

**PJM Generator Interconnection**  
*V2-030 Morrisville 500 kV*  
*875 MW Capacity / 950 MW Energy*  
**Feasibility Study Report**

November 2009  
DMS #562461v2

## **Introduction**

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

## **Preface**

The intent of a Feasibility Study is to determine a plan, with cost and construction time estimates, to allow the subject generation interconnection project to inject into the PJM network at a location specified by the Interconnection Customer. As a requirement for interconnection, the Interconnection Customer 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 system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications for the appropriate transmission owner.

In some instances Interconnection Customer may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection or merchant transmission upgrade, may also contribute to the need for the same network reinforcement. The possibility of sharing the reinforcement costs with other projects may be identified in the feasibility study, but the actual allocation will be deferred until the impact study is performed.

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. The project developer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

## **Executive Summary**

The estimated cost to interconnect V2-030 to ITO system is \$8.38 million and the upgrades will take upto 30 months to complete.

## **Potential Network Impacts**

The queue V2-030 project was studied as a 950MW injection (875MW of which was capacity) into ITO system. The project seeks to connect to the 500kV system between the Meadow Brook and Morrisville substations. Project V2-030 was evaluated for compliance with reliability criteria for summer peak conditions in 2013. Potential network impacts were as follows:

### **Generator Deliverability**

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

No issues 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 issues 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 issues identified.

### **Short Circuit Analysis**

PJM and ITO analyses both identified two breakers as overdutied at Ox substation due to V2-030 queue project. The overdutied breakers are as follow:

<b>Substation</b>	<b>Breaker</b>	<b>Duty Before</b>	<b>Duty After</b>
Ox 230 kV	22042	99.3%	100.3%
Ox 230 kV	220T2063	99.3%	100.3%

These two breakers are 200-SFMT-50F breakers that are rated for 50 kA and will need to be replaced with 63 kA breakers.

### **Stability and Reactive Power Requirement**

To be determined at the System Impact Study.

### **Interconnected Transmission Owner Analyses**

ITO assessed the impact of the proposed 875MW generation capacity on ITO system. The system was assessed using the summer 2013 RTEP case provided to VEPCO by PJM, where the proposed generation capacity was injected on the 500kV transmission line between the Meadow Brook and Morrisville substations. This analysis did include the impacts of the generation capacity for all higher order queue generators within ITO system. When performing a generation analysis, ITO main analysis was load flow study results under single contingency (both normal and stressed system conditions) and import/export system conditions. ITO criteria consider 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>.

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 V2-030 evaluation three different assessments were conducted.

- 1) The first being when local generation including the proposed V2-030 Facility is operated at their maximum capability. The result of this study showed no impacts.
- 2) The second being a stressed system condition where the largest generator in the area is unavailable. With the V2-030 generator geographically located in Northern Virginia, Possum Pt. Unit #5 is considered the most critical generating unit in the area. The impact of V2-030 was studied with the outage of Possum Point Unit #5. The result of this study is showed no impacts.
- 3) The third being import and export conditions into and out of ITO system. Any new facility that is interconnected with ITO system should not significantly decrement FCITC between utilities. The results of these studies can be found in Tables C and D.

**Table C: Import Study Results**

<b>Import Study Results</b>			
<b>Area</b>	<b>Summer 2013</b>	<b>Summer 2013 with V2-030</b>	<b>Limiting Element</b>
AEP	2000+	2000+	None
APS	2000+	2000+	None
CPL	2000+	2000+	None
PJM	2000+	2000+	None

**Table D: Export Study Results**

<b>Export Study Results</b>			
<b>Area</b>	<b>Summer 2013</b>	<b>Summer 2013 with V2-030</b>	<b>Limiting Element</b>
AEP	2000+	2000+	None
APS	2000+	2000+	None
CPL	2000+	2000+	None
PJM	2000+	2000+	None

ITO planning criteria indicate a need to have approximately 2000 MW of import and export capability. The results of these import and export studies are indicate that the proposed generation facility will not impact ITO import or export capability.

