Attachment C – Interconnection Studies

- Generation Interconnection Feasibility Study Report for Queue Position AD2-074
- System Impact Study Report for Queue Position AD2-074
- Generation Interconnection Feasibility Study Report for Queue Position AF1-042
- System Impact Study Report for Queue Position AF1-042
- Generation Interconnection Facility Study Report for PJM Generation Interconnection Request Queue Position AD2-074 & AF1-042

Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AD2-074

Garner DP – Lancaster 115kV
32.7 MW Capacity / 86 MW Energy

September / 2018

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 Virginia Electric and Power Company (VEPCO).

Preface

The intent of the Feasibility Study is to determine a plan, with high level estimated cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the IC. The IC may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the IC 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. 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 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 IC is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by ITO, the costs may be included in the study.

General

The IC has proposed a solar generating facility located in Lancaster County, VA. The installed facilities will have a total capability of 86 MW with 32.7 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is 11/30/2021. **This study does not imply an ITO commitment to this in-service date.**

Point of Interconnection

AD2-074 will interconnect with the ITO transmission system via a new three breaker ring bus switching station that connects on the Garner DP – Lancaster 115kV line # 65.

Cost Summary

The AD2-074 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$1,550,000
Direct Connection Network Upgrades	$5,500,000
Non Direct Connection Network Upgrades	$ 800,000
Total Costs	**$7,850,000**

In addition, the AD2-074 project may be responsible for a contribution to the following costs:

Description	Total Cost
New System Upgrades	$0
Previously Identified Upgrades	$17,500,000
Total Costs	**$17,500,000**

Cost allocations for these upgrades will be provided in the System Impact Study Report.

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. For New System Upgrades, 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.

The Feasibility Study is used to make a preliminary determination of the type and scope of Attachment Facilities, Local Upgrades, and Network Upgrades that will be necessary to accommodate the Interconnection Request and to provide the Interconnection Customer a preliminary estimate of the time that will be required to construct any necessary facilities and upgrades and the Interconnection Customer's cost responsibility. The System Impact Study provides refined and comprehensive estimates of cost responsibility and construction lead times for new facilities and system upgrades. Facilities Studies will include, commensurate with the degree of engineering specificity as provided in the Facilities Study Agreement, good faith estimates of the cost, determined in accordance with Section 217 of the Tariff,

(a) to be charged to each affected New Service Customer for the Facilities and System Upgrades that are necessary to accommodate this queue project;
(b) the time required to complete detailed design and construction of the facilities and upgrades; and
(c) a description of any site-specific environmental issues or requirements that could reasonably be anticipated to affect the cost or time required to complete construction of such facilities and upgrades.

Attachment Facilities

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

Transmission: Construct approximately one span of 115 kV Attachment line between the generation substation and a new AD2-074 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. These costs do not include CIAC Tax Gross-up. The single line is shown below in Attachment 1.

Direct Connection Cost Estimate

Substation: Establish the new 115 kV AD2-074 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.

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 $800,000 dollars 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.

System Reinforcement

Violation #	Upgrade Description	Upgrade Cost
# 1	Replace the Elmont 500/230 kV transformer #1 increase its line rating to 1134 MVA (normal), 1203 MVA (emergency), and 1365 MVA (load dump). It is estimated to take 24-30 months to engineer and construct.	**$17,500,000**
	Total Network Upgrades	**$17,500,000**

Interconnection Customer Requirements

ITO's Facility Connection Requirements as posted on PJM's website
http://www.pjm.com/~/media/planning/plan-standards/private-dominion/facility-connection-requirements1.ashx

Voltage Ride Through Requirements - The Customer Facility shall be designed to remain in service (not trip) for voltages and times as specified for the Eastern Interconnection in Attachment 1 of NERC Reliability Standard PRC-024-1, and successor Reliability Standards, for both high and low voltage conditions, irrespective of generator size, subject to the permissive trip exceptions established in PRC-024-1 (and successor Reliability Standards).

Frequency Ride Through Requirements - The Customer Facility shall be designed to remain in service (not trip) for frequencies and times as specified in Attachment 2 of NERC Reliability Standard PRC-024-1, and successor Reliability Standards, for both high and low frequency condition, irrespective of generator size, subject to the permissive trip exceptions established in PRC-024-1 (and successor Reliability Standards).

Reactive Power - The Generation Interconnection Customer shall design its non-synchronous Customer Facility with the ability to maintain a power factor of at least 0.95 leading to 0.95 lagging measured at the generator's terminals.

Revenue Metering and SCADA Requirements

PJM Requirements

The IC 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 Sections 24.1 and 24.2.

Meteorological Data Reporting Requirement

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

- Temperature (degrees Fahrenheit)
- Atmospheric pressure (hectopascals)
- Irradiance
- Forced outage data

Network Impacts

The Queue Project AD2-074 was evaluated as a 86.0 MW (Capacity 32.7 MW) injection at tap of the Garner DP - Lancaster 115kV line in the VAP area. Project AD2-074 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD2-074 was studied with a commercial probability of 53%. Potential network impacts were as follows:

PJM assessed the impact of the proposed Queue Project as an injection into the ITO, for compliance with NERC Reliability Criteria. The system was assessed using the summer 2021 RTEP case. When performing analysis, ITO Criteria considers a transmission facility overloaded if it exceeds 94% of its emergency rating under single contingency (normal and stressed system conditions). A full listing of the ITO's Planning Criteria and interconnection requirements can be found in the ITO's Facility Connection Requirements which are publicly available at: http://www.dom.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 NERC Category C Contingency Conditions (Bus Fault, Tower Line, N-1-1, and Stuck Breaker scenarios) allow for re-dispatch of generating units to resolve potential reliability deficiencies. For ITO 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 results of these studies are discussed in more detail below.

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
DVP_P4-2: H2T557	CONTINGENCY 'DVP_P4-2: H2T557' /* ELMONT OPEN BRANCH FROM BUS 314908 TO BUS 314903 CKT 1 /*ELMONT TO CHICKAHOMINY (LINE 557) OPEN BRANCH FROM BUS 314903 TO BUS 314214 CKT 1 /*CHICKAHOMINY 500-230 (TX#1) OPEN BRANCH FROM BUS 314908 TO BUS 314218 CKT 2 /*ELMONT 500-230 (TX#2) END

Summer Peak Analysis - 2021

Generator Deliverability

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

None

Multiple Facility Contingency

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

None

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

None

Contributions to previously identified circuit breakers found to be over-duty:

None

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)

	Contingency		Affected		Bus			Power	Loading %		Rating		MW	
#	Type	Name	Area	Facility Description	From	To	Cir.	Flow	Initial	Final	Type	MVA	Contribution	Ref
1	LFFB	DVP_P4-2: H2T557	DVP - DVP	8ELMONT 500/230 kV transformer	314218	314908	1	DC	148.7	149.31	LDR	1051	17.24	1

Steady-State Voltage Requirements

(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

To be determined during Impact Study

Stability and Reactive Power Requirement for Low Voltage Ride Through

(Summary of the VAR requirements based upon the results of the dynamic studies)

To be determined during Impact Study

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)

None

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
# 1	8ELMONT 500/230 kV transformer	Replace the Elmont 500/230 kV transformer #1 increase its line rating to 1134 MVA (normal), 1203 MVA (emergency), and 1365 MVA (load dump). It is estimated to take 24-30 months to engineer and construct.	Pending	**$17,500,000**
			Total New Network Upgrades	**$17,500,000**

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 IC 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.

None

Light Load Analysis

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

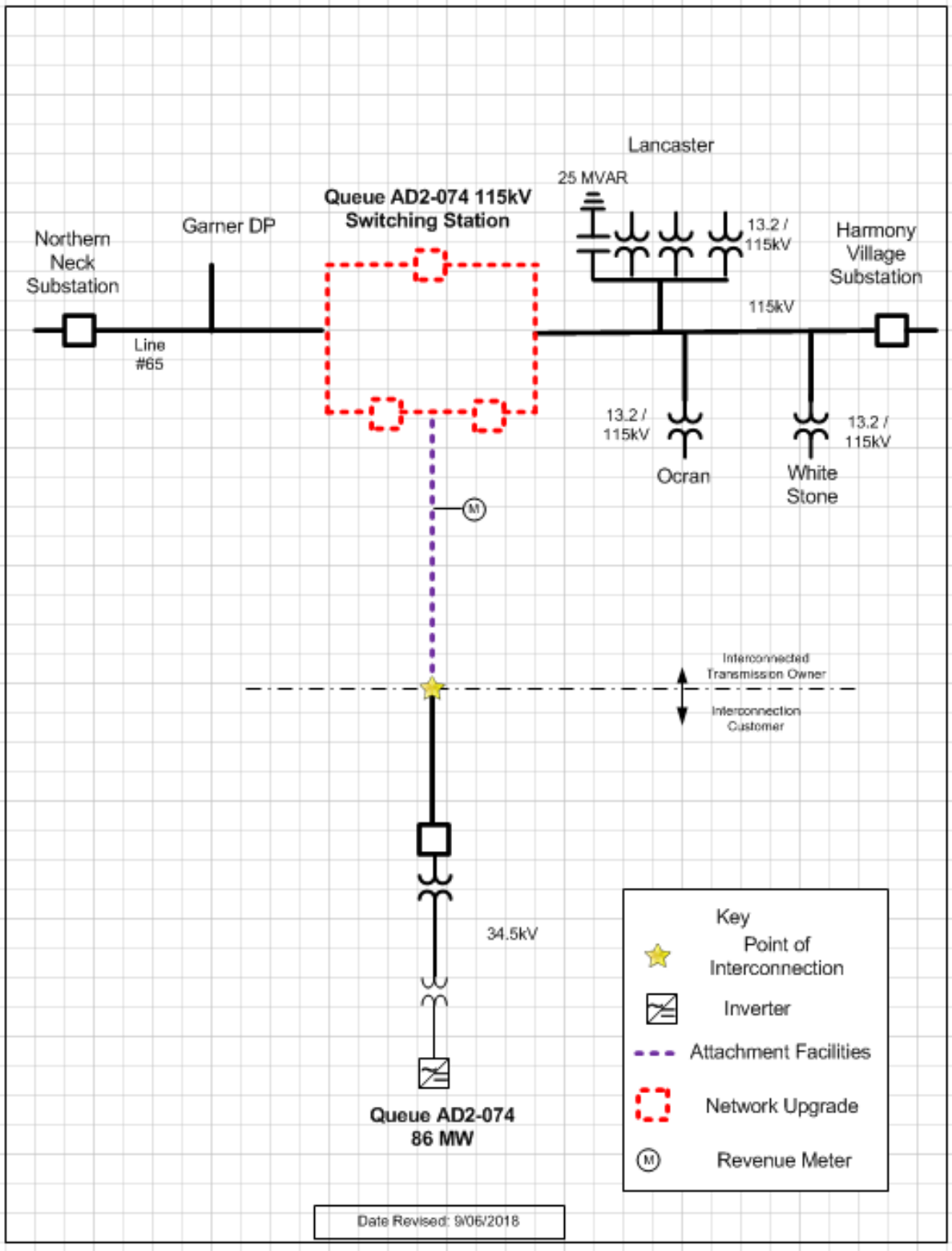
Affected System Analysis & Mitigation

Duke, Progress & TVA Impacts:

Duke Carolina, Progress, & TVA Impacts to be determined during later study phases (as applicable).

