



**Generation Interconnection
Feasibility Study Report
for
Queue Project AF2-091
OAK GROVE-DAHLGREN 230 KV
14.3 MW Capacity / 34 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.

An Interconnection Customer with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

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 an uprate to a planned Solar generating facility located in King George, Virginia. This project is an increase to the Interconnection Customer's AF1-114 project, which will share

the same point of interconnection. The AF2-091 queue position is a 34 MW uprate (14.3 MW Capacity uprate) to the previous project. The total installed facilities will have a capability of 134 MW with 56.3 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this uprate project is November 30, 2021. This study does not imply a TO commitment to this in-service date.

Queue Number	AF2-091
Project Name	OAK GROVE-DAHLGREN 230 KV
State	Virginia
County	King George
Transmission Owner	Dominion
MFO	134
MWE	34
MWC	14.3
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

AF2-091 will interconnect with the Dominion transmission system as an uprate to AF1-114 which is tapping the Oak Grove to Dahlgren 230 kV line.

5 Cost Summary

The AF2-091 project will utilize the interconnection facilities being developed under the AF1-114 project.

The AF2-091 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	\$ 0
Total System Network Upgrade Costs	\$ 2,460,000
Total Costs	\$ 2,460,000

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 AF2-091 was evaluated as a 14.28 MW Capacity (34.0 MW Energy) injection at the AF1-114 230 kV substation in the Dominion Transmission 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.

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.

10.1.1 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)

10.2 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 AF2-091 was evaluated as a 34.0 MW (Capacity 14.3 MW) injection as an uprate to AF1-114 which is tapping the Oak Grove to Dahlgren 230 kV line in the Dominion area. Project AF2-091 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF2-091 was studied with a commercial probability of 53%. 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 LOADING %	POST PROJECT LOADING %	AC D C	MW IMPACT
97173417	31386	3GREYSPT	115.0	DVP	314174	3HARMONY	115.0	DVP	1	DVP_P4-2: 2083T2090	breaker	169.0	105.71	109.4	DC	6.23

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 LOADING %	POST PROJECT LOADING %	AC D C	MW IMPACT
97173722	313886	3GREYSPT	115.0	DVP	314174	3HARMONY	115.0	DVP	1	DVP_P 1-2: LN 2083	operation	138.179992676	129.22	133.72	DC	6.23
97925373	314105	6AQUIA	230.0	DVP	314186	6FULLER ROAD	230.0	DVP	1	DVP_P 1-2: LN 2089	operation	678.679992676	105.42	107.05	DC	11.07
97925376	314132	6BIRCHWD	230.0	DVP	314163	6FINES	230.0	DVP	1	DVP_P 1-2: LN 224	operation	548.020019531	98.74	103.32	DC	28.1
97925204	314134	6CRANES	230.0	DVP	314142	6STAFORD	230.0	DVP	1	DVP_P 1-2: LN 2089	operation	678.679992676	130.56	132.19	DC	11.07
97925315	314142	6STAFORD	230.0	DVP	314145	6AQUI_HAR B_B	230.0	DVP	1	DVP_P 1-2: LN 2089	operation	678.679992676	115.35	116.98	DC	11.07

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 PROJE CT LOADI NG %	POST PROJE CT LOADI NG %	AC D C	MW IMPA CT
97925354	314144	6AQUI_HARB_A	230.0	DVP	314105	6AQUIA	230.0	DVP	1	DVP_P1-2: LN2089	operati on	678.679992676	109.09	110.72	DC	11.07
97925088	314172	6DUNNSVL	230.0	DVP	314388	6LANEXA	230.0	DVP	1	DVP_P1-2: LN2083	operati on	362.839996338	130.28	137.92	DC	27.72
97925036	314182	6NORNECK	230.0	DVP	314172	6DUNNSVL	230.0	DVP	1	DVP_P1-2: LN2083	operati on	362.839996338	135.3	142.94	DC	27.72
97925384	314186	6FULLERROAD	230.0	DVP	314074	6POSSUM	230.0	DVP	1	DVP_P1-2: LN2089	operati on	678.679992676	103.55	105.18	DC	11.07
97173717	314191	3WHITSTONE	115.0	DVP	313870	3RAPPHNCK	115.0	DVP	1	DVP_P1-2: LN2083	operati on	138.179992676	129.29	133.8	DC	6.23
97173794	936590	AD2-074 TAP	115.0	DVP	314178	3LANCAST	115.0	DVP	1	DVP_P1-2: LN2083	operati on	203.979995728	114.01	117.06	DC	6.23