## **Interconnection Requirements**

### **Non – Direct Connection Network Upgrades**

#### **New System Reinforcements**

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

The estimated cost to replace the two Ox 230 kV breakers is \$380,000 and will take four weeks to replace. However, the estimated equipment lead time is six to eight months.

#### **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.

### **Direct Connection Network Upgrades**

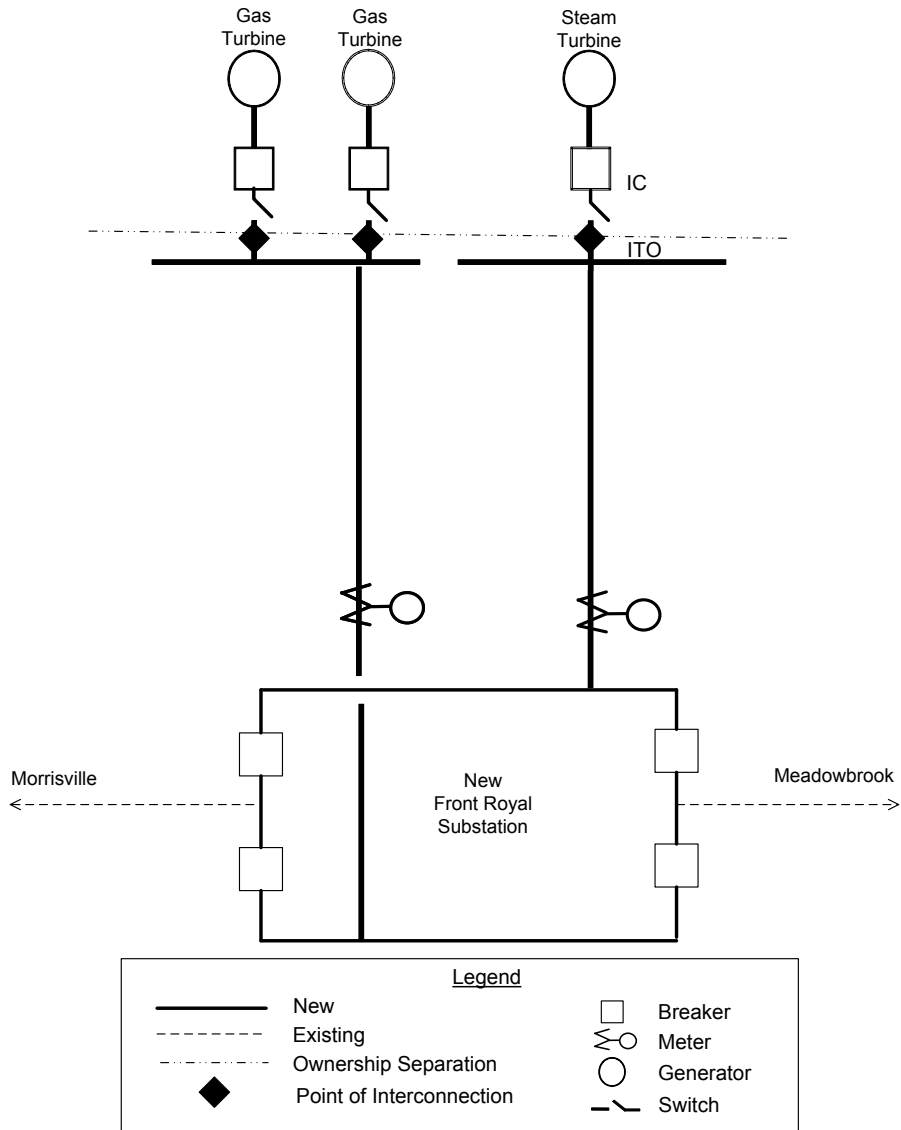
To reliably interconnect the proposed generation with ITO transmission system it will be necessary to create a four breaker 500kV ring bus at the customer’s site. At this new 500kV switching substation, four 500kV breakers and associated equipment will be installed. The 580 Line, Meadow Brook to Morrisville, will then be looped approximately 0.5 miles into the new 500kV switching substation as shown below in Figure A. The estimated cost of this work is \$6.0 Million and is estimated to take 24 to 30 months.

