Generation Interconnection
System Impact Study Report

For

PJM Generation Interconnection Request
Queue Position AA2-169

Five Forks 115kV
13.7MW Capacity / 20MW Energy

May / 2016

Introduction

This System Impact Study (SIS) has been prepared in accordance with the PJM Open Access Transmission Tariff, Section 205, as well as the System Impact Study Agreement between O2 emc, LLC, 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 System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the IC. As a requirement for interconnection, the 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 system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

In some instances an IC 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 System Impact Study is performed.

The System Impact 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 Transmission Owners, the costs may be included in the study.

General

The IC has proposed a solar generating facility located in Macon, NC (Warren County). The installed facilities will have a total capability of 20 MW with 13.7 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is June 1, 2016. **This study does not imply an ITO commitment to this in-service date.**

Point of Interconnection

Queue AA2-169 will interconnect with the ITO transmission system via ITO Five Forks 115kV substation which feeds through Halifax Electric Membership Corporation (Halifax EMC) and connects on the Carolina – Kerr Dam 115kV line #22.

Attachment Facilities and local upgrades (if required) along with terms and conditions to interconnect AA2-169 will be specified in a separate two party Interconnection Agreement (IA) between Halifax EMC and the Interconnection Customer as this project is considered FERC non-jurisdictional per the PJM Open Access Transmission Tariff (OATT). From the transmission system perspective, no network impacts were identified as detailed below.

Note: Duke Energy as an Affected System has identified an overload on the 8.5 mile Battleboro - Rocky Mt.115kV line. In order to mitigate this overload it is assumed that the line can be raised with intermediate structures to increase the rating to 164 MVA. The cost is estimated to be $9 million and take 3 years to complete. This project could have cost responsibility if it was to become the first New Service Customer to cause the need for the Network Upgrade.

Transmission Owner Scope of Work

Generation Substation: Install metering and associated protection equipment. Estimated Cost $300,000.

The proposed generation facility will connect directly to a Five Forks distribution circuit.

It is estimated to take 18-24 months to complete this work. These costs do not include CIAC Tax Gross-up. The single line is shown below in Attachment 1.

Revenue Metering and SCADA Requirements

PJM Requirements

The Interconnection Customer 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.

Interconnected Transmission Owner Requirements

Metering and SCADA/Communication equipment must meet the requirements outlined in section 3.1.6 Metering and Telecommunications of ITO's Facility Connection Requirement NERC Standard FAC-001 which is publically available at www.dom.com.

Network Impacts

The Queue Project AA2-169 was studied as a 20.0 MW (Capacity 13.7 MW) injection at the Five Forks 115kV substation in ITO area. Project AA2-169 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AA2-169 was studied with a commercial probability of 100%. 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 BRANCH FROM BUS 313845 TO BUS 314591 CKT 1 /* 2181 OPEN BRANCH FROM BUS 304226 TO BUS 314591 CKT 1 /* 2181 OPEN BRANCH FROM BUS 304222 TO BUS 313845 CKT 1 /* 2058 END

Summer Peak Analysis – 2019

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 are 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	Circuit	Flow	Initial	Final	Type	MVA	Contribution
1	DCTL	LN 2058-2181	DVP - CPLE	3BTLEBRO-3ROCKYMT115T 115 kV line	314554	304223	1	AC	112.82	113.88	ER	94	1.31

Please refer to Appendix 1 for table containing the generators having contribution to this flowgate.

See Affected System Analysis & Mitigation section.

Steady-State Voltage Requirements

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

None

Stability and Reactive Power Requirement for Low Voltage Ride Through

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

None

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this interconnection request)

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 is calculated and reported for in the Impact Study)

None

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 interconnection request by addressing 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.

None

Light Load Analysis in 2019

Not required

ITO Analysis

ITO assessed the impact of the proposed Queue Project #AA2-169 interconnection of 20 MW of energy (Capacity 13.7 MW) for compliance with reliability criteria on ITO's Transmission System. The system was assessed using the summer 2019 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 and multiple facility 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 interconnection request 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 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 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. The results of these studies are discussed in more detail below.