Attachment 1.

System Configuration



Attachment 2.

Flowgate Appendices – Option 1

Appendices

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. When a flowgate is identified in multiple analysis the appendix is presented for only the analysis with the greatest overload.

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.

Appendix 1

(DVP - DVP) The 8ELMONT 500/230 kV transformer (from bus 314218 to bus 314908 ckt 1) loads from 148.7% to 149.31% (**DC power flow**) of its load dump rating (1051 MVA) for the line fault with failed breaker contingency outage of 'DVP_P4-2: H2T557'. This project contributes approximately 17.24 MW to the thermal violation.

CONTINGENCY 'DVP_P4-2: H2T557' /* ELMONT
OPEN BRANCH FROM BUS 314908 TO BUS 314903 CKT 1 /*ELMONT TO CHICKAHOMINY (LINE 557)
OPEN BRANCH FROM BUS 314903 TO BUS 314214 CKT 1 /*CHICKAHOMINY 500-230 (TX#1)
OPEN BRANCH FROM BUS 314908 TO BUS 314218 CKT 2 /*ELMONT 500-230 (TX#2)
END

Bus Number	Bus Name	Full Contribution
315053	1BELMED1	25.65
315054	1BELMED2	25.65
315055	1BELMED3	21.29
315058	1CHESTF3	27.15
315059	1CHESTF4	44.01
315067	1DARBY 1	4.73
315068	1DARBY 2	4.74
315069	1DARBY 3	4.76
315070	1DARBY 4	4.76
315043	1FOUR RIVERA	6.29
315044	1FOUR RIVERB	4.87
315045	1FOUR RIVERC	6.29
315046	1FOUR RIVERD	4.87
315047	1FOUR RIVERE	4.87
315048	1FOUR RIVERF	6.29
315074	1HOPCGN1	11.32
315075	1HOPCGN2	11.17
315083	1SPRUNCA	14.99
315084	1SPRUNCB	14.99
315085	1SPRUNCC	11.11
315086	1SPRUNCD	11.11
315073	1STONECA	9.38
315090	1YORKTN1	31.04
315091	1YORKTN2	32.21
314566	3CRESWEL	2.12
314572	3EMPORIA	0.36
314315	3LOCKS E	1.66

314617	3TUNIS	0.72
314539	3UNCAMP	2.2
314541	3WATKINS	0.62
314620	6CASHIE	0.72
314229	6MT RD221	1.41
314236	6NRTHEST	0.35
314189	6PAPERMILL	8.84
314594	6PLYMOTH	0.74
314250	6ROCKVILLE	0.38
314256	6ROCKVILLE E	1.16
314648	6SUNBURY	0.81
314651	6WINFALL	1.6
932041	AC2-012 C	9.66
932042	AC2-012 E	15.76
932501	AC2-070 C	2.91
932502	AC2-070 E	1.2
932531	AC2-073 C	3.11
932532	AC2-073 E	1.57
932581	AC2-078 C	4.77
932582	AC2-078 E	7.78
932591	AC2-079 C	5.82
932592	AC2-079 E	9.49
932831	AC2-110 C	1.75
932832	AC2-110 E	2.85
933061	AC2-130	3.49
933071	AC2-131 1	2.36
933081	AC2-131 2	1.07
933111	AC2-132 1	1.24
933121	AC2-132 2	0.64
933261	AC2-137 C	3.17
933262	AC2-137 E	2.03
933271	AC2-138 C	0.87
933272	AC2-138 E	1.09
933291	AC2-141 C	27.28
933292	AC2-141 E	11.64
933471	AC2-161 C	2.48
933472	AC2-161 E	1.28
933481	AC2-162 C	4.18
933482	AC2-162 E	2.15
933731	AC2-196 C	1.66
933732	AC2-196 E	1.11
933991	AD1-023 C	11.34
933992	AD1-023 E	6.17
934011	AD1-025 C O1	20.89
934012	AD1-025 E O1	12.37

934061	AD1-033 C O1	6.99
934062	AD1-033 E O1	4.66
934141	AD1-041 C O1	6.76
934142	AD1-041 E O1	4.51
934191	AD1-046 C	4.73
934192	AD1-046 E	3.16
934201	AD1-047 C	6.78
934202	AD1-047 E	4.52
934211	AD1-048 C	3.83
934212	AD1-048 E	1.93
934391	AD1-063 C	2.1
934392	AD1-063 E	1.4
934521	AD1-076 C O1	47.11
934522	AD1-076 E O1	23.99
934571	AD1-082 C O1	8.3
934572	AD1-082 E O1	4.73
934781	AD1-105 C	8.11
934782	AD1-105 E	5.64
LTF	AD1-120	6.
LTF	AD1-121	5.96
935111	AD1-144 C	1.69
935112	AD1-144 E	0.92
935161	AD1-151 C O1	19.96
935162	AD1-151 E O1	13.3
935211	AD1-156 C	2.57
935212	AD1-156 E	1.71
936041	AD2-007	2.22
936051	AD2-008 C	3.64
936052	AD2-008 E	7.92
936151	AD2-021	0.36
936241	AD2-030 C	2.89
936242	AD2-030 E	1.48
936301	AD2-039 C	1.75
936302	AD2-039 E	2.85
936341	AD2-044 C	0.27
936342	AD2-044 E	0.31
936391	AD2-049 C	1.89
936392	AD2-049 E	1.89
936401	AD2-051 C O1	7.37
936402	AD2-051 E O1	3.16
936581	AD2-073 C	2.25
936582	AD2-073 E	1.12
936591	AD2-074 C	6.55
936592	AD2-074 E	10.69
936661	AD2-085 C	3.52

936662	AD2-085 E	5.74
936711	AD2-090 C O1	6.4
936712	AD2-090 E O1	4.27
LTF	AD2-099	4.59
937221	AD2-160 C O1	5.43
937222	AD2-160 E O1	2.85
937251	AD2-164	5.15
937441	AD2-195 C	7.79
937442	AD2-195 E	3.36
937541	AD2-215 C	1.7
937542	AD2-215 E	0.9
LTF	CARR	0.64
LTF	CBM-S1	4.07
LTF	CBM-S2	14.02
LTF	CBM-W1	1.05
LTF	CBM-W2	19.3
LTF	CIN	0.3
LTF	CLIFTY	1.11
LTF	CPLE	4.8
LTF	DEARBORN	0.41
LTF	G-007	2.23
LTF	IPL	0.17
LTF	LGEE	0.08
LTF	MEC	2.32
LTF	O-066	14.26
LTF	RENSSELAER	0.51
LTF	ROSETON	3.68
292791	U1-032 E	4.89
297087	V2-040	0.26
900672	V4-068 E	0.26
901082	W1-029E	42.
LTF	WEC	0.11
907092	X1-038 E	5.5
913392	Y1-086 E	2.
916042	Z1-036 E	41.03
916192	Z1-068 E	1.76
917122	Z2-027 E	0.97
918492	AA1-063AE OP	3.37
918512	AA1-065 E OP	3.76
918691	AA1-083	1.11
919152	AA1-139 E	5.94
919211	AA1-145	18.79
919692	AA2-053 E	3.07
LTF	AA2-074	3.27
920042	AA2-088 E	9.2

920672	AA2-174 E	0.36
920691	AA2-178 C	8.46
920692	AA2-178 E	3.63
930051	AB1-013 C	2.55
930052	AB1-013 E	17.1
930121	AB1-027 C	0.82
930122	AB1-027 E	1.9
930861	AB1-132 C	11.84
930862	AB1-132 E	5.07
931231	AB1-173 C	1.91
931232	AB1-173 E	0.89
931241	AB1-173AC	1.91
931242	AB1-173AE	0.89
923801	AB2-015 C O1	7.76
923802	AB2-015 E O1	6.37
923831	AB2-022 C	2.11
923832	AB2-022 E	1.14
923842	AB2-024 E	1.49
923852	AB2-025 E	1.1
923862	AB2-026 E	0.88
923911	AB2-031 C O1	1.89
923912	AB2-031 E O1	0.93
923991	AB2-040 C O1	6.22
923992	AB2-040 E O1	5.09
924061	AB2-050	1.11
924071	AB2-051	129.4
924241	AB2-068 O1	178.68
924501	AB2-099 C	0.5
924502	AB2-099 E	0.21
924511	AB2-100 C	10.53
924512	AB2-100 E	5.19
924811	AB2-134 C O1	15.92
924812	AB2-134 E O1	15.12
925051	AB2-160 C O1	7.2
925052	AB2-160 E O1	11.74
925061	AB2-161 C O1	3.64
925062	AB2-161 E O1	5.94
925171	AB2-174 C O1	5.99
925172	AB2-174 E O1	5.42
925281	AB2-186 C	0.55
925282	AB2-186 E	0.24
925291	AB2-188 C O1	2.09
925292	AB2-188 E O1	0.94
925331	AB2-190 C	24.83
925332	AB2-190 E	10.64

