Generation Interconnection

System Impact Study Report

for

Queue Project AE1-056

RED HOUSE-SOUTH CREEK 115 KV

38.8 MW Capacity / 60 MW Energy

Revision 3 / April 2022

Revision 2 / January 2022

Revised December 2019

August, 2019

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1 Introduction

This System Impact Study (SIS) has been prepared in accordance with the PJM Open Access Transmission Tariff, 205, as well as the Feasibility Study Agreement between Caden Energix Spout Spring 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).

2 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 Interconnection Customer. As a requirement for interconnection, the Interconnection Customer 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 Interconnection Customer 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 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.

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 Revision 3 (April 2022) Summary

This revision is being issued to replace the previously identified network upgrade n6115 with the already approved supplemental project s2614. The scope of s2614 meets the intent of n6115 and addresses the identified overload. The New System Reinforcement table and cost tables were updated to reflect this change

4 Revision 2 (January 2022) Summary

This revision is being issued to incorporate results of a re-tool performed in January of 2022 and the Stability Analysis. No mitigations were found to be required related to project stability.

5 General

The IC has proposed a solar generating facility located in Appomattox County, Virginia. The installed facilities will have a capability of 60 MW with 38.8 MW of this output being recognized by PJM as Capacity. The proposed in-service date for the AE1-056 project is 12/15/2020. This study does not imply an ITO commitment to either in-service date.

Queue Number	**AE1-056**
Project Name	RED HOUSE-SOUTH CREEK 115 KV
Interconnection Customer	Caden Energix Spout Spring LLC
State	Virginia
County	Appomattox
Transmission Owner	Dominion
MFO	60
MWE	60
MWC	38.8
Fuel	Solar
Basecase Study Year	2022

5.1 Point of Interconnection

AE1-056 will interconnect with the Dominion transmission system via a new three breaker ring bus switching station that connects on the Red House DP – South Creek 115kV line near the South Creek 115 kV substation. See one line in **Attachment 1**.

5.2 Cost Summary

The AE1-056 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 1,550,000
Direct Connection Network Upgrade	$ 5,500,000
Non Direct Connection Network Upgrades	$ 1,000,000
Total Costs	**$ 8,050,000**

In addition, the AE1-056 project may be responsible for a contribution to the following costs

Description	Total Cost
Allocation for New System Upgrades	$ 0
Contribution for Previously Identified Upgrades	$ 0
Total Costs	$ **0**

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. The allocation of costs for a network upgrade 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.

6 Transmission Owner Scope of Work

6.1 Attachment Facilities

Generation Substation: Install metering and associated protection equipment. Estimated Cost is $550,000.

Transmission: Construct approximately one span of 115 kV Attachment line between the generation substation and a new AE1-056 Switching Station. The estimated cost for this work is $1,000,000.

The estimated total cost of the Attachment Facilities is $1,550,000. It is estimated to take 18-24 months to complete this work. These preliminary cost estimates are based on typical engineering costs. A more detailed engineering cost estimates are normally done when the IC provides an exact site plan location for the generation substation during the Facility Study phase. The total preliminary cost estimate for the Attachment work is given in the table below.

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

Description	Total Cost
Substation	$ 550,000
Transmission	$ 1,000,000
Total Attachment Facility Costs	**$ 1,550,000**

6.2 Direct Connection Cost Estimate

Substation: Establish the new 115 kV AE1-056 Switching Substation (interconnection substation). The estimated cost of this work scope is $5,500,000. It is estimated to take 24-36 months to complete this work.

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

Description	Total Cost
Substation	$ 5,500,000
Total Direct Connection Facility Costs	**$ 5,500,000**

6.3 Non-Direct Connection Cost Estimate

Transmission: Install transmission structure in-line with transmission line to allow the proposed interconnection switching station to be interconnected with the transmission system. Estimated cost is $1,000,000 and is estimated to take 24-30 months to complete.

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.

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
Transmission	$ 1,000,000
Remote Terminal Work	TBD in the Facilities Study
Total Non-Direct Connection Facility Costs	**$ 1,000,000**

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.

