Generation Interconnection

Feasibility Study Report

for

Queue Project AG1-213

ST JOHNS 13.2 KV

4 MW Capacity / 10 MW Energy

January 2021

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1 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 Dominion.

2 Preface

The intent of the feasibility study is to determine a plan, with ballpark cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the Interconnection Customer. The Interconnection Customer may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the Interconnection Customer 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. Cost allocation rules for network upgrades can be found in PJM Manual 14A, Attachment B. 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.

3 General

The Interconnection Customer (IC), has proposed a Storage generating facility located in Caroline County, Virginia. The installed facilities will have a total capability of 10 MW with 4 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is December 31, 2022. This study does not imply a TO commitment to this in-service date.

The AG1-213 customer will be an interconnection to Rappahannock Electric Cooperative (REC) facilities. The Interconnection Customer (IC) will need to coordinate with REC for scope, cost and schedule for this physical interconnection. This PJM report identifies the effects on the transmission system. AG1-213 will interconnect within the Rappahannock Electric Cooperative (REC) system which interconnects with the Dominion transmission system at St. Johns DP 115 kV.

Queue Number	AG1-213
Project Name	ST JOHNS 13.2 KV
State	Virginia
County	Caroline
Transmission Owner	Dominion
MFO	10
MWE	10
MWC	4
Fuel	Storage
Basecase Study Year	2024

Any new service customers who can feasibly be commercially operable prior to June 1st of the basecase study year are required to request interim deliverability analysis.

4 Point of Interconnection

AG1-213 will interconnect with the Dominion transmission system at the St. Johns DP 115 kV substation.

5 Cost Summary

The AG1-213 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	$ Costs from REC to be provided in the Interconnection Agreement
Total System Network Upgrade Costs	$ 4,785,000[1]
Total Costs	$ 4,785,000 + Costs from REC to be provided in the Interconnection Agreement

This cost excludes a Federal Income Tax Gross Up charges. This tax may or may not be charged based on whether this project meets the eligibility requirements of IRS Notice 2016-36, 2016-25 I.R.B. (6/20/2016). If at a future date it is determined that the Federal Income Tax Gross charge is required, the Transmission Owner shall be reimbursed by the Interconnection Customer for such taxes.

Cost allocations for any System Upgrades will be provided in the System Impact Study Report.

6 Transmission Owner Scope of Work

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.

[1] This project currently causes and/or contributes to overloads of the Transmission System (see Summer Peak Load Flow Analysis section below) and therefore has potential to have cost allocation for the system reinforcements listed in the report. This will be re-evaluated in the System Impact phase. The results may vary with queue customers withdrawing from the queue and other generators deactivating over time. If a customer is the first to cause the need for a project (causes loading to exceed 100% of rating), then the customer is responsible. If a customer contributes to a facility that is already overloaded by a prior queue, then they may receive cost allocation.

7 Schedule

The estimated schedule for the required Network Impact Reinforcements is identified in the "System Reinforcements" section of this report.

If the customer is ultimately responsible for network upgrades, then the schedule for those upgrades will be refined in future study phases. The customer would need to wait for those upgrades to be completed prior to commercial operation unless determined deliverable by an interim deliverability study. The elapsed time to complete any network upgrades is provided in the System Reinforcements table of this report.

8 Transmission Owner Analysis

Dominion assessed the impact of the proposed AG1-213 for compliance with NERC Reliability Criteria on the Dominion Transmission System. The system was assessed using the summer 2024 AG1 case provided to Dominion by PJM.

When performing a generation analysis, Dominion's main analysis includes load flow study results following a single contingency event for both normal and stressed system conditions. Dominion Criteria considers a transmission facility overloaded if it exceeds 94% of its emergency rating under normal and stressed system conditions. A full listing of Dominion's Planning Criteria and interconnection requirements can be found in the Company's Facility Connection Requirements which are publicly available at: http://www.dominionenergy.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, in Planning Studies, NERC Planning Event 3 and 6 Contingency Conditions (Loss of generator, transmission circuit, transformer, shunt device, or Single Pole of a DC line followed by the loss of a generator, transmission circuit, transformer, shunt device or single pole of a DC line) allow for re-dispatch of generating units to resolve potential reliability deficiencies. For Dominion 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.

8.1 Power Flow Analysis

PJM performed a power flow analysis of the transmission system using a 2024 summer peak load flow model and the results were verified by Dominion. Additionally, Dominion performed an analysis of its transmission system and no further deficiencies were identified.

9 Interconnection Customer Requirements

9.1 System Protection

The IC must design its Customer Facilities in accordance with all applicable standards, including the standards in Dominion's "Dominion Energy Electric Transmission Generator Interconnection Requirements" documented in Dominion's Facility Interconnection Requirements "Exhibit C" located at: https://www.dominionenergy.com/company/moving-energy/electric-transmission-access. Preliminary Protection requirements will be provided as part of the Facilities Study. Detailed Protection Requirements will be provided once the project enters the construction phase.