925522	AC1-027 E	1.08
925692	AC1-045 E	0.92
925861	AC1-065 C	4.37
925862	AC1-065 E	7.13
926071	AC1-086 C	17.43
926072	AC1-086 E	7.93
926291	AC1-107	269.71
926411	AC1-112 C	0.64
926412	AC1-112 E	1.93
926472	AC1-118 E	1.08
926551	AC1-134	14.86
926662	AC1-147 E	1.25
926741	AC1-159	62.39
926751	AC1-161 C	27.28
926752	AC1-161 E	11.64
926771	AC1-163 C	1.64
926772	AC1-163 E	0.77
926781	AC1-164 C	58.57
926782	AC1-164 E	26.31
927041	AC1-191 C	17.49
927042	AC1-191 E	8.71
927221	AC1-216 C O1	12.15
927222	AC1-216 E O1	9.56

Generation Interconnection

Impact Study Report

for

Queue Project AD2-074

GARNER DP-LANCASTER 115 KV

32.68 MW Capacity / 86 MW Energy

June, 2019

Contents

Introduction

This System Impact Study (SIS) has been prepared in accordance with the PJM Open Access Transmission Tariff, Section 205, as well as the System Impact Study Agreement between Waller Solar I, 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).

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.

General

The Interconnection Customer (IC), has proposed a Solar generating facility located in Lancaster County, Virginia. The installed facilities will have a total capability of 86 MW with 32.68 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is November 30, 2021. This study does not imply a TO commitment to this in-service date.

Queue Number	AD2-074
Project Name	GARNER DP-LANCASTER 115 KV
Interconnection Customer	WALLER SOLAR I , LLC
State	Virginia
County	Lancaster
Transmission Owner	Dominion
MFO	86
MWE	86
MWC	32.68
Fuel	Solar
Basecase Study Year	2021

Point of Interconnection

AD2-074 will interconnect with the ITO transmission system at the new AD2-074 115kV three breaker ring bus substation connecting to the Garner DP – Lancaster 115kV line.

Cost Summary

The AD2-074 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	$ 800,000
Total Costs	**$7,850,000**

In addition, the AD2-074 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	$700,136

Transmission Owner Scope of Work

Attachment Facilities

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

Transmission: Construct approximately one span of 115 kV Attachment line between the generation substation and a new AD2-074 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. These costs do not include CIAC Tax Gross-up. The single line is shown below in Attachment 1.

Direct Connection Cost Estimate

Substation: Establish the new 115 kV AD2-074 Switching Substation (interconnection substation). The estimated cost to complete this work scope is $5,500,000. It is estimated to take 24-36 months to complete this work.

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 $800,000 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.

Interconnection Customer Requirements

ITO's Facility Connection Requirements as posted on PJM's website
http://www.pjm.com/~/media/planning/plan-standards/private-dominion/facility-connection-requirements1.ashx

Voltage Ride Through Requirements - The Customer Facility shall be designed to remain in service (not trip) for voltages and times as specified for the Eastern Interconnection in Attachment 1 of NERC Reliability Standard PRC-024-1, and successor Reliability Standards, for both high and low voltage conditions, irrespective of generator size, subject to the permissive trip exceptions established in PRC-024-1 (and successor Reliability Standards).

Frequency Ride Through Requirements - The Customer Facility shall be designed to remain in service (not trip) for frequencies and times as specified in Attachment 2 of NERC Reliability Standard PRC-024-1, and successor Reliability Standards, for both high and low frequency condition, irrespective of generator size, subject to the permissive trip exceptions established in PRC-024-1 (and successor Reliability Standards).

Reactive Power - The Generation Interconnection Customer shall design its non-synchronous Customer Facility with the ability to maintain a power factor of at least 0.95 leading to 0.95 lagging measured at the generator's terminals.

Revenue Metering and SCADA Requirements

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.

Meteorological Data Reporting Requirement

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

- Temperature (degrees Fahrenheit)
- Atmospheric pressure (hectopascals)
- Irradiance
- Forced outage data

Network Impacts

The Queue Project AD2-074 was evaluated as a 86 MW (Capacity 32.68 MW) injection as a tapped connection into the **Garner DP-Lancaster 115kV line** in the Dominion area. Project AD2-074 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD2-074 was studied with a commercial probability of 100%. Potential network impacts were as follows:

None

Summer Peak Load Flow

Generation Deliverability

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

None

Multiple Facility Contingency

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

None

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
151455	314218	6ELMONT	DVP	314908	8ELMONT	DVP	1	DVP_P4-2: H2T557	breaker	1050.6	114.03	114.05	AC	16.75

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.

None

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Contingency Definition
DVP_P4-2: H2T557	CONTINGENCY 'DVP_P4-2: H2T557' /* ELMONT OPEN BRANCH FROM BUS 314908 TO BUS 314903 CKT 1 /*ELMONT TO CHICKAHOMINY (LINE 557) OPEN BRANCH FROM BUS 314903 TO BUS 314214 CKT 1 /*CHICKAHOMINY 500-230 (TX#1) OPEN BRANCH FROM BUS 314908 TO BUS 314218 CKT 2 /*ELMONT 500-230 (TX#2) END

System Reinforcements

<table>
<tr><th>ID</th><th>Index</th><th>Facility</th><th>Upgrade Description</th><th>Cost</th><th>Cost Allocated to AD2-074</th></tr>
<tr><td>151455</td><td>1</td><td>6ELMONT 230.0 kV - 8ELMONT 500.0 kV Ckt 1</td><td>Description : Elmont 500 – 230 kV Tx#1: replace the 500-230 kV transformer #1 increase its line rating to 1134 MVA (normal), 1203 MVA (emergency), and 1365 MVA (load dump).
Time Estimate : 24-30 Months
Cost : $17,500,000

<table>
<tr><th>Queue</th><th>MW contribution</th><th>Percentage of Cost</th><th>Cost($17,500,000)</th><th>Contingency Name</th><th>Contingency Type</th></tr>
<tr><td>AC1-164</td><td>48.87</td><td>11.68%</td><td>$2,043,944.48</td><td>'H2T557'</td><td>breaker</td></tr>
<tr><td>AC1-191</td><td>26.35</td><td>6.30%</td><td>$1,102,065.42</td><td>'H2T557'</td><td>breaker</td></tr>
<tr><td>AC1-216</td><td>21.14</td><td>5.05%</td><td>$884,161.78</td><td>'H2T557'</td><td>breaker</td></tr>
<tr><td>AC2-012</td><td>24.79</td><td>5.92%</td><td>$1,036,819.80</td><td>'H2T557'</td><td>breaker</td></tr>
<tr><td>AC2-078</td><td>12.13</td><td>2.90%</td><td>$507,326.51</td><td>'H2T557'</td><td>breaker</td></tr>
<tr><td>AC2-079</td><td>14.89</td><td>3.56%</td><td>$622,761.07</td><td>'H2T557'</td><td>breaker</td></tr>
<tr><td>AC2-141</td><td>38.06</td><td>9.10%</td><td>$1,591,825.80</td><td>'H2T557'</td><td>breaker</td></tr>
<tr><td>AD1-023</td><td>17.4</td><td>4.16%</td><td>$727,739.59</td><td>'DVP_P4-2: H2T557'</td><td>breaker</td></tr>
<tr><td>AD1-025</td><td>33.16</td><td>7.93%</td><td>$1,386,887.64</td><td>'DVP_P4-2: H2T557'</td><td>breaker</td></tr>
<tr><td>AD1-033</td><td>11.6074</td><td>2.77%</td><td>$485,469.23</td><td>'DVP_P4-2: H2T557'</td><td>breaker</td></tr>
<tr><td>AD1-041</td><td>11.2355</td><td>2.69%</td><td>$469,914.84</td><td>'DVP_P4-2: H2T557'</td><td>breaker</td></tr>
<tr><td>AD1-076</td><td>70.79</td><td>16.92%</td><td>$2,960,729.07</td><td>'DVP_P4-2: H2T557'</td><td>breaker</td></tr>
<tr><td>AD1-082</td><td>12.99</td><td>3.10%</td><td>$543,295.25</td><td>'DVP_P4-2: H2T557'</td><td>breaker</td></tr>
<tr><td>AD1-105</td><td>13.706</td><td>3.28%</td><td>$573,241.31</td><td>'DVP_P4-2: H2T557'</td><td>breaker</td></tr>
<tr><td>AD1-151</td><td>33.16</td><td>7.93%</td><td>$1,386,887.64</td><td>'DVP_P4-2: H2T557'</td><td>breaker</td></tr>
<tr><td>AD2-008</td><td>11.4</td><td>2.72%</td><td>$476,794.91</td><td>'DVP_P4-2: H2T557'</td><td>breaker</td></tr>
<tr><td>AD2-074</td><td>16.74</td><td>4.00%</td><td>$700,135.68</td><td>'DVP_P4-2: H2T557'</td><td>breaker</td></tr>
</table>
</td><td>$17,500,000</td><td>$700,136</td></tr>
<tr><td></td><td></td><td></td><td>TOTAL COST</td><td>$17,500,000</td><td>$700,136</td></tr>
</table>

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.

