

**PJM Generator Interconnection
W3-043 Pendleton 230 kV
65 MW Capacity / 500 MW Energy
Feasibility Study Report**

*January 2011
DMS #628924v1*

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 W3-043 is an IC 500 MW energy (65 MW Capacity) off-shore wind interconnection request. W3-043 generation will be located approximately 20 miles off-shore of Virginia Beach, VA. The project was studied with its primary interconnection point at Pendleton 230 kV substation. The secondary interconnection point was at Fentress 230 kV substation. Project W3-043 was evaluated for compliance with reliability criteria for summer peak conditions in 2014. The requested in-service date is August 31, 2017.

Summary

Primary Option:	\$3,514,000 ¹	24 - 30 months
Secondary Option:	\$1,214,000 ¹	24 - 30 months

¹ Does not include \$50,000 optional Merchant Transmission upgrade for full energy amount.

Network Impacts: PRIMARY OPTION - Pendleton 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 Overduty breakers here)

BUS_NO	BUS	BREAKER	Rating Type	Duty Percent With w3-043	Duty Percent Without w3-043	Duty Percent Difference	Note
777	YADKIN 2&4 230.kV	SC112	S	104.10%	98.70%	5.40%	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 Fredericksburg 230 kV-Cranes Corner 230 kV 230 kV line (from bus 314137 to bus 314134 ckt 1) loads from 101.12% to 101.84% (DC power flow) of its emergency rating (637 MVA) for the operational contingency 'LN 568'. This project contributes approximately 28.30 MW to the thermal violation.

This overload can be resolved by upgrading the existing 230 kV line, line 2104, between Fredericksburg and Cranes Corner by replacing the wave trap at Fredericksburg Substation. The cost of this upgrade is estimated to be \$50,000 dollars (2011 dollars) and is expected to take 12 months to complete.

Network Impacts: SECONDARY OPTION - Fentress 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 Overduty breakers here)

BUS_NO	BUS	BREAKER	Rating Type	Duty Percent With w3-043	Duty Percent Without w3-043	Duty Percent Difference	Note
777	YADKIN 2&4 230.kv	SC112	S	104.10%	98.70%	5.40%	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 Fredericksburg 230 kV-Cranes Corner 230 kV 230 kV line (from bus 314137 to bus 314134 ckt 1) loads from 101.12% to 101.83% (DC power flow) of its emergency rating (637 MVA) for the operational contingency 'LN 568'. This project contributes approximately 28.12 MW to the thermal violation.

This overload can be resolved by upgrading the existing 230kV, 2104 line between Fredericksburg and Cranes Corner by replacing the wave trap at Fredericksburg Substation. The cost of this upgrade is estimated to be \$50,000 dollars (2011 dollars) and is expected to take 12 months to complete.

ITO Analyses

ITO assessed the impact of the proposed queue project W3-043 interconnection of 65 MW of Capacity and 500 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 Pendleton Substation, or Secondary Option, 230 kV at ITO Fentress Substation. 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 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 planning criteria and interconnection requirements can be found in the ITO *Facility Connection Requirements* which are publicly available at: <http://www.dom.com>.

Note: Further equipment data will be required from the IC on the transmission cable that will be utilized to connect the off-shore generation to the ITO substations. The impedance and susceptance of the cable will be needed to perform light load modeling to evaluate the affect on ITO system voltages. Additional system upgrades may be necessary to resolve any voltage problems that are a result of this interconnect.

Primary Option: Pendleton 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 W3-043 evaluation three different assessments were conducted.

- 1) The first being when local generation including the proposed W3-043 facility is operated at their maximum capability. The result of this study is shown below.

No problems indentified for either 65 MW Capacity or 500 MW energy from W3-043.

- 2) The second being a stressed system condition where the largest generator in the area is unavailable. With the W3-043 generator geographically located in eastern Virginia, Surry Unit 2 is considered the most critical generating unit in the area. The impact of W3-043 was studied with the outage of Surry Unit 2. The result of this study is shown below.

No problems indentified for 65 MW Capacity from W3-043.

The results of 500 MW energy from W3-043 are shown in Table A.