9.2 Compliance Issues and Interconnection Customer Requirements

The proposed Customer Facilities must be designed in accordance with Dominion's "Dominion's Facility Interconnection Requirements" document located at: https://www.dominionenergy.com/company/moving-energy/electric-transmission-access. In particular, the IC is responsible for the following:

1. The purchase and installation of a fully rated protection device (circuit breaker, circuit switcher, fuse) to protect the IC's GSU transformer(s).

2. The purchase and installation of the minimum required Dominion generation interconnection relaying and control facilities as described in the System Protection section noted above. This includes over/under voltage protection, over/under frequency protection, and zero sequence voltage protection relays.

3. The purchase and installation of supervisory control and data acquisition ("SCADA") equipment to provide information in a compatible format to the Dominion Transmission System Control Center.

4. Compliance with the Dominion and PJM generator power factor and voltage control requirements.

The GSU(s) associated with the IC queue request shall meet the grounding requirements as noted in Dominion's "Dominion's Facility Interconnection Requirements" document located at: https://www.dominionenergy.com/company/moving-energy/electric-transmission-access.

The IC will also be required to meet all PJM, SERC, and NERC reliability criteria and operating procedures for standards compliance. For example, the IC will need to properly locate and report the over and under voltage and over and under frequency system protection elements for its units as well as the submission of the generator model and protection data required to satisfy the PJM and SERC audits. Failure to comply with these requirements may result in a disconnection of service if the violation is found to compromise the reliability of the Dominion system.

9.3 Power Factor Requirements

The IC shall design its non-synchronous Customer Facility with the ability to maintain a power factor of at least 0.95 leading (absorbing VARs) to 0.95 lagging (supplying VARs) measured at the high-side of the facility substation transformer(s) connected to the Dominion transmission system.

10 Revenue Metering and SCADA Requirements

10.1 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 Section 8 of Attachment O.

10.2 Interconnected Transmission Owner Requirements

The IC will be required to comply with all Interconnected Transmission Owner's revenue metering requirements for generation interconnection customers located at the following link:

http://www.pjm.com/planning/design-engineering/to-tech-standards/

11 Summer Peak - Load Flow Analysis

The Queue Project AG1-213 was evaluated as a 10.0 MW (Capacity 4.0 MW) injection at the St. Johns DP 115 kV substation in the Dominion area. Project AG1-213 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AG1-213 was studied with a commercial probability of 53.0 %. Potential network impacts were as follows:

11.1 Generation Deliverability

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

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
168707555	314222	6HANOVER	230.0	DVP	314218	6ELMONT	230.0	DVP	1	Base Case	single	1123.30004883	99.93	100.08	DC	1.69

11.2 Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)

None

11.3 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)

None

11.4 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 developer 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.

None

11.5 System Reinforcements - Summer Peak Load Flow - Primary POI

ID	Idx	Facility	Upgrade Description	Cost
168707555	1	**6HANOVER 230.0 kV - 6ELMONT 230.0 kV Ckt 1**	**DVP** **n6159 (218) : Rebuild 3.19 miles of 230 kV Line 2032 from Hanover to Elmont with 2-768.2 ACSS 200C.** **Project Type : FAC** **Cost : $4,785,000** **Time Estimate : 30-36 Months**	$4,785,000
			TOTAL COST	**$4,785,000**

11.6 Flow Gate Details

The following indices contain additional information about each facility presented in the body of the report. For each index, a description of the flowgate and its contingency was included for convenience. The intent of the indices is to provide more details on which projects/generators have contributions to the flowgate in question. All New Service Queue Requests, through the end of the Queue under study, that are contributors to a flowgate will be listed in the indices. Please note that there may be contributors that are subsequently queued after the queue under study that are not listed in the indices. Although this information is not used "as is" for cost allocation purposes, it can be used to gage the impact of other projects/generators. It should be noted the project/generator MW contributions presented in the body of the report are Full MW Impact contributions which are also noted in the indices column named "Full MW Impact", whereas the loading percentages reported in the body of the report, take into consideration the PJM Generator Deliverability Test rules such as commercial probability of each project as well as the ramping impact of "Adder" contributions. The MW Impact found and used in the analysis is shown in the indices column named "Gendeliv MW Impact".