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
151455	314218	6ELMONT	DVP	314908	8ELMONT	DVP	1	DVP_P4-2: H2T557	breaker	1050.6	114.03	114.05	AC	16.75

Bus #	Bus	MW Impact
292791	U1-032 E	4.82
297087	V2-040	0.29
314189	6PAPERMILL	8.8
314229	6MT RD221	1.41
314236	6NRTHEST	0.38
314250	6ROCKVILLE	0.41
314256	6ROCKVILLE E	1.16
314315	3LOCKS E	1.63
314539	3UNCAMP	2.17
314541	3WATKINS	0.61
314566	3CRESWEL	2.09
314648	6SUNBURY	0.8
314651	6WINFALL	1.58
315043	1FOUR RIVERA	6.93
315044	1FOUR RIVERB	5.36
315045	1FOUR RIVERC	6.93
315046	1FOUR RIVERD	5.36
315047	1FOUR RIVERE	5.36
315048	1FOUR RIVERF	6.93
315067	1DARBY 1	5.19
315068	1DARBY 2	5.19
315069	1DARBY 3	5.21
315070	1DARBY 4	5.22
315073	1STONECA	9.26
315074	1HOPCGN1	11.17
315075	1HOPCGN2	11.02
315083	1SPRUNCA	14.88
315084	1SPRUNCB	14.88
315085	1SPRUNCC	11.03
315086	1SPRUNCD	11.03
315090	1YORKTN1	30.77
315091	1YORKTN2	31.93
901082	W1-029E	41.5
907092	X1-038 E	5.43
913392	Y1-086 E	1.98
916042	Z1-036 E	40.52
916192	Z1-068 E	1.74
917122	Z2-027 E	0.96
918691	AA1-083	1.22
919152	AA1-139 E	5.87
919211	AA1-145	20.7

Bus #	Bus	MW Impact
920042	AA2-088 E	9.07
920692	AA2-178 E	3.58
923801	AB2-015 C O1	7.66
923802	AB2-015 E O1	6.28
923831	AB2-022 C	2.08
923832	AB2-022 E	1.12
923842	AB2-024 E	1.48
923852	AB2-025 E	1.08
924061	AB2-050	1.22
924241	AB2-068 O1	176.8
924511	AB2-100 C	10.36
924512	AB2-100 E	5.1
924811	AB2-134 C O1	15.72
924812	AB2-134 E O1	14.93
925051	AB2-160 C O1	7.1
925052	AB2-160 E O1	11.59
925061	AB2-161 C O1	3.59
925062	AB2-161 E O1	5.86
925281	AB2-186 C	0.55
925282	AB2-186 E	0.23
925291	AB2-188 C O1	2.06
925292	AB2-188 E O1	0.93
925331	AB2-190 C	24.53
925332	AB2-190 E	10.51
925522	AC1-027 E	1.06
925861	AC1-065 C	4.35
925862	AC1-065 E	7.1
926291	AC1-107	266.86
926411	AC1-112 C	0.7
926412	AC1-112 E	1.93
926472	AC1-118 E	1.07
926551	AC1-134	14.9
926662	AC1-147 E	1.24
926751	AC1-161 C	26.97
926752	AC1-161 E	11.51
926781	AC1-164 C	58.36
926782	AC1-164 E	26.22
927041	AC1-191 C	17.55
927042	AC1-191 E	8.74
927221	AC1-216 C O1	12.0
927222	AC1-216 E O1	9.44
930121	AB1-027 C	0.9
930122	AB1-027 E	1.9
932041	AC2-012 C	9.55
932042	AC2-012 E	15.58
932501	AC2-070 C	2.91
932502	AC2-070 E	1.2
932531	AC2-073 C	3.09
932532	AC2-073 E	1.56
932581	AC2-078 C	4.69
932582	AC2-078 E	7.66
932591	AC2-079 C	5.74

Bus #	Bus	MW Impact
932592	AC2-079 E	9.37
932831	AC2-110 C	1.74
932832	AC2-110 E	2.84
933061	AC2-130	3.47
933071	AC2-131 1	2.35
933081	AC2-131 2	1.07
933111	AC2-132 1	1.24
933121	AC2-132 2	0.63
933261	AC2-137 C	0.64
933262	AC2-137 E	2.02
933272	AC2-138 E	1.08
933291	AC2-141 C	26.97
933292	AC2-141 E	11.51
933732	AC2-196 E	1.1
934011	AD1-025 C O1	20.63
934012	AD1-025 E O1	12.22
934061	AD1-033 C O1	6.91
934062	AD1-033 E O1	4.61
934141	AD1-041 C O1	6.72
934142	AD1-041 E O1	4.48
934211	AD1-048 C	3.82
934212	AD1-048 E	1.93
934391	AD1-063 C	2.09
934392	AD1-063 E	1.4
934571	AD1-082 C O1	8.18
934572	AD1-082 E O1	4.67
934781	AD1-105 C	8.13
934782	AD1-105 E	5.65
935111	AD1-144 C	1.67
935112	AD1-144 E	0.91
935161	AD1-151 C O1	19.71
935162	AD1-151 E O1	13.14
935211	AD1-156 C	2.52
935212	AD1-156 E	1.68
936041	AD2-007	2.19
936051	AD2-008 C	3.59
936052	AD2-008 E	7.82
936151	AD2-021	0.36
936241	AD2-030 C	2.87
936242	AD2-030 E	1.47
936301	AD2-039 C	1.74
936302	AD2-039 E	2.84
936341	AD2-044 C	0.27
936342	AD2-044 E	0.31
936391	AD2-049 C	1.87
936392	AD2-049 E	1.87
936581	AD2-073 C	2.24
936582	AD2-073 E	1.11
936591	AD2-074 C	6.36
936592	AD2-074 E	10.38
936661	AD2-085 C	3.47
936662	AD2-085 E	5.65

Bus #	Bus	MW Impact
936711	AD2-090 C O1	6.31
936712	AD2-090 E O1	4.21
937221	AD2-160 C O1	5.37
937222	AD2-160 E O1	2.81
937251	AD2-164	5.11
937541	AD2-215 C	1.68
937542	AD2-215 E	0.89
AA2-074	AA2-074	3.2
CARR	CARR	0.67
CBM-S1	CBM-S1	3.8
CBM-S2	CBM-S2	13.72
CBM-W1	CBM-W1	0.18
CBM-W2	CBM-W2	17.73
CIN	CIN	0.11
CLIFTY	CLIFTY	1.67
CPLE	CPLE	4.71
DEARBORN	DEARBORN	0.48
G-007	G-007	2.29
IPL	IPL	0.05
LGEE	LGEE	0.04
MEC	MEC	1.94
O-066	O-066	14.64
RENSSELAER	RENSSELAER	0.53
WEC	WEC	0.05

Short Circuit

The following breakers are overdutied:

None

Affected Systems

Duke Energy Progress

None

Stability

Steady-State Voltage Requirements

(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

None

Stability and Reactive Power Requirement for Low Voltage Ride Through

(Summary of the VAR requirements based upon the results of the dynamic studies)

No other mitigations were found to be required.

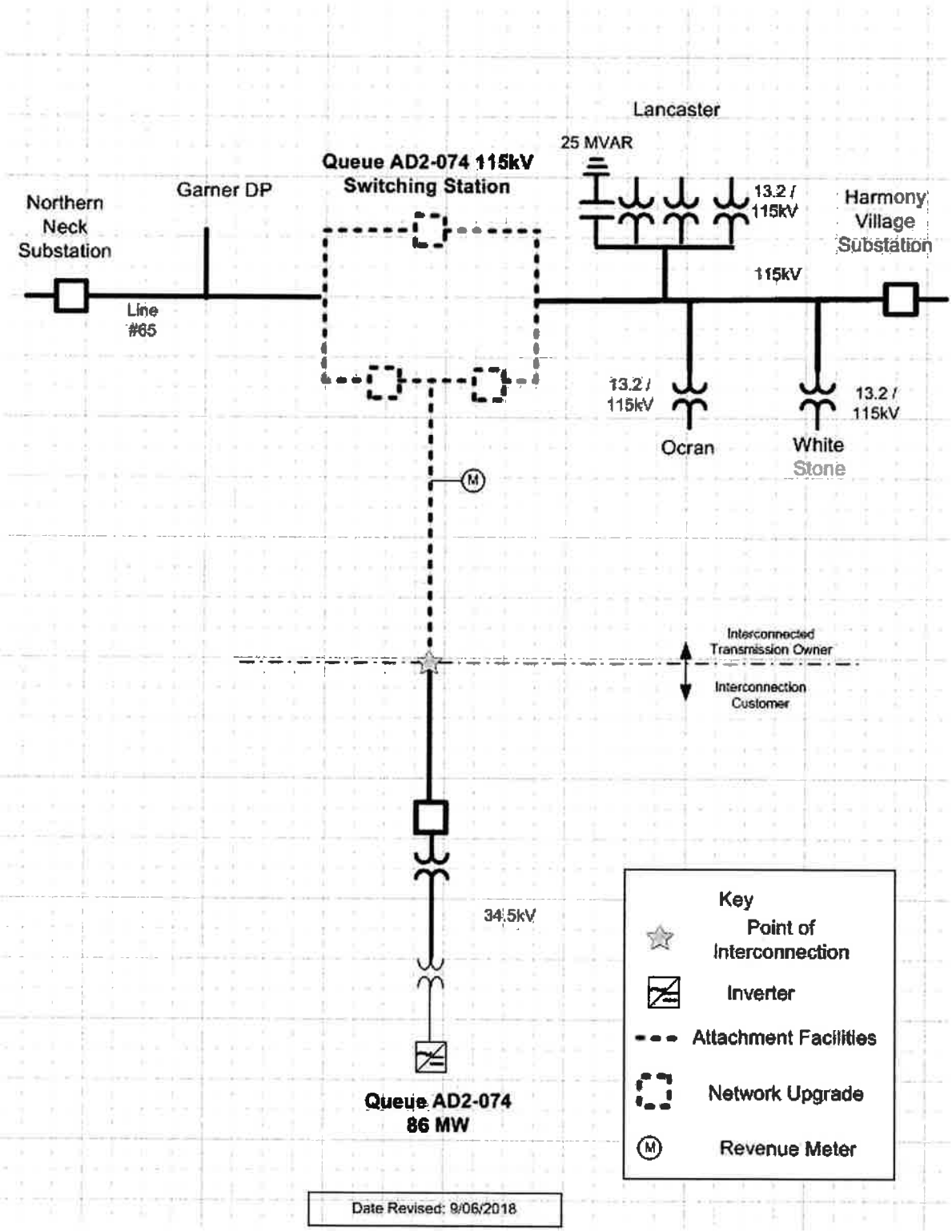
The reactive power capability of **Error! Reference source not found.** does not meet the 0.95 lagging PF requirement whereas leading PF requirement was met at the high side of the main transformer as shown in Table 1.