8.2 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 AE1-056 was evaluated as a 60.0 MW (Capacity 38.8 MW) injection at the South Creek 115kV substation in the Dominion area. Project AE1-056 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE1-056 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Load Flow

10 Generation Deliverability

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

None

11 Multiple Facility Contingency

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

None

12 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)

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
1	314702	3KERR	DVP	304102	3GW KING TAP	CPLE	1	DVP_P7-1: LN 22-90-A	tower	199.0	112.57	115.23	AC	6.41
2	314702	3KERR	DVP	304102	3GW KING TAP	CPLE	1	DVP_P4-6: CAROLIN T122	breaker	199.0	106.9	109.54	AC	6.49
3	314702	3KERR	DVP	304102	3GW KING TAP	CPLE	1	DVP_P7-1: LN 22-90-B	tower	199.0	101.37	104.03	AC	6.41

13 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
4	313867	6BREMODIST	DVP	314765	6MTEAGLE	DVP	1	DVP_P1-2: LN 2027-B	operation	662	88.95	91.39	AC	16.2
5	314559	3CAROLNA	DVP	314561	6CAROLNA	DVP	1	DVP_P1-3: 6CLUBHSE-TX#1	Operation	240	103.88	105.73	AC	4.59
6	314562	3CLUBHSE	DVP	314563	6CLUBHSE	DVP	1	DVP_P1-3: 6CAROLNA-TX#4	operation	183	130.72	132.76	AC	4.95
7	314562	3CLUBHSE	DVP	314563	6CLUBHSE	DVP	1	Base Case	operation	177	102.04	103.71	AC	4.19
8	314697	6SEDGE HILL	DVP	927250	AC1-221 TAP	DVP	1	DVP_P1-2: LN 556	operation	675	96.59	98.68	AC	14.12
9	314702	3KERR	DVP	304102	3GW KING TAP	CPLE	1	DVP_P1-2: LN 570	operation	199.0	97.27	99.21	AC	4.74
10	314747	6BREMO	DVP	313867	6BREMODIST	DVP	1	DVP_P1-2: LN 2027-B	Operation	662	91.15	93.59	AC	16.2
11	927250	AC1-221 TAP	DVP	304070	6PERSON230T	CPLE	1	DVP_P1-2: LN 556	operation	718.0	105.93	107.89	AC	14.12

14 System Reinforcements

ID	Facility	Upgrade Description	Network Upgrade Number	Cost	AE1-056 Allocation
1	3KERR-3GW KING TAP 115 kV line	This line is a joint tie line between the Dominion Energy and Duke/Progress transmission systems. **<u>Dominion:</u>** Rebuild approximately 4.7 miles Line #45 between Kerr Dam to Duke Interconnection with current 115kV standards construction practices (768 ACSS at 250 degree C). New rating: 393/393/452 MVA Expected in service date: 12/31/2022	s2614	$11,000,000	$0
		<u>Duke Energy / CPLE:</u> Duke/Progress Energy portion of this line will need to be studied under Duke's FERC tariff process: Project Id: dep0002 Project Description: Reconductor 20 miles with single 795 ACSS-TW per phase, replace breaker, disconnect switches, wave trap, line switches. Time Estimate: 48 Month Cost Estimate: $80,000,000 **Note 1: This is tie line between Duke Energy and Dominion.** **Note 2: Although Queue Project AE1-056 may not have cost responsibility for this upgrade, it may need this upgrade in-service to be deliverable to the PJM system. If Queue Project AE1-056 comes into service prior to completion of the upgrade, it will need an interim study.** **Note 3: The Duke/Progress Energy portion of this line is studied under Duke's FERC tariff process. Reference the applicable affected system study for the AE1 cluster**	Dep0002	$60,000,000	$0
		TOTAL COST		**$71,000,000**	**$0**

15 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.

