PJM Generator Interconnection

Y1-043 Mackeys 115 kV

19.5 MW Capacity / 150 MW Energy

Feasibility Study Report

August 2012
DMS #708630v1A

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

The queue project Y1-043 was studied as a 150 MW (Capacity 19.5 MW) injection in to the ITO area. Project Y1-043 was evaluated for compliance with reliability criteria for summer peak conditions in 2015. Potential network impacts were as follows:

Network Impacts (Primary Option):

Impactful Contingencies

(The following contingencies resulted in overloads identified below)

Contingency ID	Contingency Description
8LDYSMTH _8POSSUM _026	CONTINGENCY '8LDYSMTH _8POSSUM _026' DISCONNECT BRANCH FROM BUS 314911 TO BUS 314922 CKT 1 /* 500/500KV, AREA 345/345. END
LN 101_B	CONTINGENCY 'LN 101_B' /*, MACKEYS - RIDERS CREEK- RADIAL OPEN BRANCH FROM BUS 913340 TO BUS 314566 CKT 1 /*MACKEYS - CRESWELL OPEN BRANCH FROM BUS 314566 TO BUS 314597 CKT 1 /*CRESWELL - RIDERS CREEK END

Generator Deliverability

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

None.

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)

None.

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.)

None.

Short Circuit

(Report Overdutied breakers here)

There is no impact to breaker interrupting capabilities.

Steady-State Voltage Requirements

(Results of the steady-state voltage studies should be inserted here)

To be determined at System Impact or Facilities Study.

Stability and Reactive Power Requirement

(Results of the dynamic studies should be inserted here)

To be determined at System Impact or Facilities Study.

Delivery of Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of this interconnection request. Any 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 Merchant Transmission Interconnection request. 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 will study all overload conditions associated with the overloaded element(s) identified.

Queue	Contingency		Affected Area	Facility Description	Bus		Circuit	Power Flow	Loading		Rating		MW Contribution
Y1-043	Type	Name			From	To			Initial	Final	Type	MVA	
1	N-1	8LDYSMTH _8POSSUM _026	PJM	6FREDBRG-6CRANES 230 kV line	314137	314134	1	DC	114.14	114.32	ER	637	7.6
2	Non	Non	PJM	Y1-043 TAP-3MACKEYS 115 kV line	913340	314586	1	DC	16.61	103.58	NR	129	150
3	N-1	LN 101_B	PJM	Y1-043 TAP-3MACKEYS 115 kV line	913340	314586	1	DC	0.03	105.61	ER	142	150

The overload of 230kV transmission line from Fredericksburg to Cranes Corner identified above will be resolved when the proposed PJM Baseline Project b1701 is constructed. The in-service target date is May 2016, and the line will have a rating of 1047 MVA.

Items 2-4 mitigation are discussed in the subsequent ITO analyses.

This violation and associated upgrade has been previously identified with Queue X2-082. The proposed network upgrade was to upgrade the North Anna to Morrisville line #573 to a higher capacity of 3424 MVA by replacing the wave trap at North Anna with a 4000 ampere wave trap.

ITO Analysis

ITO assessed the impact of the proposed 19.5 MW of Capacity and 150 MW of generation energy on the ITO transmission system. The system was assessed using the summer 2015 RTEP case provided to ITO by PJM. For primary option, the proposed generation Capacity and energy was injected on the 115 kV transmission line between the Creswell and Mackeys 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 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.

For the primary option, the proposed generation Capacity and energy was injected on the 115 kV transmission line between the Creswell and Mackeys substations. 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 Y1-043 evaluation three different assessments were conducted.

1. The first being when local generation including the proposed Y1-043 facility is operated at their maximum capability. The result of this study is shown below.
   a. Capacity portion of Interconnection Request:

      No problems indentified for the 19.5 MW capacity from Y1-043.

   b. Energy portion of Interconnection Request:

      The results of 150 MW energy from Y1-043 are shown below in Table A.