11.6.1 Index 1

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
168707555	314222	6HANOVER	DVP	314218	6ELMONT	DVP	1	Base Case	single	1123.3	99.93	100.08	DC	1.69

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
314131	6ARNOLDS	0.0870	80/20	0.0870
314134	6CRANES	0.0270	80/20	0.0270
315033	1BIRCHWDA	17.8619	80/20	17.8619
315037	1LDYSMT1	4.7000	80/20	4.7000
315038	1LDYSMT2	4.7000	80/20	4.7000
315039	1LDYSMT3	4.5245	80/20	4.5245
315040	1LDYSMT4	4.5330	80/20	4.5330
315041	1LDYSMT5	4.5471	80/20	4.5471
315043	1FOUR RIVERA	12.0649	80/20	12.0649
315044	1FOUR RIVERB	12.0649	80/20	12.0649
315045	1FOUR RIVERC	14.7460	80/20	14.7460
315046	1FOUR RIVERD	12.0649	80/20	12.0649
315047	1FOUR RIVERE	12.0649	80/20	12.0649
315048	1FOUR RIVERF	14.7460	80/20	14.7460
315051	1AA1-145 CT1	18.9910	80/20	18.9910
315052	1AA1-145 CT2	18.9910	80/20	18.9910
939261	AE1-157 C O1	25.8887	80/20	25.8887
939271	AE1-158 C O1	26.4211	80/20	26.4211
939755	AE1-206 C	128.8913	80/20	128.8913
942191	AE2-231 C O1	11.1345	80/20	11.1345
946001	AF1-265	113.0625	80/20	113.0625
957191	AF2-013	5.3940	80/20	5.3940
957411	AF2-035 C	20.2445	80/20	20.2445
957551	AF2-049 C	11.4802	80/20	11.4802
960091	AF2-300 C	5.0611	80/20	5.0611
961781	AG1-019	5.3940	80/20	5.3940
963051	AG1-154 C	3.5892	80/20	3.5892
963341	AG1-183 C	14.9809	80/20	14.9809
963381	AG1-187	6.1071	80/20	6.1071
963621	AG1-213 C	1.6870	80/20	1.6870
964591	AG1-322 O1	5.2535	80/20	5.2535
965441	AG1-412 C	12.9048	80/20	12.9048
966711	AG1-541 C	13.4963	80/20	13.4963
966881	AG1-559 C	5.0611	80/20	5.0611
G-007A	G-007A	1.5608	Confirmed LTF	1.5608
VFT	VFT	4.1603	Confirmed LTF	4.1603
CALDERWOOD	CALDERWOOD	0.8717	Confirmed LTF	0.8717
PRAIRIE	PRAIRIE	3.3347	Confirmed LTF	3.3347
CHEOAH	CHEOAH	0.8879	Confirmed LTF	0.8879
CBM-N	CBM-N	0.7572	Confirmed LTF	0.7572
COTTONWOOD	COTTONWOOD	3.2928	Confirmed LTF	3.2928
HAMLET	HAMLET	1.5696	Confirmed LTF	1.5696

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
GIBSON	GIBSON	0.6279	Confirmed LTF	0.6279
BLUEG	BLUEG	1.9738	Confirmed LTF	1.9738
TRIMBLE	TRIMBLE	0.6288	Confirmed LTF	0.6288
CATAWBA	CATAWBA	0.8263	Confirmed LTF	0.8263

11.7 Queue Dependencies

The Queue Projects below are listed in one or more indices for the overloads identified in your report. These projects contribute to the loading of the overloaded facilities identified in your report. The percent overload of a facility and cost allocation you may have towards a particular reinforcement could vary depending on the action of these earlier projects. The status of each project at the time of the analysis is presented in the table. This list may change as earlier projects withdraw or modify their requests.

Queue Number	Project Name	Status
AA1-145	Four Rivers 230kV	In Service
AE1-157	Ladysmith CT-St. Johns 230 kV	Active
AE1-158	Ladysmith CT-St. Johns 230 kV	Active
AE1-206	Four Rivers-Hanover 230 kV	Active
AE2-231	St. Johns 115 kV	Active
AF1-265	Four Rivers-Hanover 230 kV	Active
AF2-013	Arnold's Corner-Dahlgren 230 kV	Active
AF2-035	St. Johns 115 kV	Active
AF2-049	Ladysmith CT-St. Johns 230 kV	Active
AF2-300	St. Johns 115 kV	Active
AG1-019	Arnold's Corner-Dahlgren 230 kV	Active
AG1-154	Ladysmith CT 230 kV	Active
AG1-183	St. Johns DP-REC 115 kV	Active
AG1-187	St. Johns DP-REC 115 kV	Active
AG1-213	St Johns 13.2 kV	Active
AG1-322	Birchwood 230 kV	Active
AG1-412	Ladysmith CT-Mine Road 230 kV	Active
AG1-541	St. Johns 115 kV	Active
AG1-559	Caroline Pines 22 kV	Active

11.8 Contingency Descriptions

None

12 Short Circuit Analysis

None

12.1 System Reinforcements - Short Circuit

None

13 Affected Systems

13.1 TVA

TVA Impacts to be determined during later study phases (as applicable).

13.2 Duke Energy Progress

Duke Energy Progress Impacts to be determined during later study phases (as applicable).

14 Attachment 1: One Line Diagram