15.1 Contingency Description

Contingency Name	Contingency Definition
DVP_P7-1: LN 22-90-A	CONTINGENCY 'DVP_P7-1: LN 22-90-A' OPEN BRANCH FROM BUS 314559 TO BUS 314571 CKT 1 /* 3CAROLNA 115.00 - 3EATON F 115.00 OPEN BRANCH FROM BUS 314571 TO BUS 925780 CKT 1 /* 3EATON F 115.00 - AC1-054 TAP 115.00 OPEN BUS 314571 /* ISLAND: 3EATON F 115.00 OPEN BRANCH FROM BUS 314265 TO BUS 314584 CKT 1 /* 3FIVEFORKSDP115.00 - 3LITTLTN 115.00 OPEN BRANCH FROM BUS 314265 TO BUS 314673 CKT 1 /* 3FIVEFORKSDP115.00 - 3PALMERSPRNG115.00 OPEN BRANCH FROM BUS 314559 TO BUS 314585 CKT 1 /* 3CAROLNA 115.00 - 3L GASTN 115.00 OPEN BRANCH FROM BUS 314584 TO BUS 314585 CKT 1 /* 3LITTLTN 115.00 - 3L GASTN 115.00 OPEN BUS 314265 /* ISLAND: 3FIVEFORKSDP115.00 OPEN BUS 314584 /* ISLAND: 3LITTLTN 115.00 OPEN BUS 314585 /* ISLAND: 3L GASTN 115.00 END
DVP_P4-6: CAROLIN T122	CONTINGENCY 'DVP_P4-6: CAROLIN T122' /* CAROLINA 115 KV OPEN BRANCH FROM BUS 314559 TO BUS 315126 CKT 1 /* 3CAROLNA 115.00 - 1ROARAP2 14.400 OPEN BRANCH FROM BUS 314559 TO BUS 315128 CKT 1 /* 3CAROLNA 115.00 - 1ROARAP4 14.400 OPEN BUS 315126 /* ISLAND: 1ROARAP2 14.400 OPEN BUS 315128 /* ISLAND: 1ROARAP4 14.400 OPEN BRANCH FROM BUS 314559 TO BUS 314571 CKT 1 /* 3CAROLNA 115.00 - 3EATON F 115.00 OPEN BRANCH FROM BUS 313722 TO BUS 314559 CKT 1 /* 3OCCONEECHEE115.00 - 3CAROLNA 115.00 OPEN BRANCH FROM BUS 314259 TO BUS 314559 CKT Z1 /* 3CAROL56_1 115.00 - 3CAROLNA 115.00 OPEN BRANCH FROM BUS 314559 TO BUS 314578 CKT 1 /* 3CAROLNA 115.00 - 3HORNRTN 115.00 OPEN BRANCH FROM BUS 314559 TO BUS 314585 CKT 1 /* 3CAROLNA 115.00 - 3L GASTN 115.00 OPEN BRANCH FROM BUS 314559 TO BUS 314600 CKT 1 /* 3CAROLNA 115.00 - 3PLHITP 115.00 OPEN BRANCH FROM BUS 314559 TO BUS 314561 CKT 1 /* 3CAROLNA 115.00 - 6CAROLNA 230.00 OPEN BUS 314559 /* 3CAROLNA 115.00 KV END

