obtaining all necessary North Carolina PUC permits.

Direct Connection Network Upgrades

To reliably interconnect the proposed generation with the ITO transmission system it will be necessary to install one 230 kV breaker and associated equipment at Shawboro Substation. The estimated cost of this work is $700 thousand dollars (2011 dollars) and is estimated to take 24 to 30 months to engineer and construct.



Secondary Option: Tap on 230 kV Line #269

As part of its generation impact analysis ITO routinely evaluates the impact that a proposed new generation resource will have under maximum generation conditions and stressed system conditions. For the W3-066 evaluation three different assessments were conducted.

1) The first being when local generation including the proposed W3-066 facility is operated at their maximum capability. The result of this study is shown below.

   No problems indentified for 39.0 MW Capacity or 300 MW energy from W3-066.

2) The second being a stressed system condition where the largest generator in the area is unavailable. With the W3-066 generator geographically located in Eastern Virginia, Surry Unit 2 is considered the most critical generating unit in the area. The impact of W3-066 was studied with the outage of Surry Unit 2. The result of this study is shown below.

   No problems indentified for 39 MW Capacity from W3-066.

   The results of 300 MW energy from W3-066 are shown below in Table B.

Table B: Stressed System Conditions for W3-066 Energy

Overloaded Element	Cont Loading (MVA)	Rating	Cont Loading (%)	Contingency Label
314137 6FREDBRG 230 314138 6MINE RD 230 1	754.3	797.0	94.6	314212 6FRRIVER 230 314222 6HANOVER 230 1
314137 6FREDBRG 230 314138 6MINE RD 230 1	741.7	797.0	93.1	314218 6ELMONT 230 314222 6HANOVER 230 1

As shown above in Table B, the impact of the W3-066 generator energy under single contingency conditions results in the thermal overload of one 230 kV line section and almost overloads the same line for a different contingency.

3) The third being import and export conditions into and out of the ITO system. Any new facility that is interconnected with the ITO system should not significantly decrement First Contingency Incremental Transfer Capability between utilities. This analysis will be performed during the Impact Study.

Light load analysis will be necessary during the Impact Study to determine the effects of Energy level generation on the ITO system during light load conditions. System upgrades may be necessary to resolve problems identified in this analysis.

Optional Merchant Network Upgrades

The results of these studies, as indicated above in Table B show an overload on one 230 kV line section for the full energy output of the wind facility. In order to resolve these thermal violations, IC would need to submit a Merchant Transmission queue request for the following work to be completed prior to adding the generation energy of W3-066 in the secondary location.

Upgrade the existing 230 kV, 2090 line between Fredericksburg and Mine Rd by replacing two 230 kV line switches at Mine Rd Substation. The cost of this upgrade is estimated to be $50 thousand dollars (2011 dollars) and is expected to take 12 months to complete.

Non-Direct Connection Network Upgrades

The 40 kA breaker 23112 at Yadkin 230 kV will be overdutied as a result of W3-066 for the primary option. The estimated cost to replace this breaker with a 50kA breaker is $214,000 and will take about nine months to complete including equipment order time.

Attachment Facilities

The proposed layout and Attachment Facilities are illustrated below in Figure B. The interconnection arrangement shown assumes the proposed W3-066 facility is 4 miles from the Fentress to Shawboro 230 kV Transmission Line. The Attachment Facilities interconnection costs are estimated to be $12 million dollars (2011 dollars). This cost includes metering, protection equipment and 230 kV line work to directly connect the proposed facility with the proposed 230 kV switching station. This work will take an estimated time of 36 to 48 months to engineer and construct. This includes obtaining all necessary North Carolina PUC permits.

Direct Connection Network Upgrades

To reliably interconnect the proposed generation with the ITO transmission system it will be necessary to create a three breaker 230 kV ring bus at the IC site. At this new 230 kV switching substation, three 230 kV breakers and associated equipment will be installed. The estimated cost of this work is $3 million dollars (2011 dollars) and is estimated to take 24 to 30 months to engineer and construct.