Generation Interconnection

Combined Feasibility / System Impact Study Report

for

Queue Project AF1-058

WELCO 34.5 KV

12 MW Capacity / 20 MW Energy

January, 2020

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1 Introduction

This combined Feasibility/Impact 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).

2 Preface

The intent of the combined Feasibility/Impact 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.

The Interconnection Customer seeking to interconnect a wind or solar generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per Schedule H to the Interconnection Service Agreement and Section 8 of Manual 14D.

PJM utilizes manufacturer models to ensure the performance of turbines is properly captured during the simulations performed for stability verification and, where applicable, for compliance with low voltage ride through requirements. Turbine manufacturers provide such models to their customers. The list of manufacturer models PJM has already validated is contained in Attachment B of Manual 14G. Manufacturer models may be updated from time to time, for various reasons such as to reflect changes to the control systems or to more accurately represent the capabilities turbines and controls which are currently available in the field. Additionally, as new turbine models are developed, turbine manufacturers provide such new models which must be used in the conduct of these studies. PJM needs adequate time to evaluate the new models in order to reduce delays to the System Impact Study process timeline for the Interconnection Customer as well as other Interconnection Customers in the study group. Therefore, PJM will require that any Interconnection Customer with a new manufacturer model must supply that model to PJM, along with a $10,000 fully refundable deposit, no later than three (3) months prior to the starting date of the System Impact Study (See Section 4.3 for starting dates) for the Interconnection Request which shall specify the use of the new model. The Interconnection Customer will be required to submit a completed dynamic model study request form (Attachment B-1 of Manual 14G) in order to document the request for the study.

The combined Feasibility/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 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 Solar generating facility located in Halifax County, Virginia. The installed facilities will have a total capability of 20 MW with 12 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is 12/01/2021. This study does not imply a TO commitment to this in-service date.

Final attachment facilities and local upgrades (if required) along with terms and conditions to interconnect the AF1-058 project will be specified in a separate two party Interconnection Agreement (IA) between the ITO and the Interconnection Customer as this project is considered FERC non-jurisdictional per the PJM Open Access Transmission Tariff (OATT).

Attachment 1 shows a one-line diagram of the proposed interconnection facilities. The IC may not install any facilities on Dominion's right-of-way without first obtaining the necessary approval from Dominion Energy.

From the transmission perspective, no network impacts were identified as detailed in the "Network Impacts" section below.

Queue Number	AF1-058
Project Name	WELCO 34.5 KV
State	Virginia
County	Halifax
Transmission Owner	Dominion
MFO	20
MWE	20
MWC	12
Fuel	Solar
Basecase Study Year	2023

3.1 Point of Interconnection

AF1-058 will interconnect with the Dominion distribution system at the Welco 34.5 kV substation.

3.2 Cost Summary

The AF1-058 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ To be provided in IA
Direct Connection Network Upgrade	$ To be provided in IA
Non Direct Connection Network Upgrades	$ To be provided in IA
Total Costs	$ To be provided in IA

In addition, the AF1-058 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	$ 0

4 Transmission Owner Scope of Work

Dominion assessed the impact of the proposed Queue Project AF1-058 as a 12 MW Capacity (20 MW energy) injection on the 34.5 kV line coming out of Welco substation in the Dominion distribution System, for compliance with NERC Reliability Criteria on Dominion Transmission System.

The system was assessed using the summer 2023 AF1 case provided to Dominion by PJM. When performing a generation analysis, Dominion's main analysis will be load flow study results under single contingency (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.

The required Attachment Facilities, Direct Connection and Non-Direct Connection work for the interconnection of the AF1-058 generation project to the Dominion Transmission System is detailed in the following sections. The associated one-line with the generation project attachment facilities and primary direct and non-direct connection are shown in Attachment 1.

Note that the ITO findings were made from a conceptual review of this project. A more detailed review of the connection facilities and their cost will be identified in a future study phases. Further note that the cost estimate data contained in this document should be considered high level estimates since it was produced without a detailed engineering review. The applicant will be responsible for the actual cost of construction. ITO herein reserves the right to return to any issues in this document and, upon appropriate justification, request additional monies to complete any reinforcements to the transmission systems.

5 Schedule

The schedule of work by Dominion to interconnect the IC 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).