Contingency Name	Contingency Definition
DVP_P7-1: LN 22-90-B	CONTINGENCY 'DVP_P7-1: LN 22-90-B' OPEN BRANCH FROM BUS 925780 TO BUS 314702 CKT 1 /* AC1-054 TAP 115.00 - 3KERR 115.00 OPEN BRANCH FROM BUS 314265 TO BUS 314584 CKT 1 /* 3FIVEFORKSDP115.00 - 3LITTLTN 115.00 OPEN BRANCH FROM BUS 314265 TO BUS 314673 CKT 1 /* 3FIVEFORKSDP115.00 - 3PALMERSPRNG115.00 OPEN BRANCH FROM BUS 314559 TO BUS 314585 CKT 1 /* 3CAROLNA 115.00 - 3L GASTN 115.00 OPEN BRANCH FROM BUS 314584 TO BUS 314585 CKT 1 /* 3LITTLTN 115.00 - 3L GASTN 115.00 OPEN BUS 314265 /* ISLAND: 3FIVEFORKSDP115.00 OPEN BUS 314584 /* ISLAND: 3LITTLTN 115.00 OPEN BUS 314585 /* ISLAND: 3L GASTN 115.00 END
DVP_P1-2: LN 2027-B	CONTINGENCY 'DVP_P1-2: LN 2027-B' OPEN BRANCH FROM BUS 933500 TO BUS 314333 CKT 1 /* AC2-165 TAP 230.00 - 6POWHATN 230.00 OPEN BRANCH FROM BUS 314310 TO BUS 314322 CKT 1 /* 6JUDES F 230.00 - 6MDLTHAN 230.00 OPEN BRANCH FROM BUS 314310 TO BUS 314333 CKT 1 /* 6JUDES F 230.00 - 6POWHATN 230.00 OPEN BUS 314310 /* ISLAND: 6JUDES F 230.00 OPEN BUS 314333 /* ISLAND: 6POWHATN 230.00 END
DVP_P1-3: 6CLUBHSE-TX#1	CONTINGENCY 'DVP_P1-3: 6CLUBHSE-TX#1' OPEN BRANCH FROM BUS 314562 TO BUS 314563 CKT 1 /* 3CLUBHSE 115.00 - 6CLUBHSE 230.00 END
DVP_P1-3: 6CAROLNA-TX#4	CONTINGENCY 'DVP_P1-3: 6CAROLINA-TX#4' OPEN BRANCH FROM BUS 314559 TO BUS 314561 CKT 1 /* 3CLUBHSE 115.00 - 6CLUBHSE 230.00 END
DVP_P1-2: LN 556	CONTINGENCY 'DVP_P1-2: LN 556' OPEN BRANCH FROM BUS 314686 TO BUS 314906 CKT 1 /* 6CLOVER 230.00 - 8CLOVER 500.00 OPEN BRANCH FROM BUS 314686 TO BUS 314906 CKT 2 /* 6CLOVER 230.00 - 8CLOVER 500.00 OPEN BRANCH FROM BUS 314686 TO BUS 314906 CKT 3 /* 6CLOVER 230.00 - 8CLOVER 500.00 OPEN BRANCH FROM BUS 314906 TO BUS 314936 CKT 1 /* 8CLOVER 500.00 - 8RAWLINGS 500.00 OPEN BUS 314906 /* ISLAND: 8CLOVER 500.00 OPEN BUS 314915 /* ISLAND: 8CLOVER_STC 500.00 END
DVP_P1-2: LN 570	CONTINGENCY 'DVP_P1-2: LN 570' OPEN BRANCH FROM BUS 304183 TO BUS 918500 CKT 1 /* 8WAKE 500 TT500.00 - AA1-064 TAP 500.00 OPEN BRANCH FROM BUS 314935 TO BUS 918500 CKT 1 /* 8HERITAGE 500.00 - AA1-064 TAP 500.00 OPEN BUS 918500 /* ISLAND: AA1-064 TAP 500.00 END
Base Case	N/A

15.2 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
1	314702	3KERR	DVP	304102	3GW KING TAP	CPLE	1	DVP_P7-1: LN 22-90-A	tower	199.0	112.57	115.23	AC	6.41

Bus #	Bus	MW Impact
315158	*1KERR 1*	*0.8*
315159	*1KERR 2*	*3.27*
315160	*1KERR 3*	*3.22*
315161	*1KERR 4*	*3.22*
315162	*1KERR 5*	*3.22*
315163	*1KERR 6*	*3.22*
315164	*1KERR 7*	*3.22*
936261	*AD2-033 C*	*12.6*
936262	*AD2-033 E*	*8.4*
936361	*AD2-046 C O1*	*17.92*
936362	*AD2-046 E O1*	*8.24*
936481	*AD2-063 C O1*	*16.08*
936482	*AD2-063 E O1*	*10.72*
938371	*AE1-056 C*	*4.14*
938372	*AE1-056 E*	*2.26*
939181	*AE1-148 C O1*	*17.24*
939182	*AE1-148 E O1*	*11.49*
LTF	*BLUEG*	*1.95*
LTF	*CALDERWOOD*	*0.42*
LTF	*CANNELTON*	*0.13*
LTF	*CATAWBA*	*0.42*
LTF	*CBM-N*	*0.01*
LTF	*CHEOAH*	*0.39*
LTF	*COFFEEN*	*0.23*
LTF	*COTTONWOOD*	*1.38*
LTF	*DUCKCREEK*	*0.47*
LTF	*EDWARDS*	*0.21*
LTF	*FARMERCITY*	*0.17*
LTF	*G-007A*	*0.11*
LTF	*GIBSON*	*0.08*
LTF	*HAMLET*	*0.81*