11.5 System Reinforcements - Summer Peak Load Flow - Primary POI

ID	Idx	Facility	Upgrade Description	Cost
97173417	1	3GREYSPT 115.0 kV - 3HARMONY 115.0 kV Ckt 1	DVP dom-204 (1303) : Reconductor 4.1 miles of 115 kV Line 65 from Grey Spt to Harmony with 636 ACSR. Project Type : FAC Cost : \$2,460,000 Time Estimate : 30-36 Months	\$2,460,000
TOTAL COST				\$2,460,000

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
97173417	313886	3GREYSPT	DVP	314174	3HARMONY	DVP	1	DVP_P4-2: 2083T2090	breaker	169.0	105.71	109.4	DC	6.23

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
314131	6ARNOLDS	0.2876	50/50	0.2876
314190	6WESTMOR	0.4171	50/50	0.4171
315033	1BIRCHWDA	7.5210	50/50	7.5210
315034	1NORNECKC1	1.1908	50/50	1.1908
315035	1NORNECKC2	1.1478	50/50	1.1478
925861	AC1-065 C	-1.4054	Adder	-1.65
926472	AC1-118 E	1.2458	50/50	1.2458
932831	AC2-110 C	-0.5621	Adder	-0.66
932832	AC2-110 E	-0.9172	Adder	-1.08
933271	AC2-138 C	1.3308	50/50	1.3308
933272	AC2-138 E	1.6635	50/50	1.6635
934191	AD1-046 C	5.6242	50/50	5.6242
934192	AD1-046 E	3.7556	50/50	3.7556
934392	AD1-063 E	-0.2914	Adder	-0.34
936242	AD2-030 E	-0.8015	Adder	-0.94
936301	AD2-039 C	-0.5621	Adder	-0.66
936302	AD2-039 E	-0.9172	Adder	-1.08
936341	AD2-044 C	0.4159	50/50	0.4159
936342	AD2-044 E	0.4713	50/50	0.4713
936581	AD2-073 C	2.4402	50/50	2.4402
936582	AD2-073 E	1.2091	50/50	1.2091
936591	AD2-074 C	16.3380	50/50	16.3380
936592	AD2-074 E	26.6568	50/50	26.6568
938031	AE1-004 C	-0.5621	Adder	-0.66
938961	AE1-124 C	2.4366	50/50	2.4366
938962	AE1-124 E	1.2274	50/50	1.2274
939241	AE1-155 C	40.1817	50/50	40.1817
939242	AE1-155 E	26.7878	50/50	26.7878
940552	AE2-041 BAT	2.2856	Merchant Transmission	2.2856
943472	AF1-018 BAT	2.2856	Merchant Transmission	2.2856
943741	AF1-042 C	8.5490	50/50	8.5490
943742	AF1-042 E	13.9483	50/50	13.9483
944491	AF1-114 C	7.6944	50/50	7.6944
944492	AF1-114 E	10.6256	50/50	10.6256
945831	AF1-248	0.5822	50/50	0.5822
957191	AF2-013	18.3200	50/50	18.3200
957971	AF2-091 C	2.6161	50/50	2.6161
957972	AF2-091 E	3.6127	50/50	3.6127
958261	AF2-120 C	16.7199	50/50	16.7199
958262	AF2-120 E	11.1466	50/50	11.1466
NEWTON	NEWTON	0.0365	Confirmed LTF	0.0365
FARMERCITY	FARMERCITY	0.0020	Confirmed LTF	0.0020

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
CALDERWOOD	CALDERWOOD	0.0209	Confirmed LTF	0.0209
NY	NY	0.0116	Confirmed LTF	0.0116
PRAIRIE	PRAIRIE	0.0904	Confirmed LTF	0.0904
O-066	O-066	0.1344	Confirmed LTF	0.1344
CHEOAH	CHEOAH	0.0210	Confirmed LTF	0.0210
EDWARDS	EDWARDS	0.0116	Confirmed LTF	0.0116
TILTON	TILTON	0.0208	Confirmed LTF	0.0208
G-007	G-007	0.0208	Confirmed LTF	0.0208
GIBSON	GIBSON	0.0180	Confirmed LTF	0.0180
BLUEG	BLUEG	0.0573	Confirmed LTF	0.0573
TRIMBLE	TRIMBLE	0.0184	Confirmed LTF	0.0184
CATAWBA	CATAWBA	0.0182	Confirmed LTF	0.0182