Table A: Stressed System Conditions for W3-043 Energy (Primary)

Overloaded Element			Cont Loading (MVA)	Rating	Cont Loading (%)	Contingency Label		
314137	6FREDBRG	230	771.3	797.0	96.8	314212	6FRRIVER	230
314138	6MINE RD	230 1				314222	6HANOVER	230 1
314137	6FREDBRG	230	758.7	797.0	95.2	314218	6ELMONT	230
314138	6MINE RD	230 1				314222	6HANOVER	230 1

As shown above in Table A, the impact of the W3-043 generator energy under single contingency conditions results in the thermal overload of the Fredericksburg to Mine Rd 230 kV line section.

- 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

For the full energy portion, the results of these studies, as indicated above in Table A, show a possible overload on the Fredericksburg to Mine Rd 230 kV line. In order to resolve this thermal violation, the following work would need to be completed prior to adding the generation energy of W3-043 in the primary option 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 \$50,000 dollars and is expected to take 12 months to complete. This upgrade requires a submission of a Merchant Transmission queue request.

Non-Direct Connection Network Upgrades

The estimated cost to replace this breaker with a 50kA breaker is \$214,000.00 and will take about 9 months to complete including equipment order time.

Attachment Facilities

The proposed layout and Attachment Facilities are illustrated below in Figure A. The Attachment Facilities interconnection costs are estimated to be \$300,000 dollars (2011 dollars). This cost includes metering, protection equipment and 230 kV equipment to directly connect the proposed facility with the 230 kV at Pendleton Substation. This work will take an estimated time of 24 to 30 months to engineer and construct. The developer has indicated that the 230 kV line between the W3-043 Generation Substation and Pendleton Substation will be provided by the developer.

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 Pendleton Substation. At Pendleton Substation, three 230 kV breakers and associated equipment will be installed. The estimated cost of this work is \$3.0 Million dollars (2011 dollars) and is estimated to take 24 to 30 months to engineer and construct.

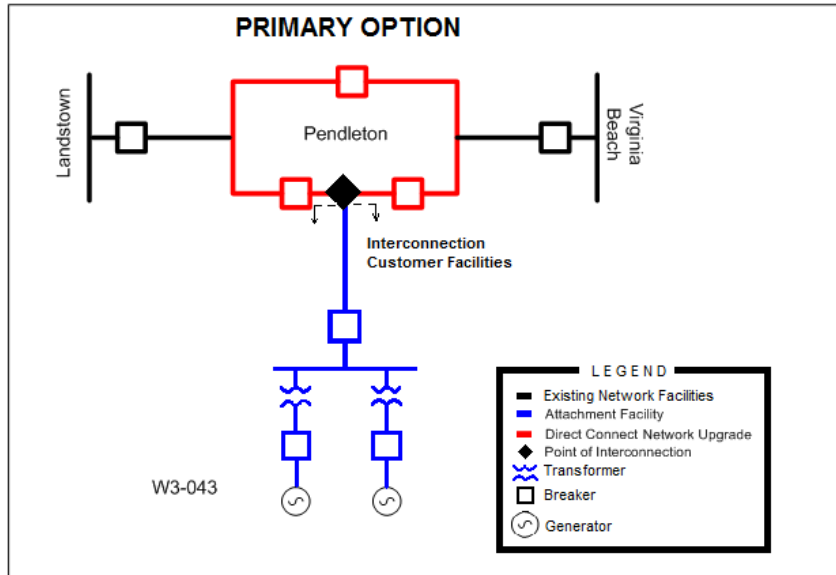


Figure A

Secondary Option: Fentress 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 W3-043 evaluation three different assessments were conducted.

- 1) The first being when local generation including the proposed W3-043 facility is operated at their maximum capability. The result of this study is shown below.

No problems identified for either 65 MW Capacity or 500 MW energy from W3-043.

- 2) The second being a stressed system condition where the largest generator in the area is unavailable. With the W3-043 generator geographically located in Eastern Virginia, Surry Unit 2 is considered the most critical generating unit in the area. The impact of W3-043 was studied with the outage of Surry Unit 2. The result of this study is shown below.

No problems identified for 65 MW Capacity from W3-043.

