

***Generation Interconnection
Feasibility Study Report***

For

***PJM Generation Interconnection Request
Queue Position AC1-106***

***Chase City 115kV
15.7 MW Capacity / 0 MW Energy***

Revised May / 2017

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 the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is Virginia Electric and Power Company (VEPCO).

Preface

The intent of the Feasibility Study is to determine a plan, with high level estimated cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the IC. The IC may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the IC may be responsible for the cost of constructing: (1) Direct Connections, which are new facilities and/or facilities upgrades needed to connect the generator to the PJM network, and (2) Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system.

In some instances a generator interconnection may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection, 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 IC is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by ITO, the costs may be included in the study.

General

The IC has proposed a solar generating facility located in Chase City, VA (Mecklenburg County). The installed facilities will have a total capability of 49.9 MW with 34.6 MW of this output being recognized by PJM as capacity. This queue request is for an additional 0 MW with 15.7 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is 12/31/2018. **This study does not imply an ITO commitment to this in-service date.**

Point of Interconnection

AC1-106 will interconnect with the ITO transmission system will connect via a new breaker tapping the bus in the Chase City 115kV substation.

Cost Summary

The AC1-106 project is not expected to have additional costs to interconnect than those identified in the AB2-043 Feasibility Study.

In addition, the AC1-106 project may be responsible for a contribution to the following costs:

Description	Total Cost
New System Upgrades	\$0
Previously Identified Upgrades	\$5,400,000
Total Costs	\$5,400,000

Cost allocations for these upgrades will be provided in the System Impact Study Report.

Note: PJM Open Access Transmission Tariff (OATT) section 217.3A outline cost allocation rules. The rules are further clarified in PJM Manual 14A Attachment B. For New System Upgrades, the cost allocation rule differ depending on whether the minimum amount of upgrades to resolve a single reliability criteria violation will cost less than \$5,000,000. For upgrades estimated to cost less than \$5,000,000 the allocation of costs will not occur outside of the Queue in which the need for the Network Upgrade was identified. Cost allocation within the Queue will be contingent each Queue projects Distribution Factor on the overloaded facility. For upgrades estimated to cost \$5,000,000 or greater the allocation of costs will start with the first Queue project to cause the need for the upgrade. Later queue projects will receive cost allocation contingent on their contribution to the violation and are allocated to the queues that have not closed less than 5 years following the execution of the first Interconnection Service Agreement which identifies the need for this upgrade.

Transmission Owner Scope of Work

Attachment Facilities

The scope identified in queue AB2-043 is sufficient to accommodate this queue request from an Attachment Facilities and Chase City substation expansion perspective. The single line is shown below in Attachment 1.

Non-Direct Connection Cost Estimate

Clubhouse 230/115 kV Transformer #1: Add a second transformer and three 155 kV Breakers. Estimated cost \$5,400,000 and it is estimated to take 14-16 months to engineer and construct

Interconnection Customer Requirements

ITO's Facility Connection Requirements as posted on PJM's website

<http://www.pjm.com/~media/planning/plan-standards/private-dominion/facility-connection-requirements1.ashx>

Voltage Ride Through Requirements - The Customer Facility shall be designed to remain in service (not trip) for voltages and times as specified for the Eastern Interconnection in Attachment 1 of NERC Reliability Standard PRC-024-1, and successor Reliability Standards, for both high and low voltage conditions, irrespective of generator size, subject to the permissive trip exceptions established in PRC-024-1 (and successor Reliability Standards).

Frequency Ride Through Requirements - The Customer Facility shall be designed to remain in service (not trip) for frequencies and times as specified in Attachment 2 of NERC Reliability Standard PRC-024-1, and successor Reliability Standards, for both high and low frequency condition, irrespective of generator size, subject to the permissive trip exceptions established in PRC-024-1 (and successor Reliability Standards).

Reactive Power - The Generation Interconnection Customer shall design its non-synchronous Customer Facility with the ability to maintain a power factor of at least 0.95 leading to 0.95 lagging measured at the generator's terminals.