Table 1: Error! Reference source not found. **Reactive Power Capability Assessment**

Generator	MFO (MW)	Required Power Factor Range		Maximum Lagging (MVAr)	Minimum Leading (MVAr)
		Lagging	Leading		
Error! Reference source not found.	86	0.95	0.95		
Total Reactive Power Required				28.27	−28.27
Reactive Power from Generators				Qmax	Qmin
				28.85	−28.85
Customer Planned Compensation				0	0
Reactive Power Losses				−11.3	−11.3
Total Available Reactive Power at high side of Main transformer				17.55	−40.15
Deficiency in Reactive Power				10.72	Meet

Attachment 1

Single Line Diagram



Generation Interconnection

Feasibility Study Report

for

Queue Project AF1-042

GARNER DP-LANCASTER 115 KV

17.1 MW Capacity / 45 MW Energy

January, 2020

Table of Contents

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 Virginia Electric and Power Company (VEPCO).

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.

PJM utilizes manufacturer models to ensure the performance of turbines is properly captured during the simulations performed for stability verification and, where applicable, for compliance with low voltage ride through requirements. Turbine manufacturers provide such models to their customers. The list of manufacturer models PJM has already validated is contained in Attachment B of Manual 14G. Manufacturer models may be updated from time to time, for various reasons such as to reflect changes to the control systems or to more accurately represent the capabilities turbines and controls which are currently available in the field. Additionally, as new turbine models are developed, turbine manufacturers provide such new models which must be used in the conduct of these studies. PJM needs adequate time to evaluate the new models in

order to reduce delays to the System Impact Study process timeline for the Interconnection Customer as well as other Interconnection Customers in the study group. Therefore, PJM will require that any Interconnection Customer with a new manufacturer model must supply that model to PJM, along with a $10,000 fully refundable deposit, no later than three (3) months prior to the starting date of the System Impact Study (See Section 4.3 for starting dates) for the Interconnection Request which shall specify the use of the new model. The Interconnection Customer will be required to submit a completed dynamic model study request form (Attachment B-1 of Manual 14G) in order to document the request for the study.

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 Lancaster County, Virginia. This projects requests an increase to the facility capability of 45 MW with 17.1 MW of this output being recognized by PJM as Capacity. The entire facilities will have a total capability of 131 MW with 49.78 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is 11/30/2021. This study does not imply a TO commitment to this in-service date.

Note that this project is an increase to the Interconnection Customer's AD2-074 project, which will share the same property and connection point.

Queue Number	AF1-042
Project Name	GARNER DP-LANCASTER 115 KV
State	Virginia
County	Lancaster
Transmission Owner	Dominion
MFO	131
MWE	45
MWC	17.1
Fuel	Solar
Basecase Study Year	2023

3.1 Point of Interconnection

AF1-042 will interconnect with the Dominion transmission system. The POI will be a 115 kV substation tapping the Garner - Lancaster 115kV line. The POI will be 5.58 miles away from Dominion Garner substation and 8.40 miles away from Lancaster substation.

3.2 Cost Summary

The AF1-042 project will utilize the interconnection facilities being developed under the AD2-074 project.

In addition, the AF1-042 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	**$ 0**

Cost allocations for upgrades will be provided in the System Impact Study Report.

The Feasibility Study is used to make a preliminary determination of the type and scope of Attachment Facilities, Local Upgrades, and Network Upgrades that will be necessary to accommodate the Interconnection Request and to provide the Interconnection Customer a preliminary estimate of the time that will be required to construct any necessary facilities and upgrades and the Interconnection Customer's cost responsibility. The System Impact Study provides refined and comprehensive estimates of cost responsibility and construction lead times for new facilities and system upgrades. Facilities Studies will include, commensurate with the degree of engineering specificity as provided in the Facilities Study Agreement, good faith estimates of the cost, determined in accordance with Section 217 of the Tariff,

(a) to be charged to each affected New Service Customer for the Facilities and System Upgrades that are necessary to accommodate this queue project;

(b) the time required to complete detailed design and construction of the facilities and upgrades; and

(c) a description of any site-specific environmental issues or requirements that could reasonably be anticipated to affect the cost or time required to complete construction of such facilities and upgrades.

4 Transmission Owner Scope of Work

Dominion assessed the impact of the proposed Queue Project AF1-042. The project was evaluated as a 17.1 MW Capacity (45.0 MW energy) injection at the existing AD2-074 substation in the Dominion Transmission System, for compliance with NERC Reliability Criteria on Dominion Transmission System. The system was assessed using the summer 2023 AF1 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 AF1-042 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.

5 Non-Direct Connection Cost Estimate

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.

6 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.

7 Transmission Owner Analysis

7.1 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.

7.2 Short Circuit Analysis

PJM performed a short circuit analysis and the results were verified by Dominion. The connection of AF1-042 project to the system does not result in any newly overdutied circuit breakers on the Dominion transmission system and does not have a significant fault current contribution to existing overdutied circuit breakers.

7.3 Stability Analysis

PJM will complete a dynamic stability analysis, if necessary, as part of the System Impact Study. The results of this analysis will be reviewed by Dominion. Should stability concerns be identified in PJM's study, Dominion will develop appropriate system reinforcement(s) and included the estimated cost of any reinforcement(s) in Dominion's System Impact Study report.

8 Interconnection Customer Requirements

8.1 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.

8.2 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.

8.3 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.

9 Revenue Metering and SCADA Requirements

9.1 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.

9.1.1 Meteorological Data Reporting Requirement

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

- Temperature (degrees Fahrenheit)
- Atmospheric pressure (hectopascals)
- Irradiance
- Forced outage data

9.2 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.

10 Network Impacts

The Queue Project AF1-042 was evaluated as a 45.0 MW (Capacity 17.1 MW) injection as an uprate to AD2-074 that taps the Garner to Lancaster 115 kV line in the Dominion area. Project AF1-042 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-042 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Load Flow

10.1 Generation Deliverability

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

None

10.2 Multiple Facility Contingency

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

None

10.3 Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

None

10.4 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	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
4301492 0	31388 6	3GREYSP T	115. 0	DVP	31417 4	3HARMON Y	115. 0	DVP	1	DVP_P1-2: LN 2083	operatio n	138.1 8	84.89	101.16	DC	22.5
4301481 6	31417 3	3GARNE R	115. 0	DVP	31418 1	3NORNECK	115. 0	DVP	1	DVP_P1-2: LN 65-B	operatio n	203.9 8	104.57	126.63	DC	45.0
4598380 8	31417 3	3GARNE R	115. 0	DVP	31418 1	3NORNECK	115. 0	DVP	1	314178 3LANCAS T 115 936590 AD2-074 TAP 115 1	operatio n	203.9 8	104.57	126.63	DC	45.0
4301491 8	31419 1	3WHIT STONE	115. 0	DVP	31387 0	3RAPPHNC K	115. 0	DVP	1	DVP_P1-2: LN 2083	operatio n	138.1 8	84.96	101.23	DC	22.5

10.5 System Reinforcements

None

10.6 Flow Gate Details

The following indices contain additional information about each flowgate presented in the body of the report. For each index, 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.

10.6.1 Contingency Descriptions

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 65-B	CONTINGENCY 'DVP_P1-2: LN 65-B' OPEN BRANCH FROM BUS 313813 TO BUS 314178 CKT 1 /* 3OCRAN 115.00 - 3LANCAST 115.00 OPEN BRANCH FROM BUS 313813 TO BUS 314191 CKT 1 /* 3OCRAN 115.00 - 3WHIT STONE 115.00 OPEN BRANCH FROM BUS 313870 TO BUS 314191 CKT 1 /* 3RAPPAHNCK 115.00 - 3WHIT STONE 115.00 OPEN BRANCH FROM BUS 936590 TO BUS 314178 CKT 1 /* AD2-074 TAP 115.00 - 3LANCAST 115.00 OPEN BRANCH FROM BUS 314178 TO BUS 314400 CKT 1 /* 3LANCAST 115.00 - 3LANCA_1 115.00 OPEN BUS 313813 /* ISLAND: 3OCRAN 115.00 OPEN BUS 314178 /* ISLAND: 3LANCAST 115.00 OPEN BUS 314191 /* ISLAND: 3WHIT STONE 115.00 OPEN BUS 314400 /* ISLAND: 3LANCA_1 115.00 END
314178 3LANCAST 115 936590 AD2-074 TAP 115 1	CONTINGENCY '314178 3LANCAST 115 936590 AD2-074 TAP 115 1' OPEN BRANCH FROM BUS 314178 TO BUS 936590 CKT 1 END

Short Circuit

10.7 Short Circuit

The following Breakers are overdutied:

None

Affected Systems

11 Affected Systems

11.1 Duke Energy Progress

Duke Energy Progress Impacts to be determined during later study phases (as applicable).

Attachment 1

System Configuration

Generation Interconnection

System Impact Study Report

for

Queue Project AF1-042

GARNER DP-LANCASTER 115 KV

17.1 MW Capacity / 45 MW Energy

August 2020

Table of Contents

1 Introduction

This System Impact Study has been prepared in accordance with the PJM Open Access Transmission Tariff, 205, as well as the System Impact 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 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.

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.

3 General

The Interconnection Customer (IC) has proposed an uprate to a planned/existing Solar generating facility located in Lancaster, Virginia. This project is an increase to the Interconnection Customer's AD2-074 project,

which will share the same point of interconnection. The AF1-042 queue position is a 45 MW uprate (17.1 MW Capacity uprate) to the previous project. The total installed facilities will have a capability of 131 MW with 49.8 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	AF1-042
Project Name	GARNER DP-LANCASTER 115 KV
State	Virginia
County	Lancaster
Transmission Owner	Dominion
MFO	131
MWE	45
MWC	17.1
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

AF1-042 will interconnect with the Dominion transmission system. The POI will be the AD2-074 115 kV substation tapping the Garner - Lancaster 115kV line. The POI will be 5.58 miles away from Dominion Garner substation and 8.40 miles away from Lancaster substation.