6 Transmission Owner Analysis

6.1 Power Flow Analysis

PJM performed a power flow analysis of the transmission system using a 2023 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.

6.2 Short Circuit Analysis

PJM performed a short circuit analysis and the results were verified by Dominion. The connection of AF1-058 project to the system does not result in any newly overdutied circuit breakers on the Dominion transmission system and does not have a significant fault current contribution to existing overdutied circuit breakers.

6.3 Stability Analysis

Not required for this project.

7 Interconnection Customer Requirements

7.1 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.

7.2 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 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.

7.3 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.

8 Revenue Metering and SCADA Requirements

8.1 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.

8.1.1 Meteorological Data Reporting Requirement

The solar generation facility shall provide the Transmission Provider with site-specific meteorological data including:

- Temperature (degrees Fahrenheit)

- Atmospheric pressure (hectopascals)
- Irradiance
- Forced outage data

8.2 Dominion Requirements

See Section 3.4.6 “Metering and telecommunications” of Dominion’s “Dominion’s Facility Interconnection Requirements” document located at: https://www.dominionenergy.com/company/moving-energy/electric-transmission-access.

9 Network Impacts

The Queue Project AF1-058 was evaluated as a 20.0 MW (Capacity 12.0 MW) injection at the Welco 115 kV substation in the Dominion area. Project AF1-058 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-058 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Load Flow

9.1 Generation Deliverability

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

None

9.2 Multiple Facility Contingency

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

None

9.3 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

9.4 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.

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
4302915 7	31466 6	3ALTVST A	115. 0	DVP	31466 7	4ALTVSTA	138. 0	DVP	2	DVP_P1-3: 4ALTVSTA -TX#3	operatio n	130.4 7	109.44	111.1	AC	2.28
4302916 2	31466 6	3ALTVST A	115. 0	DVP	31466 7	4ALTVSTA	138. 0	DVP	1	DVP_P1-3: 4ALTVSTA -TX#4	operatio n	126.5 2	105.43	107.05	AC	2.15
4302911 8	31469 4	3GRIT	115. 0	DVP	31471 2	3OTTER R	115. 0	DVP	1	DVP_P1-2: LN 556-B	operatio n	285.7 6	106.75	107.86	AC	3.19
4302910 2	31471 2	3OTTER R	115. 0	DVP	31466 6	3ALTVSTA	115. 0	DVP	1	DVP_P1-2: LN 556-B	operatio n	269.7 8	107.59	108.77	AC	3.19
4285349 3	92725 0	AC1-221 TAP	230. 0	DVP	30407 0	6PERSON23 0 T	230. 0	CPLE	1	DVP_P1-2: LN 556-B	operatio n	718.0	136.18	137.49	AC	9.58
4302910 8	94275 0	AE2-291 TAP	115. 0	DVP	31469 4	3GRIT	115. 0	DVP	1	DVP_P1-2: LN 556-B	operatio n	285.7 6	107.48	108.59	AC	3.19

9.5 System Reinforcements

None

9.6 Flow Gate Details

The following indices contain additional information about each flowgate presented in the body of the report. For each index, 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.

9.6.1 Contingency Descriptions

Contingency Name	Contingency Definition
DVP_P1-3: 4ALTVSTA-TX#4	CONTINGENCY 'DVP_P1-3: 4ALTVSTA-TX#4' OPEN BRANCH FROM BUS 314666 TO BUS 314667 CKT 2 /* 3ALTVSTA 115.00 - 4ALTVSTA 138.00 END
DVP_P1-3: 4ALTVSTA-TX#3	CONTINGENCY 'DVP_P1-3: 4ALTVSTA-TX#3' OPEN BRANCH FROM BUS 314666 TO BUS 314667 CKT 1 /* 3ALTVSTA 115.00 - 4ALTVSTA 138.00 END
DVP_P1-2: LN 556-B	CONTINGENCY 'DVP_P1-2: LN 556-B' OPEN BRANCH FROM BUS 945810 TO BUS 314936 CKT 1 /* AF1-246 TAP 500.00 - 8RAWLINGS 500.00 END

Short Circuit

9.7 Short Circuit

The following Breakers are overdutied:

None

Affected Systems

10 Affected Systems

10.1 Duke Energy Progress

No issues identified.

Attachment 1

System Configuration