Generation Interconnection

Combined Feasibility / Impact Study Report

for

Queue Project AE2-134

LOCUST GROVE-PAYTES 115 KV

16.4 MW Capacity / 0 MW Energy

July, 2019

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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/System Impact Study is to determine a plan, with approximate 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 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.

3 General

The Interconnection Customer (IC), has proposed a Solar generating facility located in Orange County, Virginia. This project is an increase to the Interconnection Customer's AC1-076 project, which will share the same property and point of interconnection. The AE2-134 queue position is a 16.4 MW capacity-only uprate to the previous project. The total installed facilities will have a capability of 62.5 MW with 40.2 MW of this output being recognized by PJM as capacity.

Queue Number	AE2-134
Project Name	LOCUST GROVE-PAYTES 115 KV
Interconnection Customer	
State	Virginia
County	Orange
Transmission Owner	Dominion
MFO	62.5
MWE	0
MWC	16.4
Fuel	Solar
Basecase Study Year	2022

3.1 Point of Interconnection

AE2-134 will interconnect with the Dominion transmission system as an uprate to the AC1-076 which is a tap of the Locust Grove to Paynes Tap 115 kV line.

3.2 Cost Summary

The AE2-134 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ N/A
Direct Connection Network Upgrade	$ N/A
Non Direct Connection Network Upgrades	$ N/A
Total Costs	$ 0

In addition, the AE2-134 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 AE2-134 was evaluated as a 16.4 MW Capacity (0.0 MW energy) injection at the proposed AC1-076 substation in the Dominion Transmission System, for compliance with NERC Reliability Criteria on Dominion Transmission System. The system was assessed using the summer 2022 AE2 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 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 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.

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 Non-Direct Connection Cost Estimate

The total preliminary cost estimate for the Non-Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
	$ 0
Total Non-Direct Connection Facility Costs	**$ 0**

6 Transmission Owner Analysis

6.1 Power Flow Analysis

PJM performed a power flow analysis of the transmission system using a 2022 summer peak load flow model and the results were verified by Dominion. Additionally, Dominion performed an analysis of its transmission system. At the Primary POI, the AE2-134 project does not contribute to overloads on the Dominion transmission system as shown in the "Network Impact" section of the report.

6.2 Short Circuit Analysis

Not required.

6.3 Stability Analysis

Not required.

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 AE2-134 was evaluated as a 16.4 MW Capacity uprate to the AC1-076 which is a tap of the Locust Grove to Paynes Tap 115 kV line in the Dominion area. Project AE2-134 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-134 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	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
1858884	314778	3PAY TAP	DVP	314755	3SPOTSYL	DVP	1	DVP_P1-2: LN 2-A	operation	226.0	106.38	110.97	AC	10.74
1858795	926000	AC1-076 TAP	DVP	314778	3PAY TAP	DVP	1	DVP_P1-2: LN 2-A	operation	226.0	115.52	120.12	AC	10.74

9.5 Light Load Analysis

Not required for solar projects.

9.6 Steady State Voltage Requirements

None

9.7 Stability

Not required for this project.

9.8 System Reinforcements

None

9.9 Flow Gate Details

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.

9.9.1 Contingency Descriptions

Contingency Name	Contingency Definition
DVP_P4-2: 573T594	CONTINGENCY 'DVP_P4-2: 573T594' /* SPOTSYLVANIA 500 KV OPEN BRANCH FROM BUS 314918 TO BUS 314934 CKT 1 /* 8NO ANNA 500.00 - 8SPOTSYL 500.00 OPEN BRANCH FROM BUS 314916 TO BUS 314934 CKT 1 /* 8MORRSVL 500.00 - 8SPOTSYL 500.00 END
DVP_P1-2: LN 2-A	CONTINGENCY 'DVP_P1-2: LN 2-A' OPEN BRANCH FROM BUS 314345 TO BUS 925670 CKT 1 /* 3MT RUN 115.00 - AC1-043 TAP 115.00 END
DVP_P7-1: LN 70-2153-A-A	CONTINGENCY 'DVP_P7-1: LN 70-2153-A-A' OPEN BRANCH FROM BUS 314078 TO BUS 926610 CKT 1 /* 3REMNGTN 115.00 - AC1-143 TAP 115.00 OPEN BRANCH FROM BUS 314080 TO BUS 939220 CKT 1 /* 6REMNGTN 230.00 - AE1-153 TAP 230.00 END
DVP_P7-1: LN 70-2153-B-A	CONTINGENCY 'DVP_P7-1: LN 70-2153-B-A' OPEN BRANCH FROM BUS 926610 TO BUS 314743 CKT 1 /* AC1-143 TAP 115.00 - 3BRANDY 115.00 OPEN BRANCH FROM BUS 314345 TO BUS 314743 CKT 1 /* 3MT RUN 115.00 - 3BRANDY 115.00 OPEN BRANCH FROM BUS 314345 TO BUS 314753 CKT 1 /* 3MT RUN 115.00 - 3CULPEPR 115.00 OPEN BRANCH FROM BUS 314753 TO BUS 314873 CKT 1 /* 3CULPEPR 115.00 - 3CULPE_1 115.00 OPEN BUS 314743 /* ISLAND: 3BRANDY 115.00 OPEN BUS 314753 /* ISLAND: 3CULPEPR 115.00 OPEN BUS 314873 /* ISLAND: 3CULPE_1 115.00 OPEN BRANCH FROM BUS 314080 TO BUS 939220 CKT 1 /* 6REMNGTN 230.00 - AE1-153 TAP 230.00 END

Contingency Name	Contingency Definition
DVP_P4-2: 2T70	CONTINGENCY 'DVP_P4-2: 2T70' /* MOUNTAIN RUN 115 KV OPEN BRANCH FROM BUS 314345 TO BUS 925670 CKT 1 /* MT. RUN 115.00 - AC1-043 TAP 115.00 /* CONTINGENCY LINE ADDED FOR AE1 BUILD OPEN BRANCH FROM BUS 926610 TO BUS 314743 CKT 1 /* AC1-143 TAP 115.00 115.00 - 3BRANDY 115.00 OPEN BRANCH FROM BUS 314345 TO BUS 314743 CKT 1 /* 3MT RUN 115.00 - 3BRANDY 115.00 OPEN BRANCH FROM BUS 314345 TO BUS 314753 CKT 1 /* 3MT RUN 115.00 - 3CULPEPR 115.00 OPEN BRANCH FROM BUS 314753 TO BUS 314873 CKT 1 /* 3CULPEPR 115.00 - 3CULPE_1 115.00 OPEN BUS 314743 /* ISLAND: 3BRANDY 115.00 OPEN BUS 314753 /* ISLAND: 3CULPEPR 115.00 OPEN BUS 314873 /* ISLAND: 3CULPE_1 115.00 END

Affected Systems

10 Affected Systems

10.1 LG&E

None

10.2 MISO

None

10.3 TVA

None

10.4 Duke Energy Progress

None

10.5 NYISO

None

Short Circuit

11 Short Circuit

The following Breakers are overduty: none

Attachment 1

System Configuration