Revenue Metering and SCADA Requirements

PJM Requirements

The IC will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Sections 24.1 and 24.2.

Network Impacts

The Queue Project AC1-106 was evaluated as a 15.7 MW (Capacity 15.7 MW) uprate to the AB2-043 project at the Chase City 115kV substation in the ITO area. Project AC1-106 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC1-106 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
T122C	CONTINGENCY 'T122C' /* CAROLINA OPEN BUS 314559 /* CAROLINA 115KV BUS OPEN BUS 315126 /* ROANOKE RAPIDS GEN 1 AND 2 OPEN BUS 315128 /* ROANOKE RAPIDS GEN 3 AND 4 OPEN BRANCH FROM BUS 314559 TO BUS 314561 CKT 1 /* TX. #4 END
2202_A	CONTINGENCY '2202_A' /* CAROLINA OPEN BRANCH FROM BUS 314559 TO BUS 314571 CKT 1 /* LINE 22 OPEN BRANCH FROM BUS 314571 TO BUS 925780 CKT 1 /* LINE 22 OPEN BRANCH FROM BUS 314559 TO BUS 314259 CKT Z1 /* LINE 56 OPEN BRANCH FROM BUS 314559 TO BUS 921751 CKT 1 /* LINE 54 OPEN BRANCH FROM BUS 314559 TO BUS 314600 CKT 1 /* LINE 130 OPEN BRANCH FROM BUS 314559 TO BUS 314561 CKT 1 /* TX. #4 DECREASE BUS 314559 LOAD BY 100 PERCENT /* REMOVE ALL LOAD AT CAROLINA END

Contingency Name	Description
T132_A	CONTINGENCY 'T132_A' /* CAROLINA OPEN BRANCH FROM BUS 314559 TO BUS 314259 CKT Z1 /* LINE 56 OPEN BRANCH FROM BUS 314559 TO BUS 921751 CKT 1 /* LINE 54 AA2-053 TAP OPEN BRANCH FROM BUS 314559 TO BUS 314571 CKT 1 /* LINE 22 OPEN BRANCH FROM BUS 314559 TO BUS 314600 CKT 1 /* LINE 130 OPEN BRANCH FROM BUS 314559 TO BUS 314561 CKT 1 /* TX. #4 DECREASE BUS 314559 LOAD BY 100 PERCENT /* REMOVE ALL LOAD AT CAROLINA END
5602_A	CONTINGENCY '5602_A' /* CAROLINA OPEN BRANCH FROM BUS 314559 TO BUS 314259 CKT Z1 /* LINE 56 OPEN BRANCH FROM BUS 314259 TO BUS 921161 CKT 1 /* LINE 56 AA1-063A TAP OPEN BRANCH FROM BUS 314604 TO BUS 314587 CKT 1 /* LINE 56 OPEN BRANCH FROM BUS 314587 TO BUS 314558 CKT 1 /* LINE 56 OPEN BRANCH FROM BUS 314559 TO BUS 921751 CKT 1 /* LINE 54 AA2-053 TAP OPEN BRANCH FROM BUS 314559 TO BUS 314571 CKT 1 /* LINE 22 OPEN BRANCH FROM BUS 314559 TO BUS 314600 CKT 1 /* LINE 130 OPEN BRANCH FROM BUS 314559 TO BUS 314561 CKT 1 /* TX. #4 DECREASE BUS 314559 LOAD BY 100 PERCENT /* REMOVE ALL LOAD AT CAROLINA END

