Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AC1-163

Ahoskie 34.5kV
12.6 MW Capacity / 18.5 MW Energy

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 Hertford County, NC. The installed facilities will have a total capability of 18.5 MW with 12.6 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is 10/01/2019. **This study does not imply an ITO commitment to this in-service date.**

Point of Interconnection

AC1-163 will interconnect with the ITO distribution system via a tap on to the Ahoskie 34.5kV circuit.

Attachment facilities and local upgrades (if required) along with terms and conditions to interconnect AC1-163 will be specified in a separate two party Interconnection Agreement (IA) between ITO and the IC as this project is considered FERC non-jurisdictional per the PJM Open Access Transmission Tariff (OATT).

Cost Summary

The AC1-163 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$300,000
Direct Connection Network Upgrades	$0
Non Direct Connection Network Upgrades	$5,000,000
Total Costs	**$5,300,000**

In addition, the AC1-163 project may be responsible for a contribution to the following costs:

Description	Total Cost
New System Upgrades	$0
Previously Identified Upgrades	$15,000
Total Costs	**$15,000**

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

An express 34.5kV line will need to be built to the IC's site and the requested POI because of the close proximity to the substation. The proposed 34.5 kV express feed, will be served from a new 56 MVA, 115/34.5 kV transformer in Ahoskie Substation.

Attachment Facilities

To provide the interconnection the ITO will need to install approximately 300 feet of overhead three phase primary voltage conductors will be installed to provide an interconnection to the existing primary voltage conductors. A pole mounted electronic recloser, pole mounted primary bi-directional metering equipment, a power quality monitoring relay and a set of disconnects to provide an isolation point will also be provided. The estimated cost of these attachment facilities is $300,000. These costs do not include CIAC Tax Gross-up. The single line is shown below in Attachment 1.

Non-Direct Connection Cost Estimate

Ahoskie Substation Upgrades - $4,500,000

- Install a new 115/34.5kV, 56MVA substation transformer
- Install a new circuit breaker
- Install a DG panel
- Expand control house if necessary
- Expand substation fenced area to accommodate new 56MVA transformer if necessary

Ahoskie Distribution Upgrades – $500,000

- Install a new 1000MCM underground getaway from new breaker to new terminal pole
- Install a new 34.5kV express feed to site

The estimated cost of these required System Upgrades to accommodate the 18.5 MW request is **$5,300,000.** Estimated time for engineering, material acquisition, and construction: **24 months**

Remote Terminal Work: During the Facilities Study, ITO's System Protection Engineering Department will review transmission line protection as well as anti-islanding required to accommodate the new generation and interconnection substation. System Protection Engineering will determine the minimal acceptable protection requirements to reliably interconnect the proposed generating facility with the transmission system. The review is based on maintaining system reliability by reviewing ITO's protection requirements with the known transmission system configuration which includes generating facilities in the area. This review may determine that transmission line protection and communication upgrades are required at remote substations.

Contributions to Previously Identified System Reinforcements

Reinforcement: Battleboro – Rocky Mt 115kV: Replace Battleboro substation terminal equipment. Estimated cost is $15,000.

Note: Duke/Progress Energy portion of this line will need to be studied under Duke's FERC tariff process.

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

The ITO's preferred transformer configuration is wye grounded (primary)/delta (secondary) with provisions for external resistance grounding of the primary with the level of resistance to be determined by the IC and approved by the ITO. If a wye (primary)/wye (secondary) transformer configuration is utilized the IC will apply a ground bank configured transformer [zig-zag or wye (interconnection side) – delta (floated)] at (near) the point where the generation is connected. Additionally, the ITO will require the IC to provide specific inverter information including the model and parameter data required for a short-circuit analysis including Positive, Negative and Zero Sequence Resistance and Reactance for the initial 4 to 6 cycles.