#### **Attachment Facilities**

The proposed layout and attachment facilities are illustrated below in Figure A. The estimated cost of these facilities which includes metering, protection equipment along with two 0.5 mile 500kV lines is \$2 Million and is estimated to take 24 to 30 months to complete.

**Figure A**

**V2-030 One-Line Diagram**



**PJM Generator Interconnection**  
*V2-030 Morrisville 500 kV*  
*875 MW Capacity / 950 MW Energy*  
**Feasibility Study Report**

October 2009  
DMS #562461v1

## **Introduction**

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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. The project developer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

## **Executive Summary**

The estimated cost to interconnect V2-030 to ITO system is \$50.88 million and the upgrades will take upto 72 months to complete.

## **Potential Network Impacts**

The queue V2-030 project was studied as a 950MW injection (875MW of which was capacity) into ITO system. The project seeks to connect to the 500kV system between the Meadow Brook and Morrisville substations. Project V2-030 was evaluated for compliance with reliability criteria for summer peak conditions in 2013. Potential network impacts were as follows:

### **Generator Deliverability**

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

No issues 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 issues 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 issues identified.

### **Short Circuit Analysis**

PJM and ITO analyses both identified two breakers as overdutied at Ox substation due to V2-030 queue project. The overdutied breakers are as follow:

<b>Substation</b>	<b>Breaker</b>	<b>Duty Before</b>	<b>Duty After</b>
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These two breakers are 200-SFMT-50F breakers that are rated for 50 kA and will need to be replaced with 63 kA breakers.

### **Stability and Reactive Power Requirement**

To be determined at the System Impact Study.

### **Interconnected Transmission Owner Analyses**

ITO assessed the impact of the proposed 875MW generation capacity on ITO system. The system was assessed using the summer 2013 RTEP case provided to VEPCO by PJM, where the proposed generation capacity was injected on the 500kV transmission line between the Meadow Brook and Morrisville substations. This analysis did include the impacts of the generation capacity for all higher order queue generators within ITO system. When performing a generation analysis, ITO main analysis was load flow study results under single contingency (both normal and stressed system conditions) and import/export system conditions. ITO criteria consider 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>.

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 V2-030 evaluation three different assessments were conducted.

- 1) The first being when local generation including the proposed V2-030 Facility is operated at their maximum capability. The result of this study is shown below in Table A.

**Table A: PMax System Conditions**

Overloaded Element				Cont Loading (MVA)	Rating	Cont Loading (%)	Contingency Label
14004	6ASHBURN	230		752.8	762.0	98.8	LN 558
14010	6BEAMEAD	230	1				
14061	6LOUDOUN	230		1013.7	1057.0	95.9	LN 2045
14171	6BRAMBL	230	1				
14061	6LOUDOUN	230		1006.8	896.0	112.4	LN 2094
14171	6BRAMBL	230	2				
14900	8BRISTER	500		2496.0	2598.0	96.1	LN 568
14919	8OX	500	1				
14913	8LOUDOUN	500		2313.8	2323.0	99.6	LN 551
14925	8PL VIEW	500	1				

As shown above in Table A, the impact of the V2-030 generator under single contingency conditions results in thermal overloads of several 230kV and 500kV line sections.

- 2) The second being a stressed system condition where the largest generator in the area is unavailable. With the V2-030 generator geographically located in Northern Virginia, Possum Pt. Unit #5 is considered the most critical generating unit in the area. The impact of V2-030 was studied with the outage of Possum Point Unit #5. The result of this study is shown below in Table B.

