



**Generation Interconnection
Feasibility Study Report
for
Queue Project AG1-023
NORTH ANNA-LOUISA 230 KV
15 MW Capacity / 75 MW Energy**

January 2021

Table of Contents

1	Introduction.....	4
2	Preface.....	4
3	General.....	5
4	Point of Interconnection.....	6
1.1	Primary Point of Interconnection	6
1.2	Secondary Point of Interconnection.....	6
5	Cost Summary	6
6	Transmission Owner Scope of Work.....	7
7	Schedule.....	8
8	Transmission Owner Analysis.....	8
A.	Power Flow Analysis	9
9	Interconnection Customer Requirements.....	9
	System Protection	9
	Compliance Issues and Interconnection Customer Requirements.....	9
	Power Factor Requirements	10
10	Revenue Metering and SCADA Requirements	10
10.1	PJM Requirements.....	10
10.2	Meteorological Data Reporting Requirements	10
10.3	Interconnected Transmission Owner Requirements.....	10
11	Summer Peak - Load Flow Analysis	11
11.1	Generation Deliverability	12
11.2	Multiple Facility Contingency	12
11.3	Contribution to Previously Identified Overloads.....	12
11.4	Potential Congestion due to Local Energy Deliverability.....	12
11.5	System Reinforcements - Summer Peak Load Flow - Primary POI.....	14
11.6	Flow Gate Details.....	15
11.6.1	Index 1	16
11.7	Queue Dependencies	17
11.8	Contingency Descriptions.....	18
12	Short Circuit Analysis.....	19
13	Affected Systems	20

13.1 TVA.....20

13.2 Duke Energy Progress.....20

14 Attachment 1: One Line Diagram21

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 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.

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 Solar generating facility located in Louisa County, Virginia. The installed facilities will have a total capability of 75 MW with 15 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is October 01, 2023. This study does not imply a TO commitment to this in-service date.

Queue Number	AG1-023
Project Name	NORTH ANNA-LOUISA 230 KV
State	Virginia
County	Louisa
Transmission Owner	Dominion
MFO	75
MWE	75
MWC	15
Fuel	Solar
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

1.1 Primary Point of Interconnection

AG1-023 "North Anna-Louisa 230 kV" will interconnect with the Dominion transmission system. The primary POI will be a newly constructed 230 kV three breaker ring bus located on the line between the North Anna substation and Louisa substation.

The IC is responsible for securing right-of-way, permits, and constructing the proposed attachment line from the generating facility site to the Point of Interconnection. The IC may not install any facilities on Dominion's right-of-way without first obtaining the necessary approval from Dominion Energy.

Attachment 1 shows a one-line diagram of the proposed interconnection facilities.

1.2 Secondary Point of Interconnection

There is no secondary point of interconnection specified for AG1-023.

5 Cost Summary

The AG1-023 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	\$10,400,000
Total System Network Upgrade Costs	\$11,150,000 ¹
Total Costs	\$21,550,000

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.

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.

6 Transmission Owner Scope of Work

The required Attachment Facilities, Direct Connection and Non-Direct Connection work for the interconnection of AG1-023 to the Dominion Transmission System is detailed in the following sections. The associated one-line showing the generation project attachment facilities and primary direct and non-direct connection is 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 phase. 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.

The total physical interconnection costs is given in the table below:

Description	Total Cost
Attachment Facilities	\$2,100,000
230 kV Three Breaker Ring-Bus Substation	\$6,500,000
Re-arrange line and tie-in new substation	\$1,800,000
Total Physical Interconnection Costs	\$10,400,000

AG1-023 "North Anna-Louisa 230 kV" will interconnect with the Dominion transmission system. The primary POI will be a newly constructed 230 kV three breaker ring bus located on the line between the North Anna substation and Louisa substation.

It is estimated to take 18-30 months to complete this work upon execution of an Interconnection Construction Service Agreement (ICSA). 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.

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.

7 Schedule

The estimated schedule for the Attachment Facilities, Direct Connection and Non-Direct Connection work is identified in the “Transmission Owner Scope of Work” section of this report.

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

These schedules will be more clearly identified in future study phases.

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 report¹.

8 Transmission Owner Analysis

Dominion assessed the impact of the proposed AG1-023 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.

A. 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

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.

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.

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 Meteorological Data Reporting Requirements

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

- Back Panel temperature (Fahrenheit) - (Required for plants with Maximum Facility Output of 3 MW or higher)
- Irradiance (Watts/meter²) - (Required for plants with Maximum Facility Output of 3 MW or higher)
- Ambient air temperature (Fahrenheit) - (Accepted, not required)
- Wind speed (meters/second) - (Accepted, not required)
- Wind direction (decimal degrees from true north) - (Accepted, not required)

10.3 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 AG1-023 was evaluated as a 75.0 MW (Capacity 15.0 MW) injection tapping the North Anna to Louisa 230 kV line in the Dominion area. Project AG1-023 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AG1-023 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)

None

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)

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CK T ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADIN G %	POST PROJECT LOADIN G %	AC D C	MW IMPAC T
16983365 1	96181 0	AG1-023 TAP	230. 0	DVP	31423 2	6NO ANNA	230. 0	DVP	1	DVP_P1 -2: LN 2088	single	749.17999267 6	133.6	135.6	DC	14.94

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.