5 Cost Summary

The AF1-042 project will utilize the interconnection facilities being developed under the AD2-074 project.

The AF1-042 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	$ 0
Allocation towards System Network Upgrade Costs*	$ 0
Total Costs	$ 0

*As your project progresses through the study process and other projects modify their request or withdraw, then your cost allocation could change.

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.

Note 1: 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.

Note 2: For customers with System Reinforcements listed: If your present cost allocation to a System Reinforcement indicates $0, then please be aware that as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, reducing in size, etc, the cost responsibilities can change and a cost allocation may be assigned to your project. In addition, although your present cost allocation to a System Reinforcement is presently $0, your project may need this system reinforcement completed to be deliverable to the PJM system. If your project comes into service prior to completion of the system reinforcement, an interim deliverability study for your project will be required.

6 Transmission Owner Scope of Work

Dominion assessed the impact of the proposed Queue Project AF1-042. The project was evaluated as a 17.1 MW Capacity (45.0 MW energy) injection at the existing AD2-074 substation in the Dominion Transmission System, for compliance with NERC Reliability Criteria on Dominion Transmission System. The system was assessed using the summer 2023 AF1 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 ITO findings were made from a conceptual review of this project and 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 Analysis

The Queue Project AF1-042 was evaluated as a 45.0 MW (Capacity 17.1 MW) uprate to AD2-074 which is an injection that taps the Garner to Lancaster 115 kV line in the Dominion area. Project AF1-042 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-042 was studied with a commercial probability of 100%. 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)

None

11.4 Steady-State Voltage Requirements

To be determined

11.5 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	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
89852700	314134	6CRANES	230.0	DVP	314142	6STAFORD	230.0	DVP	1	DVP_P1-2: LN 2089	operation	678.68	117.87	118.83	AC	7.68
89852831	314142	6STAFORD	230.0	DVP	314145	6AQUI_HARB_B	230.0	DVP	1	DVP_P1-2: LN 2089	operation	678.68	103.84	104.8	AC	7.68
43014816	314173	3GARNER	115.0	DVP	314181	3NORNECK	115.0	DVP	1	DVP_P1-2: LN 65-B	operation	203.98	103.36	125.01	AC	45.0
45983808	314173	3GARNER	115.0	DVP	314181	3NORNECK	115.0	DVP	1	3141783LANCAST 115 936590 AD2-074 TAP 115 1	operation	203.98	103.36	125.02	AC	45.0

11.6 System Reinforcements

None

11.7 Contingency Descriptions

Contingency Name	Contingency Definition
DVP_P1-2: LN 65-B	CONTINGENCY 'DVP_P1-2: LN 65-B' OPEN BRANCH FROM BUS 313813 TO BUS 314178 CKT 1 /* 3OCRAN 115.00 - 3LANCAST 115.00 OPEN BRANCH FROM BUS 313813 TO BUS 314191 CKT 1 /* 3OCRAN 115.00 - 3WHIT STONE 115.00 OPEN BRANCH FROM BUS 313870 TO BUS 314191 CKT 1 /* 3RAPPAHNCK 115.00 - 3WHIT STONE 115.00 OPEN BRANCH FROM BUS 936590 TO BUS 314178 CKT 1 /* AD2-074 TAP 115.00 - 3LANCAST 115.00 OPEN BRANCH FROM BUS 314178 TO BUS 314400 CKT 1 /* 3LANCAST 115.00 - 3LANCA_1 115.00 OPEN BUS 313813 /* ISLAND: 3OCRAN 115.00 OPEN BUS 314178 /* ISLAND: 3LANCAST 115.00 OPEN BUS 314191 /* ISLAND: 3WHIT STONE 115.00 OPEN BUS 314400 /* ISLAND: 3LANCA_1 115.00 END
314178 3LANCAST 115 936590 AD2-074 TAP 115 1	CONTINGENCY '314178 3LANCAST 115 936590 AD2-074 TAP 115 1' OPEN BRANCH FROM BUS 314178 TO BUS 936590 CKT 1 END
DVP_P1-2: LN 2089	CONTINGENCY 'DVP_P1-2: LN 2089' OPEN BRANCH FROM BUS 314196 TO BUS 314197 CKT 1 /* 6LADYSMITH 230.00 - 6LDYSMITH CT230.00 END

12 Short Circuit Analysis

No circuit breakers were identified as overdutied as part of this analysis.

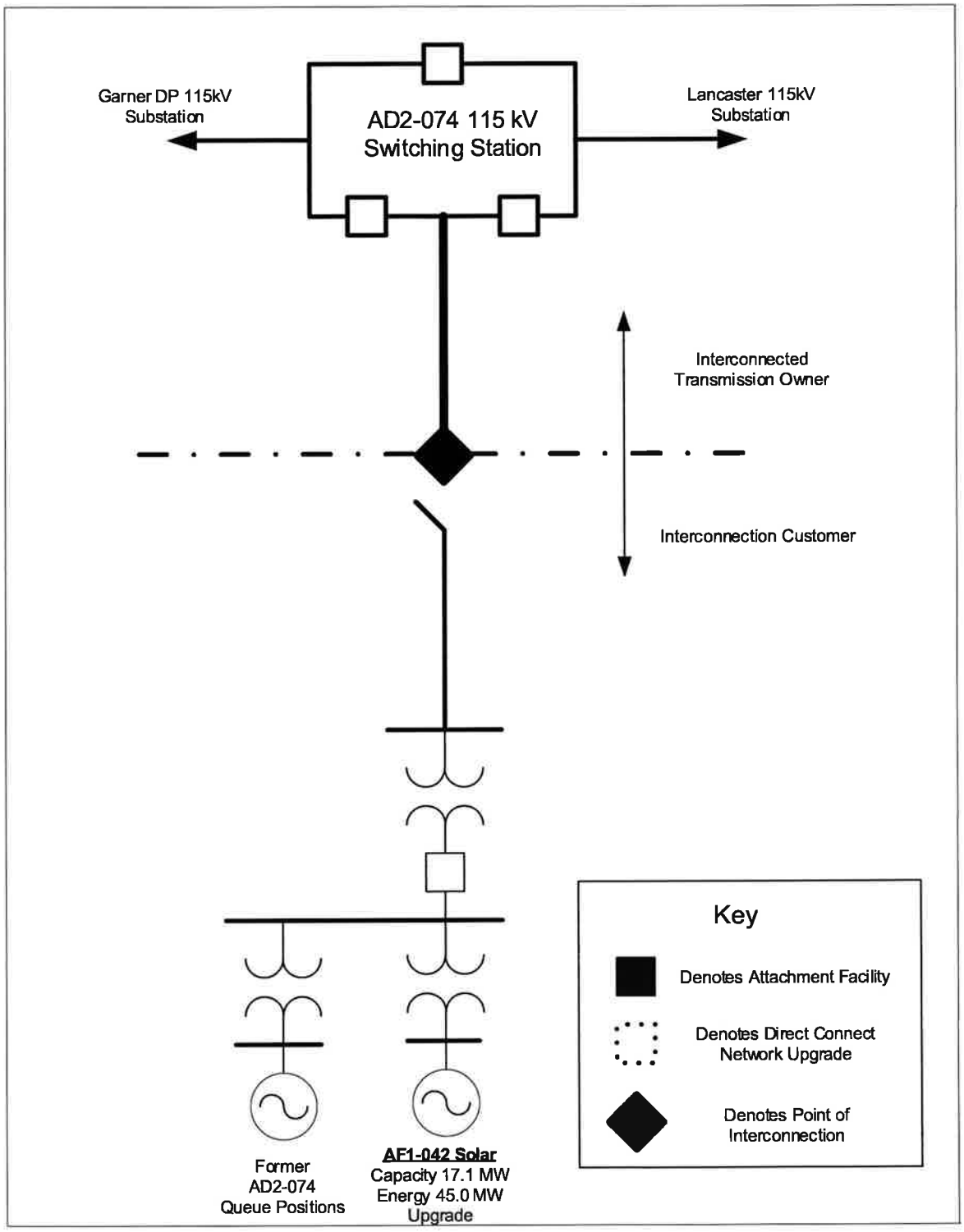
13 Stability and Reactive Power

To be determined in the Facilities Study Phase.

14 Affected Systems

No Affected Systems issues were identified as part of this analysis.

Attachment 1: One Line Diagram



Generation Interconnection Facility Study Report

For

PJM Generation Interconnection Request Queue Position AD2-074 & AF1-042

Garner DP-Lancaster 115 kV 49.78 MW Capacity / 131 MW Energy

Rev 0: Nov, 2021

General

This Facilities Study has been prepared in accordance with the PJM Open Access Transmission Tariff §207, as well as the Facilities Study Agreement between Waller Solar, 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).

Point of Interconnection

AD2-074/AF1-074 will interconnect with the ITO transmission system at the new 115kV three breaker ring bus substation connecting to the Garner DP-Lancaster 115kV line.

Cost Summary

The AD2-074/AF1-074 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$545,875
Direct Connection Network Upgrades	$5,441,906
Non Direct Connection Network Upgrades	$1,287,460
Allocation for New System Upgrades	$0
Contribution for Previously Identified Upgrades	$0
Total Costs	**$7,275,241**

A. Transmission Owner Facilities Study Summary

1. Description of Project

Queue AD2-074 is a request to interconnect a new solar generating facility to be located in Lancaster County, Virginia. AF1-042 is a request to increase the MFO and capacity rating of the entire facility. After both projects are completed, the solar facility will have a MFO of 131 MW and a capacity rating of 49.78 MW. AD2-074/AF1-042 will interconnect with the ITO transmission system via a new three breaker ring bus switching station that connects on the existing Line 65 115kV Northern Neck to Rappahannock Substation. The interconnection facilities being constructed under the AD2-074 project are sufficient to support the AF1-042 project.

