



Generation Interconnection

Feasibility Study Report

for

Queue Project AF2-399

CREWE 12.5 KV

1.938 MW Capacity / 5.2 MW Energy

July 2020

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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 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 Nottoway County, Virginia. The installed facilities will have a total capability of 5.2 MW with 1.938 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is October 29, 2021. This study does not imply a TO commitment to this in-service date.

Queue Number	AF2-399
Project Name	CREWE 12.5 KV
State	Virginia
County	Nottoway
Transmission Owner	Dominion
MFO	5.2
MWE	5.2
MWC	1.938
Fuel	Solar
Basecase Study Year	2023

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

AF2-399 will interconnect with the Dominion distribution system. The POI is a single line tap on the distribution circuit 497 approximately 2.1 miles from its termination at the Crewe substation. This is the primary Point of Interconnection (POI) chosen by the IC with the ITO's transmission system. The IC is responsible for securing right-of-way, permits and constructing the proposed attachment line from the solar facility site to the proposed new substation. 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.

5 Cost Summary

The AF2-399 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	\$ To be provided in the two-party IA with ITO
Total System Network Upgrade Costs	\$ 200,000
Total Costs	\$ 200,000

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 88-129. 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

Dominion assessed the impact of the proposed Queue Project AF2-399 was evaluated as a 1.938 MW Capacity (5.2 MW Energy) injection at the AF2-399 12.5 kV substation in the Dominion Distribution System, for compliance with NERC Reliability Criteria on Dominion Transmission System. The system was assessed using the summer 2023 AF2 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 AF2-399 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.

7 Schedule

The schedule for the required Network Impact Reinforcements will be more clearly identified in future study phases. The estimate elapsed time to complete each of the required reinforcements is identified in the “System Reinforcements” section of the report.

8 Transmission Owner Analysis

8.1 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.

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 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 Meteorological Data Reporting Requirements

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

- Back panel temperature (Fahrenheit)
- Irradiance (Watts/meter²)
- 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

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>.

11 Summer Peak - Load Flow Analysis

The Queue Project AF2-399 was evaluated as a 5.2 MW (Capacity 1.9 MW) injection at the Crewe 115 kV substation in the Dominion area. Project AF2-399 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF2-399 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
97583617	924160	AB2-060 TAP	115.0	DVP	314267	3CHASCTY2	115.0	DVP	1	DVP_P4-2: 235T298	breaker	349.0	100.59	101.72	DC	3.93

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 PROJECT LOADIN G %	POST PROJECT LOADIN G %	AC D C	MW IMPAC T
97583971	314701	3LONEN	115.0	DVP	314707	3MORAN	115.0	DVP	1	DVP_P1-2: LN 98-C	operation	203.979995728	117.94	120.5	DC	5.22

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
97583987	314707	3MORAN	115.0	DVP	314691	3FARMVIL	115.0	DVP	1	DVP_P1-2: LN98-C	operation	203.979995728	115.74	118.29	DC	5.22

11.5 System Reinforcements - Summer Peak Load Flow - Primary POI

ID	Idx	Facility	Upgrade Description	Cost
97583617	1	AB2-060 TAP 115.0 kV - 3CHASCTY2 115.0 kV Ckt 1	<u>DVP</u> dom-151 (1203) : Replace circuit breaker switch at Chase City Project Type : FAC Cost : \$200,000 Time Estimate : 30-36 Months	\$200,000
			TOTAL COST	\$200,000

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
97583617	924160	AB2-060 TAP	DVP	314267	3CHASCTY2	DVP	1	DVP_P4-2:235T298	breaker	349.0	100.59	101.72	DC	3.93