Contingency Name	Description
5402_A	CONTINGENCY '5402_A' /* CAROLINA OPEN BRANCH FROM BUS 314559 TO BUS 921751 CKT 1 /* LINE 54 AA2-053 TAP OPEN BRANCH FROM BUS 314581 TO BUS 314626 CKT 1 /* LINE 54 OPEN BRANCH FROM BUS 314626 TO BUS 314625 CKT 1 /* LINE 54 OPEN BRANCH FROM BUS 314625 TO BUS 314568 CKT 1 /* LINE 54 OPEN BRANCH FROM BUS 314559 TO BUS 314571 CKT 1 /* LINE 22 OPEN BRANCH FROM BUS 314559 TO BUS 314259 CKT Z1 /* LINE 56 OPEN BRANCH FROM BUS 314559 TO BUS 314600 CKT 1 /* LINE 130 OPEN BRANCH FROM BUS 314559 TO BUS 314561 CKT 1 /* TX. #4 DECREASE BUS 314559 LOAD BY 100 PERCENT /* REMOVE ALL LOAD AT CAROLINA END

Summer Peak Analysis - 2020

Generator Deliverability

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

None

Multiple Facility Contingency

(Double Circuit Tower Line contingencies were studied for the full energy output. The contingencies of Line with Failed Breaker and Bus Fault will be performed for the Impact Study.)

None

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

None

Contributions to previously identified circuit breakers found to be over-duty:

None

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)

#	Contingency		Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution	Ref
	Type	Name			From	To	Cir.		Initial	Final	Type	MVA		
1	LFFB	T122C	DVP - DVP	6CLUBHSE 230/115 kV transformer	314562	314563	1	DC	128	129.25	LD	209	2.61	1

#	Contingency		Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution	Ref
	Type	Name			From	To	Cir.		Initial	Final	Type	MVA		
2	LFFB	2202_A	DVP - DVP	6CLUBHSE 230/115 kV transformer	314562	314563	1	DC	122.76	123.94	LD	209	2.47	
3	LFFB	T132_A	DVP - DVP	6CLUBHSE 230/115 kV transformer	314562	314563	1	DC	121.8	122.98	LD	209	2.47	
4	LFFB	5602_A	DVP - DVP	6CLUBHSE 230/115 kV transformer	314562	314563	1	DC	121.75	122.93	LD	209	2.47	
5	LFFB	5402_A	DVP - DVP	6CLUBHSE 230/115 kV transformer	314562	314563	1	DC	121.61	122.79	LD	209	2.47	

Steady-State Voltage Requirements

(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

To be determined during Impact Study

Stability and Reactive Power Requirement for Low Voltage Ride Through

(Summary of the VAR requirements based upon the results of the dynamic studies)

To be determined during Impact Study

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)

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
# 1 - 5	6CLUBHSE 230/115 kV transformer	Add a second Clubhouse 230/115kV transformer and three 115kV breakers. Estimated time 14 – 16 months	Pending	\$5,400,000
Total New Network Upgrades				\$5,400,000

Potential Congestion due to Local Energy Deliverability

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 IC can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

Note: Only the most severely overloaded conditions are listed below. 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 shall study all overload conditions associated with the overloaded element(s) identified.

Not applicable

Light Load Analysis

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

ITO Analysis

ITO assessed the impact of the proposed Queue Project #AC1-106 interconnection of a 0 MW Energy (15.7 MW Capacity) injection into the ITO's Transmission System at the Chase City 115kV substation, for compliance with NERC Reliability Criteria on ITO's Transmission System. Project is a capacity uprate of AB2-043 which is interconnection at Chase City Substation. The system was assessed using the summer 2020 RTEP case provided to ITO by PJM. When performing a generation analysis, ITO's main analysis will be load flow study results under single contingency (both normal and stressed system conditions). ITO Criteria considers a transmission facility overloaded if it exceeds 94% of its emergency rating under normal and stressed system conditions. 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>.

The results of these studies evaluate the system under a limited set of operating conditions and do not guarantee the full delivery of the capacity and associated energy of this proposed generation facility under all operating conditions. NERC Planning and Operating Reliability Criteria allow for the

re-dispatch of generating units to resolve projected and actual deficiencies in real time and planning studies. Specifically NERC Category C Contingency Conditions (Bus Fault, Tower Line, N-1-1, and Stuck Breaker scenarios) allow for re-dispatch of generating units to resolve potential reliability deficiencies. For ITO's Planning Criteria the re-dispatch of generating units for these contingency conditions is allowed as long as the projected loading does not exceed 100% of a facility Load Dump Rating.