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 AC1-163 was evaluated as a 18.5 MW (Capacity 12.6 MW) injection at the Ahoskie 115kV substation in the ITO area. Project AC1-163 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC1-163 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
LN 2058-2181	CONTINGENCY 'LN 2058-2181' OPEN BUS 304226 /* ISLAND: 6PA-RMOUNT#4115.00 OPEN BRANCH FROM BUS 304226 TO BUS 314591 CKT 1 /* 6PA-RMOUNT#4230.00 - 6NASH 230.00 OPEN BRANCH FROM BUS 313845 TO BUS 314591 CKT 1 /* 6HATHAWAY 230.00 - 6NASH 230.00 OPEN BUS 314591 /* ISLAND: 6NASH 230.00 OPEN BRANCH FROM BUS 304222 TO BUS 313845 CKT 1 /* 6ROCKYMT230T230.00 - 6HATHAWAY 230.00 END
LN 56_A	CONTINGENCY 'LN 56_A' OPEN BRANCH FROM BUS 314259 TO BUS 314559 CKT Z1 /* 3CAR56_1 115.00 - 3CAROLNA 115.00 OPEN BRANCH FROM BUS 314259 TO BUS 921161 CKT 1 /* 3CAR56_1 115.00 - AA1-063A OPEN BUS 314259 /* ISLAND END
LN 68	CONTINGENCY 'LN 68' OPEN BRANCH FROM BUS 314527 TO BUS 314536 CKT 1 /* 3HOLLAND 115.00 - 3SUFFOLK 115.00 OPEN BRANCH FROM BUS 314527 TO BUS 314539 CKT 1 /* 3HOLLAND 115.00 - 3UNCAMP 115.00 OPEN BUS 314527 /* ISLAND 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		Bus			Power	Loading %		Rating		MW	
#	Type	Name	Area	Facility Description	From	To	Cir.	Flow	Initial	Final	Type	MVA	Contribution	Ref
1	DCTL	LN 2058-2181	DVP - CPLE	3BTLEBRO-3ROCKYMT115T 115 kV line	314554	304223	1	DC	164.67	165.13	ER	164	1.67	1

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	3BTLEBRO-3ROCKYMT115T 115 kV line	Upgrade Battleboro terminal equipment	Pending	$15,000
			Total New Network Upgrades	**$15,000**

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.

	Contingency		Affected		Bus			Power	Loading %		Rating		MW
#	Type	Name	Area	Facility Description	From	To	Circuit	Flow	Initial	Final	Type	MVA	Contribution
2	N-1	LN 68	DVP - DVP	3CAR56_1-3CAROLNA 115 kV line	314259	314559	Z1	DC	113.03	114.4	ER	225	3.08
3	N-1	LN 56_A	DVP - DVP	3FRNKLN-3UNCAMP 115 kV line	314524	314539	1	DC	115.06	116.47	ER	225	3.16
4	N-1	LN 56_A	DVP - DVP	3HOLLAND-3SUFFOLK 115 kV line	314527	314536	1	DC	115.83	117.23	ER	225	3.16
5	N-1	LN 56_A	DVP - DVP	3S HAMPT-3WATKINS 115 kV line	314534	314541	1	DC	105.29	106.69	ER	225	3.16
6	N-1	LN 56_A	DVP - DVP	3UNCAMP-3HOLLAND 115 kV line	314539	314527	1	DC	124.86	126.27	ER	225	3.16
7	N-1	LN 68	DVP - DVP	3AHOSKIE-3EARLEYS 115 kV line	314551	314568	1	DC	86.53	97.46	ER	141	15.41
8	N-1	LN 68	DVP - DVP	3SEABORD-AA1-063A TAP 115 kV line	314604	921161	1	DC	85.59	86.96	ER	225	3.08
9	N-1	LN 68	DVP - DVP	AA1-063A TAP-3CAR56_1 115 kV line	921161	314259	1	DC	113.03	114.4	ER	225	3.08

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 #AC1-163 interconnection of a 18.5 MW Energy (12.6 MW Capacity) injection into the ITO's Transmission System at Ahoskie Substation at 34.5 kV, for compliance with NERC Reliability Criteria on ITO's Transmission System. 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

Since the proposed generation facility is less than 20 MW, no import / export studies need to be completed.

Affected System Analysis & Mitigation

Duke, Progress & TVA Impacts:

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

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 gage 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 - CPLE) The 3BTLEBRO-3ROCKYMT115T 115 kV line (from bus 314554 to bus 304223 ckt 1) loads from 164.67% to 165.13% (**DC power flow**) of its emergency rating (164 MVA) for the tower line contingency outage of 'LN 2058-2181'. This project contributes approximately 1.67 MW to the thermal violation.

CONTINGENCY 'LN 2058-2181'
OPEN BUS 304226 /* ISLAND: 6PA-RMOUNT#4115.00
OPEN BRANCH FROM BUS 304226 TO BUS 314591 CKT 1 /* 6PA-RMOUNT#4230.00 - 6NASH 230.00
OPEN BRANCH FROM BUS 313845 TO BUS 314591 CKT 1 /* 6HATHAWAY 230.00 - 6NASH 230.00
OPEN BUS 314591 /* ISLAND: 6NASH 230.00
OPEN BRANCH FROM BUS 304222 TO BUS 313845 CKT 1 /* 6ROCKYMT230T230.00 - 6HATHAWAY 230.00
END