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CK T ID	CONT NAME	Type	Rating MVA	PRE PROJEC T LOADIN G %	POST PROJEC T LOADIN G %	AC D C	MW IMPAC T
1693065 89	31474 5	6LOISAC T	230. 0	DVP	31475 8	6GORDNV L	230. 0	DVP	1	DVP_P 1-2: LN 255-E	operati on	1072.540039 06	112.98	119.95	DC	74.7
1634514 35	31491 8	8NO ANNA	500. 0	DVP	96284 0	AG1-133 TAP	500. 0	DVP	1	DVP_P 1-2: LN 573	operati on	3218.560058 59	138.38	138.78	DC	38.89
1634514 41	31491 8	8NO ANNA	500. 0	DVP	31493 4	8SPOTS YL	500. 0	DVP	1	DVP_P 1-2: LN 575-A	operati on	3218.560058 59	137.01	137.32	DC	33.36
1634513 82	31493 4	8SPOTS YL	500. 0	DVP	31491 6	8MORRSV L	500. 0	DVP	1	DVP_P 1-2: LN 575-A	operati on	3218.560058 59	144.08	144.42	DC	32.8
1698336 50	96181 0	AG1-023 TAP	230. 0	DVP	31423 2	6NO ANNA	230. 0	DVP	1	DVP_P 1-2: LN 2088	operati on	749.1799926 76	161.75	171.72	DC	74.7

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 LOADIN G %	POST PROJECT LOADIN G %	AC D C	MW IMPACT
163451429	962840	AG1-133 TAP	500.0	DVP	314911	8LADYSMI TH	500.0	DVP	1	DVP_P1-2: LN573	operati on	3218.56005859	136.92	137.6	DC	38.89

11.5 System Reinforcements - Summer Peak Load Flow - Primary POI

ID	Idx	Facility	Upgrade Description	Cost
169833651	1	AG1-023 TAP 230.0 kV - 6NO ANNA 230.0 kV Ckt 1	<u>DVP</u> dom-410 (453) : Rebuild 7.3 miles of 230 kV Line 255 from AG1-023 Tap to North Anna with 2-795 ACSR 150 C. Replace Wave Trap at North Anna terminal. Project Type : FAC Cost : \$11,150,000 Time Estimate : 30-36 Months	\$11,150,000
			TOTAL COST	\$11,150,000 ¹

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
169833651	961810	AG1-023 TAP	DVP	314232	6NO ANNA	DVP	1	DVP_P1-2: LN 2088	single	749.18	133.6	135.6	DC	14.94

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
315172	1LOISA A	12.1157	80/20	12.1157
315173	1LOISA B	12.1786	80/20	12.1786
315174	1LOISA C	12.1786	80/20	12.1786
315175	1LOISA D	12.1786	80/20	12.1786
315176	1LOISA E	24.8286	80/20	24.8286
315177	1S ANNAG1	9.1077	80/20	9.1077
315178	1S ANNAS1	4.6803	80/20	4.6803
315179	1S ANNAG2	9.1077	80/20	9.1077
315180	1S ANNAS2	4.6803	80/20	4.6803
925021	AB2-158 C	9.5857	80/20	9.5857
939231	AE1-154 C	9.9603	80/20	9.9603
944111	AF1-079 C	18.9246	80/20	18.9246
946371	AF1-301 C	75.6983	80/20	75.6983
957431	AF2-037 C	56.1761	80/20	56.1761
957691	AF2-063 C	89.6427	80/20	89.6427
961811	AG1-023 C	14.9405	80/20	14.9405
964421	AG1-305 C O1	70.5189	80/20	70.5189
CALDERWOOD	CALDERWOOD	0.1973	Confirmed LTF	0.1973
NY	NY	0.2195	Confirmed LTF	0.2195
PRAIRIE	PRAIRIE	1.0255	Confirmed LTF	1.0255
CHEOAH	CHEOAH	0.1987	Confirmed LTF	0.1987
COTTONWOOD	COTTONWOOD	0.8337	Confirmed LTF	0.8337
HAMLET	HAMLET	0.2293	Confirmed LTF	0.2293
GIBSON	GIBSON	0.2168	Confirmed LTF	0.2168
BLUEG	BLUEG	0.6892	Confirmed LTF	0.6892
TRIMBLE	TRIMBLE	0.2209	Confirmed LTF	0.2209
CATAWBA	CATAWBA	0.1389	Confirmed LTF	0.1389

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
AB2-158	Louisa-South Anna 230kV	Under Construction
AE1-154	Louisa-South Anna 230 kV	Engineering and Procurement
AF1-079	Louisa-South Anna 230 kV	Active
AF1-301	Louisa-South Anna 230 kV	Active
AF2-037	Louisa-North Anna 230 kV	Active
AF2-063	Louisa-North Anna 230 kV	Active
AG1-023	North Anna-Louisa 230 kV	Active
AG1-305	Louisa-North Anna 230 kV	Active

11.8 Contingency Descriptions

Contingency Name	Contingency Definition
DVP_P1-2: LN 2088	CONTINGENCY 'DVP_P1-2: LN 2088' OPEN BRANCH FROM BUS 314745 TO BUS 314758 CKT 1 /* 6LOISACT 230.00 - 6GORDNVL 230.00 END
DVP_P1-2: LN 575-A	CONTINGENCY 'DVP_P1-2: LN 575-A' OPEN BRANCH FROM BUS 314911 TO BUS 962840 CKT 1 /* 8LADYSMITH 500.00 - AG1-133 TAP 500.00 END
DVP_P1-2: LN 573	CONTINGENCY 'DVP_P1-2: LN 573' OPEN BRANCH FROM BUS 314918 TO BUS 314934 CKT 1 /* 8NO ANNA 500.00 - 8SPOTSYL 500.00 END
DVP_P1-2: LN 255-E	CONTINGENCY 'DVP_P1-2: LN 255-E' OPEN BRANCH FROM BUS 961810 TO BUS 314232 CKT 1 /* AG1-023 TAP 230.00 - 6LOUISA 230.00 END

12 Short Circuit Analysis

The following Breakers are overdutied:

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