Bus #	Bus	MW Impact
LTF	*NEWTON*	*0.6*
LTF	*NYISO*	*0.05*
LTF	*PRAIRIE*	*1.26*
LTF	*SMITHLAND*	*0.11*
LTF	*TATANKA*	*0.28*
LTF	*TILTON*	*0.25*
LTF	*TRIMBLE*	*0.21*
LTF	*TVA*	*1.16*
LTF	*UNIONPOWER*	*0.58*
LTF	*VFT*	*0.28*
924021	*AB2-043 C O1*	*0.65*
924022	*AB2-043 E O1*	*6.02*
924161	*AB2-060 C O1*	*1.84*
924162	*AB2-060 E O1*	*4.91*
924301	*AB2-077 C O1*	*0.42*
924302	*AB2-077 E O1*	*1.58*
924311	*AB2-078 C O1*	*0.42*
924312	*AB2-078 E O1*	*1.58*
924321	*AB2-079 C O1*	*0.42*
924322	*AB2-079 E O1*	*1.58*
925611	*AC1-036 C*	*0.15*
925612	*AC1-036 E*	*1.43*
925781	*AC1-054 C O1*	*15.6*
925782	*AC1-054 E O1*	*7.19*
926271	*AC1-105 C O1*	*2.87*
926272	*AC1-105 E O1*	*1.43*

Affected Systems

16 Affected Systems

16.1 Duke Energy Progress

Potential constraints were identified by PJM on the following Dominion – Duke Energy/Progress (DEP) tie lines. Duke/Progress Energy portion of this line will need to be studied under Duke's FERC tariff process.

The following facilities were identified in this report:

- Henderson-Kerr Dam 115 kV line

Short Circuit

17 Short Circuit

The following Breakers are overduty

None

Stability Analysis

18 Stability Analysis

18.1 Executive Summary

Generator Interconnection Request AE1-056 is for a 60 MW Maximum Facility Output (MFO) solar generation plant. AE1-056 consists of 28 x 2.163 MW SMA Sunny Central 2500-US 2.5 MVA solar inverters. The Point of Interconnection (POI) is a tap to be built on Red House DP to South Creek 115 kV circuit in the Dominion Virginia Power (DVP) transmission system, Appomattox County, Virginia.

This report describes a dynamic simulation analysis of AE1-056 as part of the overall system impact study.

The load flow scenario for the analysis was based on the RTEP 2022 peak load case, modified to include applicable queue projects. AE1-056 has been dispatched online at maximum power output, with 1.0 p.u. voltage at the generator bus.

AE1-056 was tested for compliance with NERC, PJM, Transmission Owner and other applicable criteria. Steady-state condition and 23 contingencies were studied, each with a 20 second simulation time period. Studied faults included:

a) Steady state operation (30 second);

b) Three phase faults with normal clearing time;

c) Single phase faults with stuck breaker;

d) Single-phase faults placed at 80% of the line with delayed (Zone 2) clearing at line end remote from the fault due to primary communications/relay failure;

No relevant bus fault, multiple-circuit tower line faults and high-speed reclosing (HSR) contingencies were identified for this study.

For all simulations, the queue project under study along with the rest of the PJM system were required to maintain synchronism and with all states returning to an acceptable new condition following the disturbance.

For all of the fault contingencies tested on the 2022 peak load case:

a) AE1-056 was able to ride through the faults (except for faults where protective action trips a generator(s)),

b) The system with AE1-056 included is transiently stable and post-contingency oscillations were positively damped with a damping margin of at least 3% for interarea modes and 4% for local modes.

c) Following fault clearing, all bus voltages recovered to a minimum of 0.7 per unit after 2.5 seconds (except where protective action isolates that bus).

d) No transmission element tripped, other than those either directly connected or designed to trip as a consequence of that fault.

Based on the Impact Study data provided, the reactive power capability of AE1-056 meets the 0.95 lagging and leading PF requirement at the high side of the main transformer.

Fictitious frequency response at AE1-056 POI tripped the Queue Project due to under-frequency during P1 fault application at Pamplin 115 kV Substation (P1.04 – P1.08). After the frequency protection was disabled at AE1-056 the tripping issues were resolved.

The initial results showed inadequate voltage recovery at AE1-056 POI, South Creek, Red House, and Pamplin 115 kV for contingencies P4.10 and P4.11. It was found that this was due to AE1-056 utilizing Q control rather than voltage control. Changing the control mode to voltage control resolved the voltage recovery issues.

With control mode changed to V control, a slower post fault reactive power recovery was observed for all contingencies. This does not affect the stability of the system and can be mitigated with further model tuning if required.

No mitigations were found to be required.

Attachment 1

System Configuration