Category B Analysis (Single Contingency):

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

Category C Analysis: (Multiple Facility Contingency)

- Bus Fault - No deficiencies identified
- Line Stuck Breaker - No deficiencies identified
- Tower Line – No deficiencies identified

Affected System Analysis & Mitigation

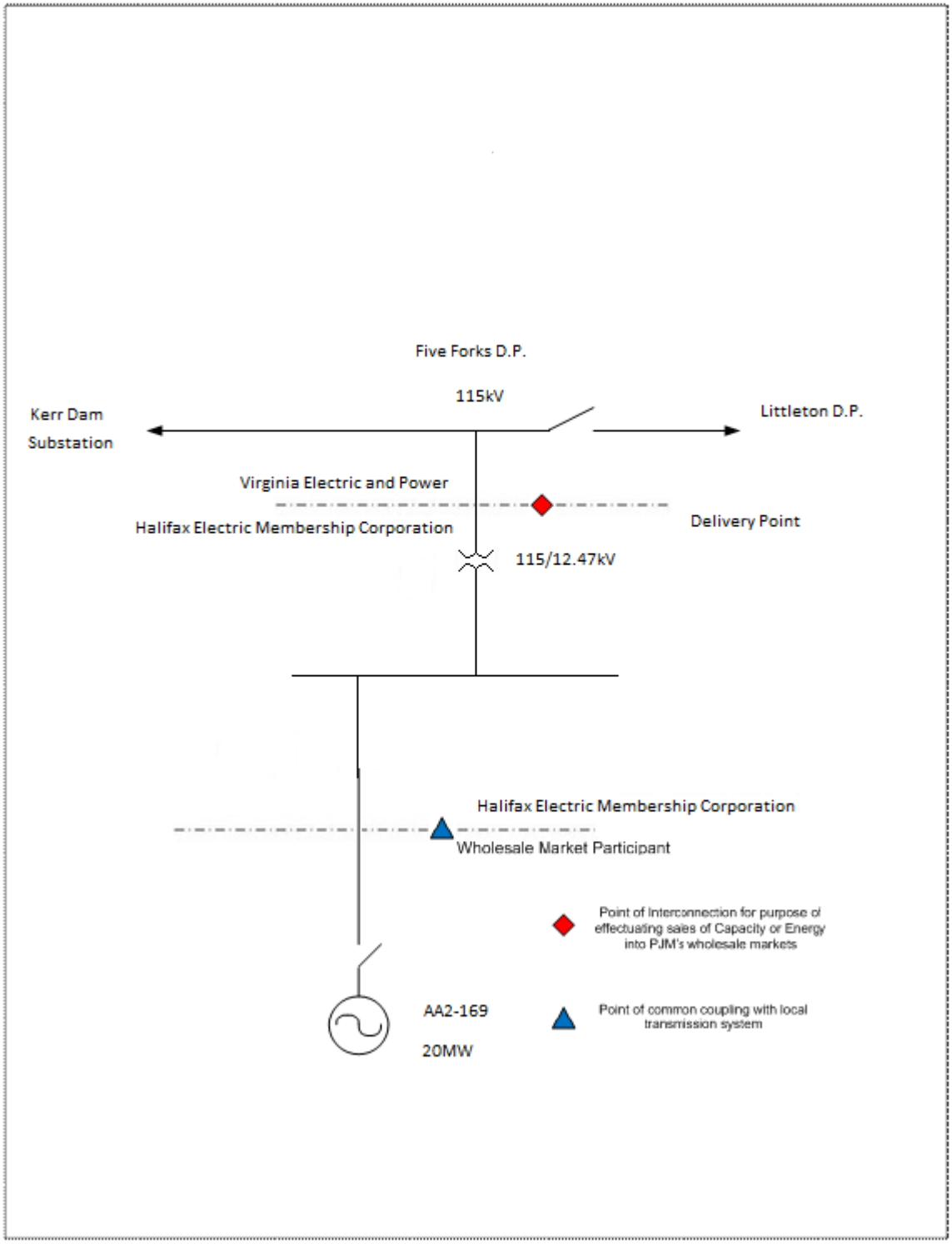
Duke Energy:

In order to mitigate the Battleboro - Rocky Mt.115kV overload, the fix is to increasing a clearance for the section by adding intermediate structures, an emergency rating can be increased to 164 MVA. The estimated cost is $9M, and it will take 3 years to complete.