The results of 500 MW energy from W3-043 are shown below in Table B.

Table B: Stressed System Conditions for W3-043 Energy (Secondary)

Overloaded Element	Cont Loading (MVA)	Rating	Cont Loading (%)	Contingency Label
314137 6FREDBRG 230 314138 6MINE RD 230 1	755.8	797.0	94.8	314212 6FRRIVER 230 314222 6HANOVER 230 1
314137 6FREDBRG 230 314138 6MINE RD 230 1	743.2	797.0	93.3	314218 6ELMONT 230 314222 6HANOVER 230 1

As shown above in Table B, the impact of the W3-043 generator energy under single contingency conditions results in the thermal overload of the Fredericksburg to Mine Rd 230 kV line section.

- 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

No upgrades are required for the Capacity Portion. The results of these studies, as indicated above in Table B, show an overload on the Fredericksburg to Mine Rd 230kV line for the energy portion. In order to resolve this thermal violation, the following work would need to be completed prior to adding the generation energy of W3-043 in the secondary location.

Upgrade the existing 230kV, 2090 line between Fredericksburg and Mine Rd by replacing two 230kV line switches at Mine Rd Substation. The cost of this upgrade is estimated to be \$50,000 dollars and is expected to take 12 months to complete. This upgrade requires a submission of a Merchant Transmission queue request.

Non-Direct Connection Network Upgrades

The estimated cost to replace this breaker with a 50kA breaker is \$214,000.00 and will take about 9 months to complete including equipment order time.

Attachment Facilities

The proposed layout and attachment facilities are illustrated below in Figure B. The Direct Assigned interconnection costs are estimated to be \$300,000 dollars (2011 dollars). This cost includes metering, protection equipment and 230kV equipment to directly connect the proposed facility with the 230kV at Fentress Substation. This work will take an estimated time of 24 to 30 months to engineer and construct. The developer has indicated that the 230kV line between the W3-043 Generation Substation and Fentress Substation will be provided by the developer.

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 Fentress Substation. The estimated cost of this work is \$700,000 dollars (2011 dollars) and is estimated to take 24 to 30 months to engineer and construct.

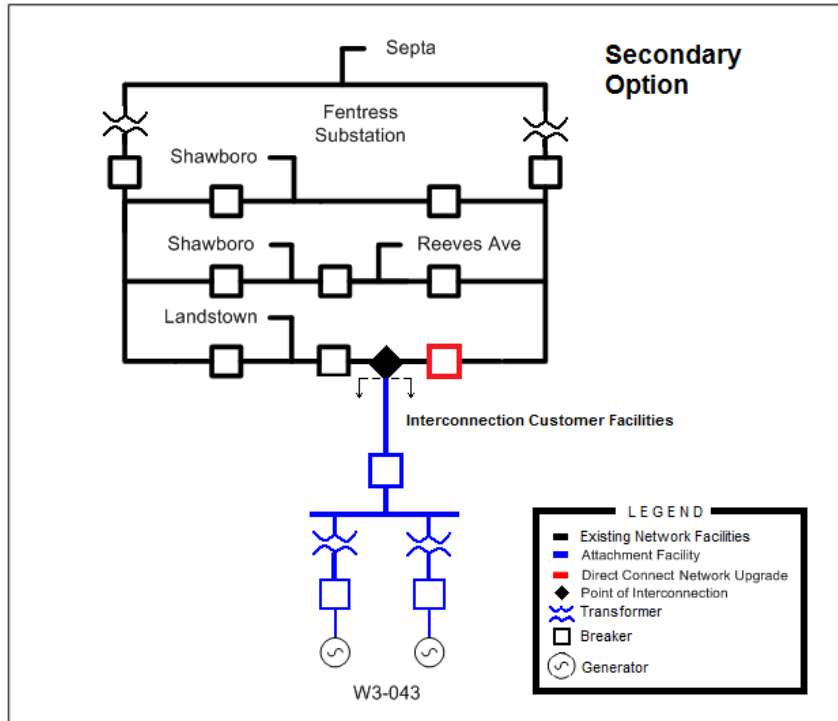


Figure B