Table A: Pmax System Conditions for Y1-043 Energy

Overloaded Element	Cont. Loading (MVA)	Base Loading (MVA)	Rating (MVA)	Cont. Loading (%)	Contingency Description
314586 3MACKEYS 115 913340 Y1-043 TAP 115 1	129.0	129.0	129.0	100.0%	** Base Case **
314586 3MACKEYS 115 913340 Y1-043 TAP 115 1	150.0	129.0	142.0	106.0%	314566 3CRESWEL 115 913340 Y1-043 TAP 115 1

As shown above in Table A, the impact of the Y1-043 generator energy under base case conditions (normal loading) results in the thermal overload of the 115 kV line section from the Y1-043 tap point to Mackeys Substation. The power flow on the 115 kV line section from the Y1-043 tap point to Mackeys Substation, under base case conditions (normal loading) before and after the injection of 150 MW energy from Y1-043 are listed below in Table B.

Table B: Power Flow (MVA) Before and After Injection of Y1-043 (MWE)

	From Bus Name	From Bus Number	To Bus Name	To Bus Number	MVA	Comments
Without Y1-043	3MACKEYS	314586	Y1-043 TAP	913340	+ 22	(+) sign indicates flow out of Mackeys.
With Y1-043 (MWE)	3MACKEYS	314586	Y1-043 TAP	913340	- 129	(-) sign indicates flow in to Mackeys.

2. The second being a stressed system condition where the largest generator in the area is unavailable. With the Y1-043 generator geographically located in Eastern Virginia, Surry Unit #2 is considered the most critical generating unit in the area. The impact of Y1-043 was studied with the outage of Surry Unit #2. The result of this study is shown below.

   c. Capacity Portion of Interconnection Request:

No problems indentified for the 19.5 MW capacity from Y1-043.

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 FCITC between utilities.

   Since the Capacity value of the proposed queue request is less than 20 MW no analysis needs to be done.

Attachment Facilities

The proposed layout and attachment facilities are illustrated below in Figure A. The interconnection arrangement shown assumes the proposed Y1-043 facility is five miles from the 115 kV transmission line Mackeys to Creswell. The Attachment Facilities interconnection costs are estimated to be $15 million (2012 dollars). This cost includes metering, protection equipment and 115 kV line work to directly connect the proposed facility. This work will take an estimated time of 36 to 48 months to engineer and construct. This includes obtaining all necessary permits.

Direct Connection Network Upgrades

In order to reliably interconnect the proposed generation with the ITO transmission system it will be necessary to construct a three breaker 115 kV ring bus as shown below in Figure A. This arrangement will require the installation of three 115 kV breakers and associated equipment. The estimated cost for this work is $3.0 million and is estimated to take 24 to 36 months to complete. Should the Y1-043 facility be located in remote location (> 1 mile) an additional customer owned 115 kV interconnect breaker would be required at the generating facility. In addition, an anti-islanding scheme will need to be installed between Mackeys Substation and the proposed Y1-043 three breaker 115 kV ring bus. The estimated cost for the anti-islanding scheme and associated equipment is $800,000 and is expected to 18 to 20 months to complete. Due to the location of the proposed facilities, ITO anticipates that the Y1-043 Queue Project will need to provide sufficient reactive VAR support to maintain adequate voltage levels on the 115 kV transmission system in the area.