As part of its generation impact analysis, the ITO routinely evaluates the impact that a proposed new generation resource will have under maximum generation conditions, stress system conditions and import/export system conditions (greater than 20 MW). The results of these studies are discussed in more detail below.

Category B Analysis (Single Contingency):

1. System Normal – No deficiencies identified
2. Critical System Condition (No Surry 230 kV Unit) – No deficiencies identified.

Category C Analysis: (Multiple Facility Analysis)

1. Bus Fault - No deficiencies identified
2. Line Stuck Breaker - No deficiencies identified
3. Tower Line – No deficiencies identified

The import and export conditions into and out of the ITO System are evaluated with any new interconnection greater than 20 MW, any new facility that is interconnected with the ITO System should not significantly decrement FCITC between utilities. These studies will be performed during the System Impact Study.

Affected System Analysis & Mitigation

Duke, Progress & TVA Impacts:

Duke Carolina, Progress, & TVA Impacts to be determined during later study phases (as applicable).

Flowgate Appendices

Appendices

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gauge other generators impact. When a flowgate is identified in multiple analysis the appendix is presented for only the analysis with the greatest overload.

It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

Appendix 1

(DVP - DVP) The 6CLUBHSE 230/115 kV transformer (from bus 314562 to bus 314563 ckt 1) loads from 128.0% to 129.25% (**DC power flow**) of its load dump rating (209 MVA) for the line fault with failed breaker contingency outage of 'T122C'. This project contributes approximately 2.61 MW to the thermal violation.

CONTINGENCY 'T122C'

OPEN BUS 314559

OPEN BUS 315126

OPEN BUS 315128

OPEN BRANCH FROM BUS 314559 TO BUS 314561 CKT 1

END

/* CAROLINA

/* CAROLINA 115KV BUS

/* ROANOKE RAPIDS GEN 1 AND 2

/* ROANOKE RAPIDS GEN 3 AND 4

/* TX. #4

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
315159	1KERR 2	1.22
315163	1KERR 6	1.21
315164	1KERR 7	1.21
314704	3LAWRENC	1.38
922472	AA2-169 C	1.68
922473	AA2-169 E	0.77
923572	AB1-173 C OP	10.72
923573	AB1-173 E OP	5.
923582	AB1-173AC OP	10.72
923583	AB1-173AE OP	5.
923911	AB2-031 C OP	10.64
923912	AB2-031 E OP	5.24
923991	AB2-040 C OP	34.93
923992	AB2-040 E OP	28.58
924021	AB2-043 C OP	3.15
924022	AB2-043 E OP	5.16
924161	AB2-060 C OP	7.15
924162	AB2-060 E OP	3.37
924301	AB2-077 C OP	1.93
924302	AB2-077 E OP	1.29
924311	AB2-078 C OP	1.93
924312	AB2-078 E OP	1.29
924321	AB2-079 C OP	1.93
924322	AB2-079 E OP	1.29
924401	AB2-089 C	1.61

924402	AB2-089 E	0.83
924411	AB2-090 C	3.96
924412	AB2-090 E	2.03
924931	AB2-147 C	11.82
924932	AB2-147 E	19.28
924951	AB2-150 C OP	11.82
924952	AB2-150 E OP	19.28
925171	AB2-174 C OP	33.34
925172	AB2-174 E OP	30.17
925221	AB2-176 C	1.63
925222	AB2-176 E	0.7
925611	AC1-036 C	0.76
925612	AC1-036 E	1.24
925781	AC1-054 C OP	5.44
925782	AC1-054 E OP	2.51
926281	AC1-106	2.61
927211	AC1-215 C	10.43
927212	AC1-215 E	4.73