Attachment Facility and Network Upgrade construction is estimated to be 24-36 months.

2. Amendments to the System Impact Study data or System Impact Study Results

None

3. Interconnection Customer's Milestone Schedule

- Plan to break ground October 15, 2023
- Permits – state level Permit By Rule and county level final site plan approval complete September 30, 2023
- Substantial site work completed September 15, 2024
- Delivery of major electrical equipment September 15, 2024
- Back Feed Power November 1, 2024
- Commercial Operation May 31, 2025

4. Scope of Customer's Work

Generator interconnection request AD2-074 is for an 86 MW Maximum Facility Output (MFO) solar generation facility. AF1-042 is an uprate to AD2-074 adding 45MW (MFO) for a total of 131 MW (MFO) at the facility.

5. Description of Facilities Included in the Facilities Study

The ITO will connect the proposed generator lead via Attachment Facilities to a new AD2-074/AF1-042 three-breaker ring bus switching station on the 65 line between the existing Northern Neck and Rappahannock substations. The site is located along Dominion Energy's existing 115kV line from Garner DP to Lancaster stations. The cut line will consume two of the positions in the ring bus. The third position will be for the 115kV feed from the Waller Solar I, LLC collector station for the new Solar farm.

The new 115kV three breaker ring substation will share a common footprint and fence line with Waller Solar I, LLC collector station. The demarcation point between the two stations will be the 115kV breaker disconnect switch 4-hole pad in the Waller Solar I, LLC collector station by the common fence. Dominion Energy will bring its bus to the demarcation point. The bus, structures, disconnect switch, metering accuracy CCVT's, metering accuracy CT's, protection and metering

equipment will be Attachment Facilities. The grounding systems for each station will be tied together. All substation permitting, site preparation and grading activity will be performed by Waller Solar I LLC.

The existing line segment between the new three breaker ring substation and Rappahannock Substation will be renumbered. The existing line segment between the new three breaker ring substation and Northern Neck Substation will remain line 65.

Additional work is required at Northern Neck, Rappahannock, and Harmony Village Substations.

Security and fence type – design level 4.

Note: Currently, the scope and estimate assume DVP standard spread footer foundations. Once the soil information is received and if it is decided to change that to "pile foundations" then DVP team should be informed at the earliest to adjust the project estimate.

6. Total Costs of Transmission Owner Facilities included in Facilities Study

Cost estimates for Dominion to perform construction:

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
Attachment Facilities	$317,096	$157,062	$54,535	$17,182	$545,875
Total Attachment Facilities Cost	$317,096	$157,062	$54,535	$17,182	$545,875
Generator Interconnect (n7973)	$2,552,037	$2,267,281	$387,553	$235,035	$5,441,906
Transmission Line (n7972)	$543,138	$308,954	$82,056	$35,136	$969,284
Total Remote Changes (n7974)	$156,231	$110,415	$34,289	$17,241	$318,176
Total Network Upgrades	$3,251,406	$2,686,650	$503,898	$287,412	$6,729,366
Total Project Costs	$3,568,502	$2,843,712	$558,433	$304,594	$7,275,241

7. Summary of Milestone Schedules for Completion of Work Included in Facilities Study:

Facilities are estimated to take 24-36 months from ISA execution and is based on the ability to obtain outages to construct and test the proposed facilities.

Proposed Schedule

- Detailed design: 6-12 months
- Permitting: 6-18 months (some overlap with design)
- Construction 8-12 months

ITO requires the site to be fully graded and permitted site so they can start construction by October 15 2023.

B. Transmission Owner Facilities Study Results

1. Attachment Facilities

The Attachment Facilities include the portion of the interconnecting switching station which is associated solely with the single feed to the generating facilities collector station. The equipment associated with the Attachment Facilities include the metering accuracy CCVT's, metering accuracy CT's, disconnect switch, conductors and connectors.

Purchase and install substation material:

1. One (1), 115kV, 2000A, 3-phase center break gang operated switch.
2. Three (3), 115kV, metering accuracy CCVT's.
3. Three (3), 115kV,500:5 metering accuracy CT's.
4. Conductor, connectors, conduits, control cables, foundations, steel structures and grounding material as per engineering standards.

Purchase and install relay material:

1. One (1), 1109 – 28" dual SEL-587Z transmission bus panel
2. One (1), 4200 – Bus differential C.T. make-up (M.U.) box
3. One (1), 1425 – 28" dual SEL-735 transmission & generator interconnect metering panel
4. One (1), 4524 – Revenue metering C.T. make-up (M.U.) box
5. One (1), 4506 – CCVT potential M.U. box
6. One (1), 1323 – 28" SEL-487E/735 PMU & PQ monitoring panel
7. Two (2), 4541 - Control cable make-up (M.U.) box

2. Transmission Line – Upgrades

PJM Network Upgrade #n7972 – Split Line #65 between Northern Neck Substation and Rappahannock Substation

The AD2-074/AF1-042 substation will be built in line with line 65 approximately halfway between existing structures 65/541 and 65/542. This location is approximately 5.4 miles to the southeast of Garner DP. The final location of the substation is subject to change but shall remain within the same vicinity. The portion of the 65 line between the Northern Neck substation and the AD2-074/AF1-042 substation will be assigned a new line number and the structures will be renumbered accordingly (This estimate will refer to this line as XXXX. Line number TBD).

The project work summary is described below:

TEMPORARY FACILITIES TO BE INSTALLED

1. None

EXISTING FACILITIES TO BE REMOVED

1. None

PERMANENT FACILITIES TO BE INSTALLED

1. Install (1) standard 70' 115 kV steel backbone structures (31'-6" pole spacing) within the limits of the proposed substation. (Str. 65/541A)
2. Install (2) galvanized static pole structures with foundations within the limits of the proposed substation. (Str. 65/541B and 65/541C)
3. Install approximately 575 feet total (3 spans) of one 7#7 alumoweld shield wire between the proposed static poles (Str. 65/541B & 65/541C) and proposed backbone (65/541A). This will include the installation of dampers
4. Renumber approximately 130 existing structures between Northern Neck and AD2-074 with new line number XXXX (Line Number TBD)

EXISTING FACILITIES TO BE TRANSFERRED:

1. Cut and transfer (2) spans of existing 3-phase 477 ACSR conductor to proposed backbone (Str. 65/541A).
2. Cut and transfer (4) spans of existing 3#6 static wire to proposed backbone (Str. 65/541A)

PROJECT ASSUMPTIONS:

1. The final location of the AD2-074/AF1-042 substation is subject to change. Final cost and structure locations may vary from the estimate as a result.
2. It is assumed that fiber is not required for this project.

3. New Substation/Switchyard Facilities

PJM Network Upgrade #n7973 - Build a three breaker AD2-074/AF1-042 115 kV switching station.

The objective of this project is to build a 115kV, 3-breaker ring bus to support the new solar farm built by Waller Solar I, LLC. The site is located along Dominion Energy's existing 115kV, 65 Line from Northern Neck Substation to Rappahannock Substation. The cut line will consume two of the positions in the ring bus. The third position will be for the 115kV feed from Waller Solar I, LLC collector station for the new solar farm.

The new 115kV three breaker ring substation will share a common footprint and fence line with Waller Solar I, LLC collector station. The demarcation point between the two stations will be the 115kV breaker disconnect switch 4-hole pad in the Waller Solar I, LLC collector station by the common fence. Dominion Energy will bring its bus to the demarcation point. The bus, structures, disconnect switch, metering accuracy CCVT's, metering accuracy CT's, protection and metering equipment will be Attachment Facilities. The grounding systems for each station will be tied together. All substation permitting, site preparation and grading activity will be performed by Waller Solar I LLC.

The work required is as follows:

Purchase and install substation material – Direct Network Upgrade:

1. Approximately 291' x 186' site preparation and grading as required for installation of the switching station (by the developer).
2. Approximately 954 linear FT of 5/8" chain link, 12 ft tall, perimeter fence around the station along with the security cameras and integrators as per design 4 fence standards.
3. Three (3), 115 kV, 3000A, 40kAIC, SF-6 circuit breakers.
4. Six (6), 115 kV, 2000A, 3-phase center break gang operated switches.
5. Six (6), 115kV, relay accuracy CCVTs.
6. Two (2), 115 kV, 2000A wave traps.
7. Two (2), Line tuners.
8. Nine (9), 90 kV, 74 kV MCOV surge arresters.
9. Two (2), 115kV, 2000A, 2-phase center break gang operated switches (for PVT's).
10. Two (2), 115kV, 100KVA power PT's for station service.
11. One (1), 24' x 40' control enclosure.
12. One (1), 125 VDC, 300 Ah station battery and 50 amp charger (size to be verified during detail engineering).
13. Approximately 166 FT of cable trough, with a 20FT road crossing section.
14. Station stone as required.
15. Station lighting as required.
16. Steel structures as required including switch stands, bus supports, station service transformers, CCVT and wave trap supports.
17. Foundations as required including control house, equipment, and bus support stands.
18. Conductors, connectors, conduits, control cables, cable trough, and grounding materials as per engineering standards

Purchase and install relay material – Direct Network Upgrade:

1. Three (3), 1510 – 28" dual SEL-351-7 transmission breaker w/ reclosing panel
2. Three (3), 4510 - SEL-2411 breaker annunciator
3. Two (2), 1340 – 28" dual SEL 411L DCB line panel
4. Two (2), 4506 – 3-phase CCVT potential make-up (M.U.) box
5. One (1), 1603 – 28" SEL-451 islanding control scheme panel
6. Two (2), 4000 – Station service potential make-up (M.U.) box
7. Two (2), 4018 – 500A station service AC distribution panel
8. Two (2), 4007 – 225A outdoor transmission yard AC NQOD
9. Two (2), 4019 – 225A three phase throw over switch
10. Two (2), 4016 – 600A PVT disconnect switch
11. One (1), 4153 – Wall mount station battery monitor
12. One (1), 5618 - SEL-3555 communications panel
13. One (1), 1255 – Station annunciator panel
14. One (1), 5021 – SEL-2411 RTU panel
15. One (1), 5609 – Fiber optic management panel
16. Three (3), 4526_A – Circuit breaker fiber optic make-up (M.U.) box
17. One (1), 5202 – 26" APP 601 digital fault recorder
18. One (1), 5603 – Station network panel No. 1
19. One (1), 5603 – Station network panel No. 2

20. One (1), 4523 – Security camera interface box
21. One (1), 5616 – Station security panel
22. One (1), High voltage protection (HVP) box (Provided by IT)
23. One (1), Telephone interface box
24. One (1), 5616 - Security fence panel
25. Four (4), 4040 - Security fiber/power makeup (M.U.) box
26. One (1), 4044 – 225A 1Ø outdoor main security AC NQOD
27. Two (2), 4040 – 100A 1Ø outdoor security AC NQOD
28. Two (2), 4018 – 225A station service AC distribution panel branch breaker

4. Upgrades to Substation / Switchyard Facilities

PJM Network Upgrade #n7974 - Remote protection and communication work.