Bus Number	*Bus Name*	*Full Contribution*
315131	*1EDGECMA*	*2.54*
315132	*1EDGECMB*	*2.54*
315139	*1GASTONA*	*2.41*
315141	*1GASTONB*	*2.41*
315126	*1ROARAP2*	*1.*
315128	*1ROARAP4*	*0.96*
315134	*1ROAVALA*	*3.42*
315135	*1ROAVALB*	*0.91*
315136	*1ROSEMG1*	*1.96*
315138	*1ROSEMG2*	*0.92*
315137	*1ROSEMS1*	*1.21*
900672	*V4-068 E*	*0.15*
917331	*Z2-043 C*	*0.36*
917332	*Z2-043 E*	*0.83*
917341	*Z2-044 C*	*0.55*
917342	*Z2-044 E*	*1.25*
917511	*Z2-088 C OP1*	*0.71*
917512	*Z2-088 E OP1*	*6.1*
917592	*Z2-099 E*	*0.2*
918411	*AA1-050*	*0.59*
LTF	*AA1-055*	*9.47*
921162	*AA1-063AC*	*4.88*
921163	*AA1-063AE*	*2.3*
918512	*AA1-065 E OP*	*1.96*
921182	*AA1-067 C*	*0.73*

921183	*AA1-067 E*	*0.31*
918561	*AA1-072 C*	*0.05*
918562	*AA1-072 E*	*0.14*
921562	*AA1-135 C*	*4.03*
921563	*AA1-135 E*	*1.73*
921752	*AA2-053 C*	*5.42*
921753	*AA2-053 E*	*2.33*
921762	*AA2-057 C*	*12.88*
921763	*AA2-057 E*	*6.44*
921862	*AA2-068 C*	*3.3*
921863	*AA2-068 E*	*1.52*
920022	*AA2-086 E*	*0.11*
921982	*AA2-088 C*	*2.94*
921983	*AA2-088 E*	*4.8*
922442	*AA2-165 C*	*1.76*
922443	*AA2-165 E*	*0.85*
922512	*AA2-174 C*	*0.25*
922513	*AA2-174 E*	*0.27*
922722	*AB1-053 C*	*0.84*
922723	*AB1-053 E*	*0.47*
922732	*AB1-054 C*	*3.16*
922733	*AB1-054 E*	*1.55*
922922	*AB1-081 C OP*	*20.07*
922923	*AB1-081 E OP*	*8.6*
923262	*AB1-132 C OP*	*9.76*
923263	*AB1-132 E OP*	*4.18*
923572	*AB1-173 C OP*	*1.21*
923573	*AB1-173 E OP*	*0.57*
923582	*AB1-173AC OP*	*1.21*
923583	*AB1-173AE OP*	*0.57*
923911	*AB2-031 C OP*	*1.2*
923912	*AB2-031 E OP*	*0.59*
923941	*AB2-035 C*	*0.37*
923942	*AB2-035 E*	*0.16*
923991	*AB2-040 C OP*	*3.95*
923992	*AB2-040 E OP*	*3.23*
924151	*AB2-059 C OP*	*23.66*
924152	*AB2-059 E OP*	*12.19*
924381	*AB2-087 C*	*0.31*
924382	*AB2-087 E*	*0.15*
924391	*AB2-088 C*	*0.47*
924392	*AB2-088 E*	*0.23*
924491	*AB2-098 C*	*0.24*
924492	*AB2-098 E*	*0.1*
924501	*AB2-099 C*	*0.32*

924502	*AB2-099 E*	*0.14*
924511	*AB2-100 C*	*6.41*
924512	*AB2-100 E*	*3.16*
924761	*AB2-128 C*	*5.49*
924762	*AB2-128 E*	*2.16*
924931	*AB2-147 C*	*1.14*
924932	*AB2-147 E*	*1.86*
924951	*AB2-150 C OP*	*1.14*
924952	*AB2-150 E OP*	*1.86*
925141	*AB2-171 C OP*	*1.93*
925142	*AB2-171 E OP*	*3.14*
925171	*AB2-174 C OP*	*3.57*
925172	*AB2-174 E OP*	*3.23*
925591	*AC1-034 C OP*	*7.52*
925592	*AC1-034 E OP*	*5.67*
926071	*AC1-086 C*	*14.37*
926072	*AC1-086 E*	*6.54*
926201	*AC1-098 C*	*8.*
926202	*AC1-098 E*	*4.76*
926211	*AC1-099 C*	*2.68*
926212	*AC1-099 E*	*1.57*
926771	*AC1-163 C*	*1.14*
926772	*AC1-163 E*	*0.53*
927021	*AC1-189 C*	*5.15*
927022	*AC1-189 E*	*2.56*
927051	*AC1-193 C*	*1.41*
927052	*AC1-193 E*	*2.31*
927111	*AC1-206 C OP*	*5.11*
927112	*AC1-206 E OP*	*2.42*
927141	*AC1-208 C*	*10.06*
927142	*AC1-208 E*	*4.47*