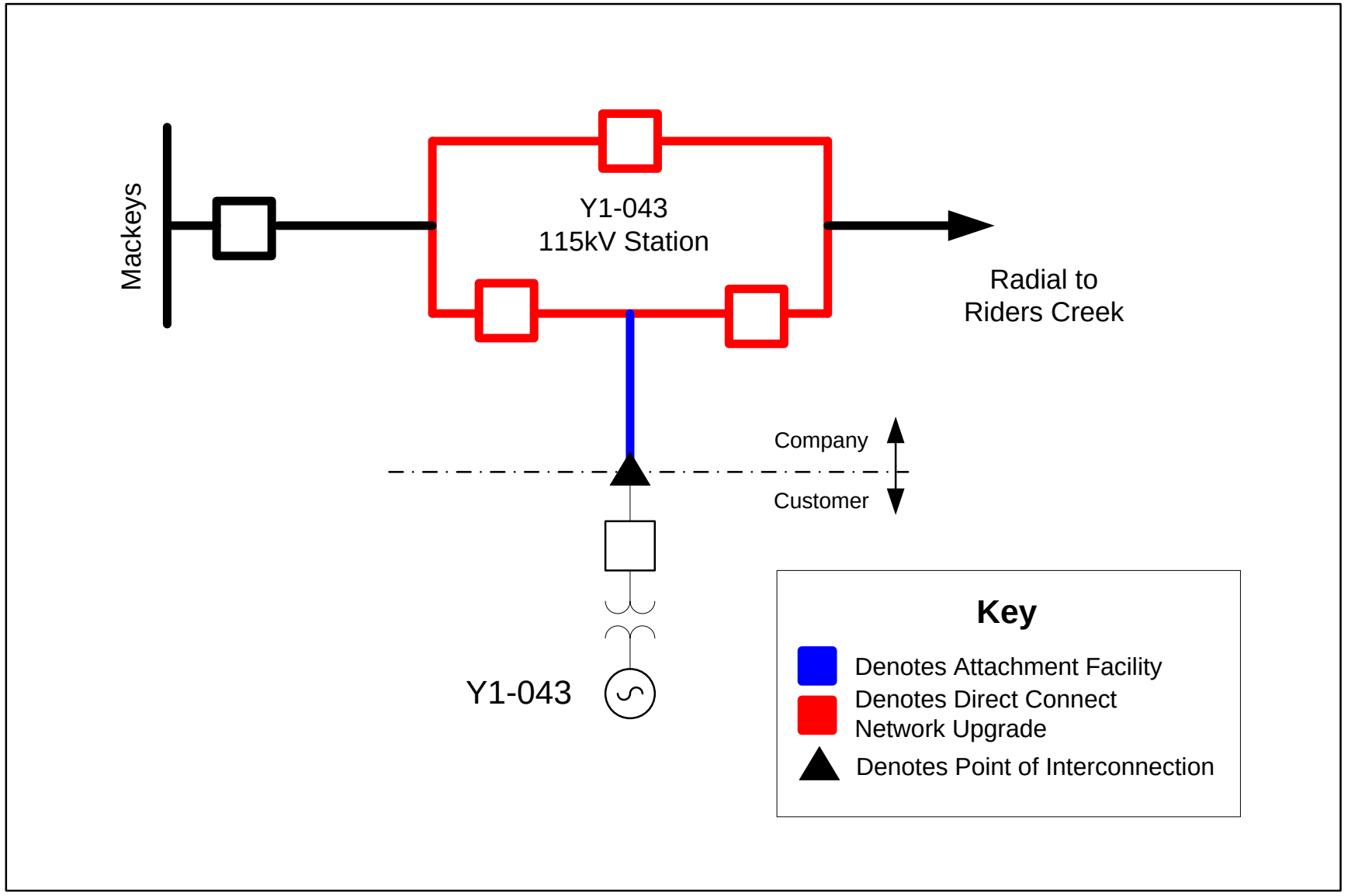
Non-Direct Connection Network Upgrades

The results of these studies indicate that the injection of the 150 MW of energy results in a thermal overload of the 115 kV line section from the Y1-043 tap point to Mackeys Substation. In order to

resolve these thermal violations, the following work would need to be completed prior to injection of the generation energy of Y1-043.

Reconductor approximately 7.0 miles of the existing 115 kV transmission line between the Y1-043 tap point and Mackeys Substations (It is assumed that the Y1-043 tap point is located half way between Mackeys Substation and the Creswell Substation). The cost of this upgrade is estimated to be $7.5 Million dollars (2012 dollars) and is expected to take 24 to 36 months to complete.