Additional work to be required at Harmony Village, Rappahannock, Northern Neck and Garner DP, Lancaster, Ocran & White Stone substations. These costs include the following:

Harmony Village 115 kV Substation

Project Summary
This project provides for the installation of islanding transfer trip to work with the AD2-074/AF1-042 project via Rappahannock substation. This project is the Non-Direct Connect for the AD2-074/AF1-042 generator interconnect project.

Purchase and install relay material:
1. One (1), 1603 – 24" SEL-451 islanding control scheme panel w/ SEL-2506 fiber modem

Rappahannock 115 kV Substation

Project Summary
This project provides for the drawing work, relay resets, and field support necessary to change the Line 65 destination at Rappahannock Substation. The line number may or may not be changed. Install islanding transfer trip to work with the AD-074/AF1-042 project (Receive islanding from Harmony Village via fiber and transmit islanding to AD2-074/AF1-042 via PLC). This project is the Non-Direct Connect for the AD2-074/AF1-042 generator interconnect project.

Purchase and install relay material:
1. One (1), 1603 – 24" SEL-451 islanding control scheme panel w/ SEL-2506 & PLC transmitter.

Northern Neck 115 kV Substation

Project Summary:
This project provides for the drawing work, relay resets, and field support necessary to change the Line 65 destination at Northern Neck substation. The line number may or may not be changed. Install islanding transfer trip to work with the AD2-074/AF1-042 project. Remove breaker failure transfer trip receive from Lancaster substation's transmission capacitor bank. This function will be moved to the AD2-074/AF1-042 project. This project is the Non-Direct Connect for the AD2-074/AF1-042 generator interconnect project.

Purchase and install substation material:

1. One (1), 1603 – 24" SEL-451 islanding control scheme panel

Garner DP, Lancaster, Ocran, White Stone Substations – Change Line 65 Destinations

Project Summary:
This project provides for the drawing work, relay resets, and field support necessary to change the Line 65 destination(s) at Garner DP, Lancaster, Ocran & White Stone substation(s). The line number may or may not be changed. This project is the Non-Direct Connect for the AD2-074/AF1-042 generator interconnect project.

Modify Lancaster transmission capacitor bank carrier blocking & transfer trip schemes to work with AD2-074/AF1-042 instead of Northern Neck Substation.

Modify Ocran DG transfer trip to work with AD2-074/AF1-042 instead of Northern Neck.

Purchase and install substation material:

1. No relay material

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
Harmony Village Substation	$27,862	$36,805	$6,016	$5,747	$76,430
Rappahannock Substation	$36,527	$36,805	$7,618	$5,747	$86,697
Northern Neck Substation	$36,527	$36,805	$7,618	$5,747	$86,697
Change Line 65 Destinations	$55,315	$0	$13,037	$0	$68,352
Total Remote Relay Upgrades	$156,231	$110,415	$34,289	$17,241	$318,176

5. Metering & Communications

PJM Requirements

The IC 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 Appendix 2.

ITO Requirements

Metering and SCADA/Communication equipment must meet the requirements outlined in section 3.1.6 Metering and Telecommunications of ITO's Facility Interconnection Connection Requirement NERC Standard FAC-001 which is publicly available at www.dom.com.

At the IC's expense, the ITO will supply and own at the Point of Interconnection bi-directional revenue metering equipment that will provide the following data:

a. Hourly compensated MWh received from the Customer Facility to the ITO;
b. Hourly compensated MVARh received from the Customer Facility to the ITO;

c. Hourly compensated MWh delivered from the ITO to the Customer Facility; and
d. Hourly compensated MVARh delivered from the ITO to the Customer Facility.

The IC will supply and own metering equipment that will provide Instantaneous net MW and MVar per unit values in accordance with PJM Manuals M-01 and M-14D, and Sections 8.1 through 8.5 of Appendix 2 to the ISA.

The IC will access revenue meter via wireless transceivers or fiber cabling to meter with RS-485 or Ethernet communication port for dial-up reads. IC must provide revenue and real time data to PJM from Interconnection Customer Market Operations Center per "PJM Telemetry Data Exchange Summary" document available at PJM.com.

6. Environmental, Real Estate and Permitting Issues

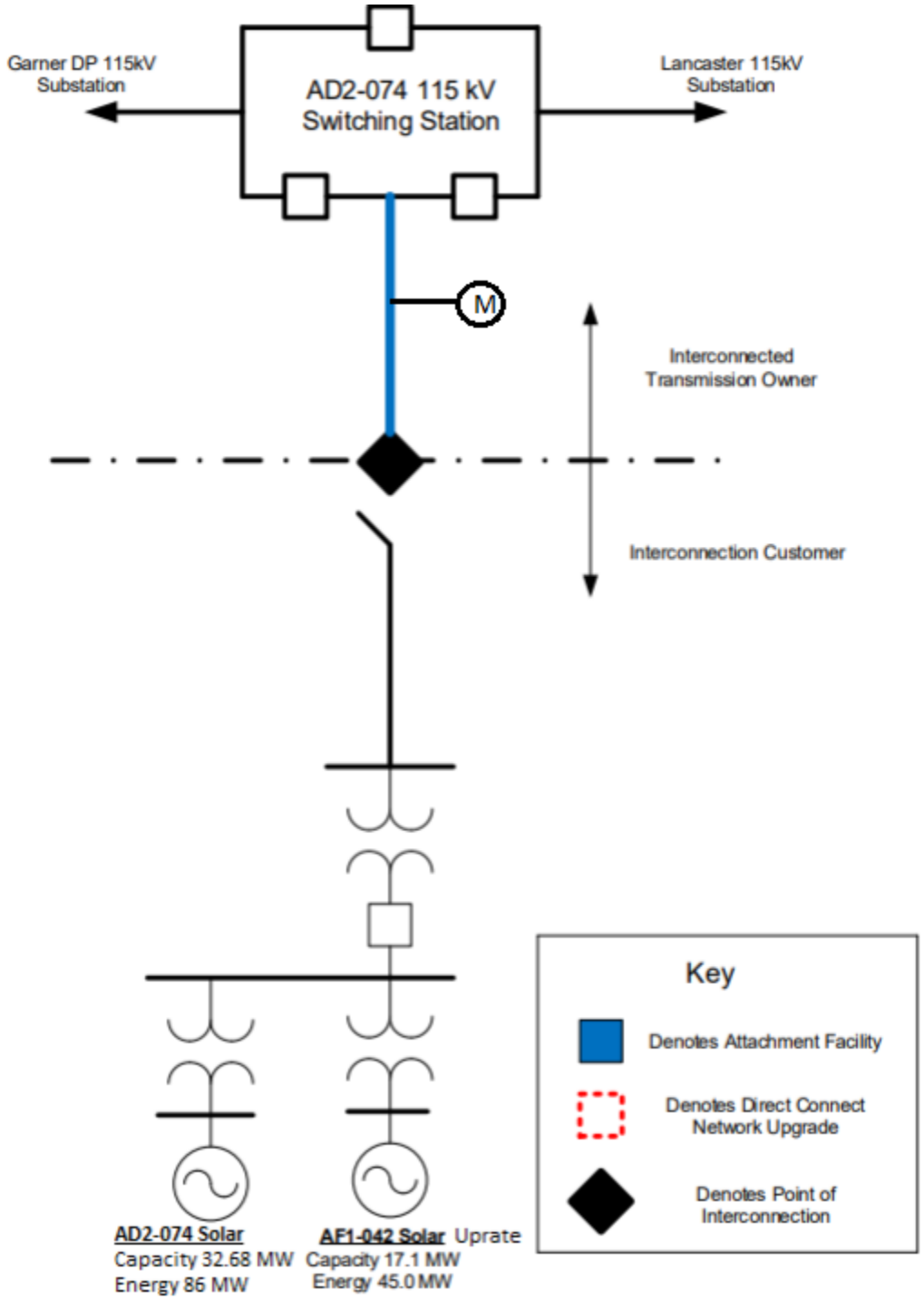
The IC would be responsible for the following expectations in the area of Environmental, Real Estate and Permitting:

- Suitable Access Road from Substation to a Virginia State Maintained Roadway.
- Any additional land needed for Storm Water Management, Landscaping, and Wetlands/Wetlands Mitigation.
- Conditional Use Permit for Substation.
- Any other Land/Permitting requirements required by the Substation.

ITO Real Estate Needs:

- The substation layout is complete and ITO requires a 291' x 186' piece of property (title in fee) to build the substation. The property includes the piece of property between the substation and collector station for the strain bus.
    - ITO requires ownership transfer of the substation site before they start construction. Target for the deed by October 15, 2023.
    - The size of the station assumes ITO will not need a separate storm water management system for the substation. If the county rules differently than the ITO will need to revisit the land requirements.
- ITO will need a letter similar to the zoning letter from the county stating that if the solar farm is retired and / or decommissioned the substation will remain.

Attachment 1.
Single Line Diagram



Attachment 2.
AE1-084 Switching Station General Arrangement