Note: PJM OATT section 217.3A outlines the cost allocation rules for Network Upgrades. This circumstance is when the minimum amount of Network Upgrades required to resolve a single reliability criteria violation will meet or exceed $5,000,000. The first Interconnection Request in the New Services Queue contributing for the need for such upgrades will always receive a cost allocation. Costs shall be further allocated to subsequent projects in the New Services Queue, pursuant to queue order, and pursuant to the Interconnection Request's megawatt contribution to the need for the Network Upgrades. The rules for cost allocation are defined in more detail in PJM Manual 14A Attachment B. The governing rule in this case is that "For a transmission facility whose rated voltage level is below 500 kV, a New Service Customer will have some cost allocation if its Distribution Factor (DFAX) on the facility is greater than 5% OR if its MW impact on the facility's rating is greater than 5%". The AA2-169 project does not meet to minimum DFAX or MW impact so it does not have cost responsibility for this reinforcement at this time. However, if a prior queue project associated with this overload is withdrawn this project could become financially responsible if it was to become the first New Service Customer to cause the need for the Network Upgrade.

Attachment 1.

System Configuration



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.

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 112.82% to 113.88% (AC power flow) of its emergency rating (94 MVA) for the tower line contingency outage of 'LN 2058-2181'. This project contributes approximately 1.31 MW to the thermal violation.

CONTINGENCY 'LN 2058-2181'
OPEN BRANCH FROM BUS 313845 TO BUS 314591 CKT 1 /* 2181
OPEN BRANCH FROM BUS 304226 TO BUS 314591 CKT 1 /* 2181
OPEN BRANCH FROM BUS 304222 TO BUS 313845 CKT 1 /* 2058
END

Bus Number	Bus Name	Full Contribution
315131	1EDGECMA	1.55
315132	1EDGECMB	1.55
315139	1GASTONA	1.49
315141	1GASTONB	1.48
315126	1ROARAP2	0.62
315128	1ROARAP4	0.6
315134	1ROAVALA	2.09
315135	1ROAVALB	0.56
315136	1ROSEMG1	1.2
315138	1ROSEMG2	0.56
315137	1ROSEMS1	0.74
314539	3UNCAMP	0.83
314541	3WATKINS	0.27
314784	P-043 E	0.77
900672	V4-068 E	0.15
902241	W2-022 C OP1	0.61
902242	W2-022 E OP1	4.1
907092	X1-038 E	2.08
917331	Z2-043 C	0.23
917332	Z2-043 E	0.85
917341	Z2-044 C	0.34
917342	Z2-044 E	1.26
917511	Z2-088 C OP1	0.42
917512	Z2-088 E OP1	2.9
917592	Z2-099 E	0.21
918411	AA1-050	0.36
LTF	AA1-053	6.08
LTF	AA1-054	5.26
LTF	AA1-055	9.46
918491	AA1-063AC OP	5.23

918492	AA1-063AE OP	2.47
918512	AA1-065 E OP	1.97
918532	AA1-067 E	0.31
918561	AA1-072 C	0.3
918562	AA1-072 E	0.14
919131	AA1-135 C OP	4.03
919132	AA1-135 E OP	1.73
919691	AA2-053 C OP	5.53
919692	AA2-053 E OP	2.38
919701	AA2-057 C OP	12.21
919702	AA2-057 E OP	5.74
919821	AA2-068 C	3.39
919822	AA2-068 E	1.56
920022	AA2-086 E	0.11
920041	AA2-088 C OP	3.
920042	AA2-088 E OP	4.9
920091	AA2-105 C	1.75
920092	AA2-105 E	0.82
920181	AA2-113 C	1.4
920182	AA2-113 E	0.66
920591	AA2-165 C	1.39
920592	AA2-165 E	0.79
920631	AA2-169 C	0.9
920632	AA2-169 E	0.41
920671	AA2-174 C OP	0.25
920672	AA2-174 E OP	0.27
920691	AA2-178 C	2.95
920692	AA2-178 E	1.26