**Table B: Stressed System Conditions**

Overloaded Element				Cont Loading (MVA)	Rating	Cont Loading (%)	Contingency Label
14061	6LOUDOUN	230		993.7	1057.0	94.0	LN 2045
14171	6BRAMBL	230	1				
14061	6LOUDOUN	230		987.0	896.0	110.2	LN 2094
14171	6BRAMBL	230	2				
14900	8BRISTER	500		2631.2	2598.0	101.3	LN 568
14919	8OX	500	1				
14913	8LOUDOUN	500		2184.7	2323.0	94.0	LN 551
14925	8PL VIEW	500	1				

As shown in Table B, the impact of the V2-030 generator under single contingency conditions results in thermal overloads of several 230kV and 500kV line sections.

- 3) The third being import and export conditions into and out of ITO system. Any new facility that is interconnected with ITO system should not significantly decrement FCITC between utilities. The results of these studies can be found in Tables C and D.

**Table C: Import Study Results**

<b>Import Study Results</b>			
<b>Area</b>	<b>Summer 2013</b>	<b>Summer 2013 with V2-030</b>	<b>Limiting Element</b>
AEP	2000+	2000+	None
APS	2000+	2000+	None
CPL	2000+	2000+	None
PJM	2000+	2000+	None

**Table D: Export Study Results**

<b>Export Study Results</b>			
<b>Area</b>	<b>Summer 2013</b>	<b>Summer 2013 with V2-030</b>	<b>Limiting Element</b>
AEP	2000+	2000+	None
APS	2000+	2000+	None
CPL	2000+	2000+	None
PJM	2000+	2000+	None

ITO planning criteria indicate a need to have approximately 2000 MW of import and export capability. The results of these import and export studies are indicate that the proposed generation facility will not impact ITO import or export capability.

PJM reviewed ITO criteria, their V2-030 model, and the results they provided, and PJM agrees that their results are reasonable using ITO study criteria.

## **Interconnection Requirements**

### **Non – Direct Connection Network Upgrades**

#### **New System Reinforcements**

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

The results of these studies, as indicated above in Table A and Table B, show overloads on the two 230 kV line sections Loudoun to Brambleton, the 230kV line section Ashburn to Beaumeade, and the 500kV line section Loudoun to Pleasant View. In order to resolve these thermal violations, the existing 500kV line Loudoun to Pleasant View will need to be rebuilt using new 5-2 structures (500kV with 230kV underbuild). This would uprate the existing 500kV line and provides an additional 230kV line from Loudoun to Pleasant View utilizing existing right-of-way. The 230kV Loudoun substation has very limited space, and may require expansion to accommodate the proposed 230kV line. Space limitations at the 230kV Loudoun substation will need to be evaluated further. The cost of these new lines is estimated to be \$42 million dollars and is expected to take 60 to 72 months to complete. This includes obtaining all necessary SCC permits.

To resolve the thermal overload on the 500kV line section Bristers to Ox, replace the 3000A wave-traps at Ox and Bristers with 4000A wave-traps. This is estimated to cost \$500,000 dollars and is expected to take 12 months to complete.

The estimated cost to replace the two Ox 230 kV breakers is \$380,000 and will take four weeks to replace. However, the estimated equipment lead time is six to eight months.

#### **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.

### **Direct Connection Network Upgrades**

To reliably interconnect the proposed generation with ITO transmission system it will be necessary to create a four breaker 500kV ring bus at the customer’s site. At this new 500kV switching substation, four 500kV breakers and associated equipment will be installed. The 580 Line, Meadow Brook to Morrisville, will then be looped approximately 0.5 miles into the new 500kV switching substation as shown below in Figure A. The estimated cost of this work is \$6.0 Million and is estimated to take 24 to 30 months.

**Attachment Facilities**

The proposed layout and attachment facilities are illustrated below in Figure A. The estimated cost of these facilities which includes metering, protection equipment along with two 0.5 mile 500kV lines is \$2 Million and is estimated to take 24 to 30 months to complete.

**Figure A**

**V2-030 One-Line Diagram**