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
AC1-065	Harmony Village-Shackleford 115kV	Engineering and Procurement
AC1-118	Westmoreland 34.5kV	In Service
AC2-110	Harmony Village-Shackleford 115kV	Engineering and Procurement
AC2-138	Northern Neck 34.5kV	Under Construction
AD1-046	Oak Grove 34.5 kV III	Engineering and Procurement
AD1-063	Harmony Village 34.5 kV	In Service
AD2-030	Wan 34.5 kV	In Service
AD2-039	Harmony Village-Shackleford 115 kV	Engineering and Procurement
AD2-044	Northern Neck 34.5 kV	Under Construction
AD2-073	Sanders DP 230 kV	Active
AD2-074	Garner DP-Lancaster 115 kV	Active
AE1-004	Harmony Village-Shackleford 115 kV	Engineering and Procurement
AE1-124	Oak Grove 34.5 kV	Engineering and Procurement
AE1-155	Garner-Northern Neck 115 kV	Active
AE2-041	Harmony Village 230 kV	Active
AF1-018	Harmony Village 230 kV	Active
AF1-042	Garner DP-Lancaster 115 kV	Active
AF1-114	Oak Grove-Dahlgren 230 kV	Active
AF1-248	Northern Neck 34.5 kV	Engineering and Procurement
AF2-013	Arnold's Corner-Dahlgren 230 kV	Active
AF2-091	Oak Grove-Dahlgren 230 kV	Active
AF2-120	Garner-Northern Neck 115 kV	Active

11.8 Contingency Descriptions

Contingency Name	Contingency Definition
DVP_P1-2: LN 2089	CONTINGENCY 'DVP_P1-2: LN 2089' OPEN BRANCH FROM BUS 314196 TO BUS 314197 CKT 1 /* GLADYSMITH 230.00 - 6LDYSMITH CT230.00 END

Contingency Name	Contingency Definition
DVP_P1-2: LN 2083	CONTINGENCY 'DVP_P1-2: LN 2083' OPEN BRANCH FROM BUS 314132 TO BUS 314163 CKT 1 /* 6BIRCHWD 230.00 - 6FINES 230.00 OPEN BRANCH FROM BUS 314137 TO BUS 314163 CKT 1 /* 6FREDBRG 230.00 - 6FINES 230.00 OPEN BUS 314163 /* ISLAND: 6FINES 230.00 END
DVP_P1-2: LN 224	CONTINGENCY 'DVP_P1-2: LN 224' OPEN BRANCH FROM BUS 314172 TO BUS 314182 CKT 1 /* 6DUNNSVL 230.00 - 6NORNECK 230.00 OPEN BRANCH FROM BUS 314172 TO BUS 314388 CKT 1 /* 6DUNNSVL 230.00 - 6LANEXA 230.00 OPEN BUS 314172 /* ISLAND: 6DUNNSVL 230.00 END
DVP_P4-2: 2083T2090	CONTINGENCY 'DVP_P4-2: 2083T2090' /* FREDERICKSBURG 230 KV OPEN BRANCH FROM BUS 314132 TO BUS 314163 CKT 1 /* 6BIRCHWD 230.00 - 6FINES 230.00 OPEN BRANCH FROM BUS 314137 TO BUS 314163 CKT 1 /* 6FREDBRG 230.00 - 6FINES 230.00 OPEN BUS 314163 /* ISLAND: 6FINES 230.00 OPEN BRANCH FROM BUS 313837 TO BUS 314138 CKT 1 /* 6SUMMIT 230.00 - 6MINE RD 230.00 OPEN BRANCH FROM BUS 313837 TO BUS 314197 CKT 1 /* 6SUMMIT 230.00 - 6LDYSMITH CT230.00 OPEN BRANCH FROM BUS 314137 TO BUS 314138 CKT 1 /* 6FREDBRG 230.00 - 6MINE RD 230.00 OPEN BUS 313837 /* ISLAND: 6SUMMIT 230.00 OPEN BUS 314138 /* ISLAND: 6MINE RD 230.00 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).

Attachment 1: One Line Diagram