Figure A: Proposed Primary Option One-Line Diagram



Network Impacts (Secondary Option):

Impactful Contingencies

(The following contingencies resulted in overloads identified below)

Contingency ID	Contingency Description
8LDYSMTH _8POSSUM _026	CONTINGENCY '8LDYSMTH _8POSSUM _026' DISCONNECT BRANCH FROM BUS 314911 TO BUS 314922 CKT 1 /* 500/500KV, AREA 345/345. END

Generator Deliverability

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

None.

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)

None.

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.)

None.

Short Circuit

(Report Overdutied breakers here)

There is no impact to breaker interrupting capabilities.

Steady-State Voltage Requirements

(Results of the steady-state voltage studies should be inserted here)

To be determined at System Impact or Facilities Study.

Stability and Reactive Power Requirement

(Results of the dynamic studies should be inserted here)

To be determined at System Impact or Facilities Study.

Delivery of Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of this interconnection request. Any 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 Merchant Transmission Interconnection request. 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 will study all overload conditions associated with the overloaded element(s) identified.

Queue	Contingency		Affected Area	Facility Description	Bus		Circuit	Power Flow	Loading		Rating		MW Contribution
Y1-043	Type	Name			From	To			Initial	Final	Type	MVA	
1	N-1	8LDYSMTH _8POSSUM _026	PJM	6FREDBRG-6CRANES 230 kV line	314137	314134	1	DC	113.63	113.81	ER	637	7.6

The overload of 230kV transmission line from Fredericksburg to Cranes Corner identified above will be resolved when the proposed PJM Baseline Project b1701 is constructed. The in-service target date is May 2016, and the line will have a rating of 1047 MVA.

ITO Analysis

ITO assessed the impact of the proposed 19.5 MW of Capacity and 150 MW of generation energy on the ITO transmission system. The system was assessed using the summer 2015 RTEP case provided to ITO by PJM. For the secondary option, the proposed generation capacity and energy was injected at the Mackeys 115 kV 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 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 Y1-043 evaluation three different assessments were conducted.

1. The first being when local generation including the proposed Y1-043 Facility is operated at their maximum capability. The result of this study is shown below:

   a. Capacity portion of Interconnection Request:

      No problems indentified for the 19.5 MW Capacity from Y1-043.

   b. Energy portion of Interconnection Request:

      No problems indentified for the 150 MW energy from Y1-043.

2. The second being a stressed system condition where the largest generator in the area is unavailable. With the Y1-043 generator geographically located in Eastern Virginia, Surry Unit #2 is considered the most critical generating unit in the area. The impact of Y1-043 was studied with the outage of Surry Unit #2. The result of this study is shown below.

   c. Capacity portion of Interconnection Request:

      No problems indentified for the 19.5 MW Capacity from Y1-043.

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 FCITC between utilities.

Since the Capacity value of the proposed queue request is less than 20 MW no analysis needs to be done.

Attachment Facilities

The proposed layout and attachment facilities are illustrated below in Figure B. The interconnection arrangement shown assumes the proposed Y1-043 facility is five miles from the Mackeys Substation. The Attachment Facilities interconnection costs are estimated to be $15 million (2012 dollars). This cost includes metering, protection equipment and 115 kV line work to directly connect the proposed facility. This work will take an estimated time of 36 to 48 months to engineer and construct. This includes obtaining all necessary permits.

Direct Connection Network Upgrades

To reliably interconnect the proposed generation with the ITO transmission system it will be necessary to purchase and install a 115 kV breaker at the Mackeys Substation as shown below in Figure B. The estimated cost of this work is $1.0 million (2012 dollars) and is estimated to take 24 to 36 months to engineer and construct. This substation may also need to be expanded to accommodate the additional equipment. In addition, an anti-islanding scheme will need to be installed at the Mackeys Substation. The estimated cost for the anti-islanding scheme and associated equipment is $400,000 and is expected to 18 to 20 months to complete.

Due to the location of the proposed facilities, ITO anticipates that the Y1-043 queue project will need to provide sufficient reactive VAR support to maintain adequate voltage levels on the 115 kV transmission system in the area.

Non-Direct Connection Network Upgrades

None.

Figure B: Proposed Secondary Option One-Line Diagram