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
313853	3PONTONDP	0.4144	50/50	0.4144
314429	3JTRSVLE	1.6576	50/50	1.6576
924161	AB2-060 C OP	9.3045	50/50	9.3045
924162	AB2-060 E OP	25.3842	50/50	25.3842
925611	AC1-036 C	0.9854	50/50	0.9854
925612	AC1-036 E	1.6078	50/50	1.6078
925831	AC1-062	0.2461	50/50	0.2461
935221	AD1-157 C	3.3619	50/50	3.3619
935222	AD1-157 E	2.2413	50/50	2.2413
936261	AD2-033 C	69.4434	50/50	69.4434
936262	AD2-033 E	46.2956	50/50	46.2956
938371	AE1-056 C	14.4937	50/50	14.4937
938372	AE1-056 E	7.9193	50/50	7.9193
940241	AE2-006	0.5014	50/50	0.5014
942461	AE2-259 C O1	30.9984	50/50	30.9984
942462	AE2-259 E O1	20.6656	50/50	20.6656
946301	AF1-294 C	18.4689	50/50	18.4689
946302	AF1-294 E	12.3126	50/50	12.3126
958211	AF2-115 C	11.2616	50/50	11.2616
958212	AF2-115 E	7.5077	50/50	7.5077
958801	AF2-171 C O1	28.6200	50/50	28.6200
958802	AF2-171 E O1	19.0800	50/50	19.0800
959311	AF2-222 C	19.4010	50/50	19.4010
959312	AF2-222 E	12.9987	50/50	12.9987
961081	AF2-399 C	1.4591	50/50	1.4591
961082	AF2-399 E	2.4670	50/50	2.4670
NEWTON	NEWTON	0.0376	Confirmed LTF	0.0376
FARMERCITY	FARMERCITY	0.0020	Confirmed LTF	0.0020
CALDERWOOD	CALDERWOOD	0.0174	Confirmed LTF	0.0174
NY	NY	0.0194	Confirmed LTF	0.0194
PRAIRIE	PRAIRIE	0.0904	Confirmed LTF	0.0904
O-066	O-066	0.2352	Confirmed LTF	0.2352
CHEOAH	CHEOAH	0.0175	Confirmed LTF	0.0175
EDWARDS	EDWARDS	0.0122	Confirmed LTF	0.0122
TILTON	TILTON	0.0220	Confirmed LTF	0.0220
G-007	G-007	0.0364	Confirmed LTF	0.0364
GIBSON	GIBSON	0.0191	Confirmed LTF	0.0191
BLUEG	BLUEG	0.0608	Confirmed LTF	0.0608
TRIMBLE	TRIMBLE	0.0195	Confirmed LTF	0.0195
CATAWBA	CATAWBA	0.0122	Confirmed LTF	0.0122

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
AB2-060	Chase City-Lunenburg 115kV	Under Construction
AC1-036	Twittys Creek 34.5kV	Engineering and Procurement
AC1-062	Jetersville 34.5kV	In Service
AD1-157	South Creek 34.5 kV	Engineering and Procurement
AD2-033	Chase City-Lunenburg 115 kV	Active
AE1-056	Red House-South Creek 115 kV	Active
AE2-006	Twittys Creek 34.5 kV	Engineering and Procurement
AE2-259	Curdsville-Willis Mtn 115 kV	Active
AF1-294	Jetersville-Ponton 115 kV	Active
AF2-115	Jetersville-Ponton 115 kV	Active
AF2-171	Madisonville 115 kV	Active
AF2-222	Pamplin-Chase City 115 kV	Active
AF2-399	Crewe 12.5 kV	Active

11.8 Contingency Descriptions

Contingency Name	Contingency Definition
DVP_P4-2: 235T298	CONTINGENCY 'DVP_P4-2: 235T298' /* FARMVILLE 230 KV OPEN BRANCH FROM BUS 313802 TO BUS 314268 CKT 1 /* 6PRINCE EDW 230.00 - 6BRIERY 230.00 OPEN BRANCH FROM BUS 313802 TO BUS 314692 CKT 1 /* 6PRINCE EDW 230.00 - 6FARMVIL 230.00 OPEN BRANCH FROM BUS 314268 TO BUS 934620 CKT 1 /* 6BRIERY 230.00 - AD1- 088 TAP 230.00 OPEN BRANCH FROM BUS 314691 TO BUS 314692 CKT 1 /* 3FARMVIL 115.00 - 6FARMVIL 230.00 OPEN BUS 313802 /* ISLAND: 6PRINCE EDW 230.00 OPEN BUS 314268 /* ISLAND: 6BRIERY 230.00 OPEN BRANCH FROM BUS 314677 TO BUS 314692 CKT 1 /* 6BUCKING 230.00 - 6FARMVIL 230.00 OPEN BRANCH FROM BUS 314677 TO BUS 314747 CKT 1 /* 6BUCKING 230.00 - 6BREMO 230.00 OPEN BRANCH FROM BUS 314691 TO BUS 314692 CKT 2 /* 3FARMVIL 115.00 - 6FARMVIL 230.00 OPEN BUS 314677 /* ISLAND: 6BUCKING 230.00 OPEN BUS 924032 /* ISLAND: AB2-045 E 230.00 OPEN BUS 932511 /* ISLAND: AC2-071 C 230.00 OPEN BUS 932512 /* ISLAND: AC2-071 E 230.00 END
DVP_P1-2: LN 98-C	CONTINGENCY 'DVP_P1-2: LN 98-C' OPEN BRANCH FROM BUS 924160 TO BUS 314267 CKT 1 /* AB2-060 TAP 115.00 - 3CHASCTY2 115.00 END

12 Short Circuit Analysis

Short circuit analysis will be provided in the System Impact Study report.

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