Generation Interconnection

Impact Study Report

for

Queue Project AD2-074

GARNER DP-LANCASTER 115 KV

32.68 MW Capacity / 86 MW Energy

Revision 1 November 2021

June, 2019

Contents

1 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).

2 Preface

The intent of the System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

In some instances an Interconnection Customer may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection or merchant transmission upgrade, may also contribute to the need for the same network reinforcement. The possibility of sharing the reinforcement costs with other projects may be identified in the Feasibility Study, but the actual allocation will be deferred until the System Impact Study is performed.

The System Impact Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. The project developer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

The Interconnection Customer seeking to interconnect a wind or solar generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per Schedule H to the Interconnection Service Agreement and Section 8 of Manual 14D.

3 Revision 1 Summary- October 2021

This revision is being issued to incorporate results of a re-tool performed. Additionally, the Stability Study Executive Summary was added for reference. SLD was updated to reflect this projects relationship to queue project AF1-042 as well.

4 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

5 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.

6 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	$0

7 Transmission Owner Scope of Work

7.1 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.

7.2 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.

7.3 Non-Direct Connection Cost Estimate

Transmission: Install transmission structure in-line with transmission line to allow the proposed interconnection switching station to be interconnected with the transmission system. Estimated cost is $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.

8 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.

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.

9.2 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

10 Network Impacts

The Queue Project AD2-074 was evaluated as a 86.0 MW (Capacity 32.7 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

11 Summer Peak Load Flow

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 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

11.5 Contingency Descriptions

The following contingencies resulted in overloads:

None

11.6 System Reinforcements

None

12 Short Circuit

The following breakers are overdutied:

None

13 Affected Systems

None

14 Stability

14.1 Steady-State Voltage Requirements

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

None

14.2 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.

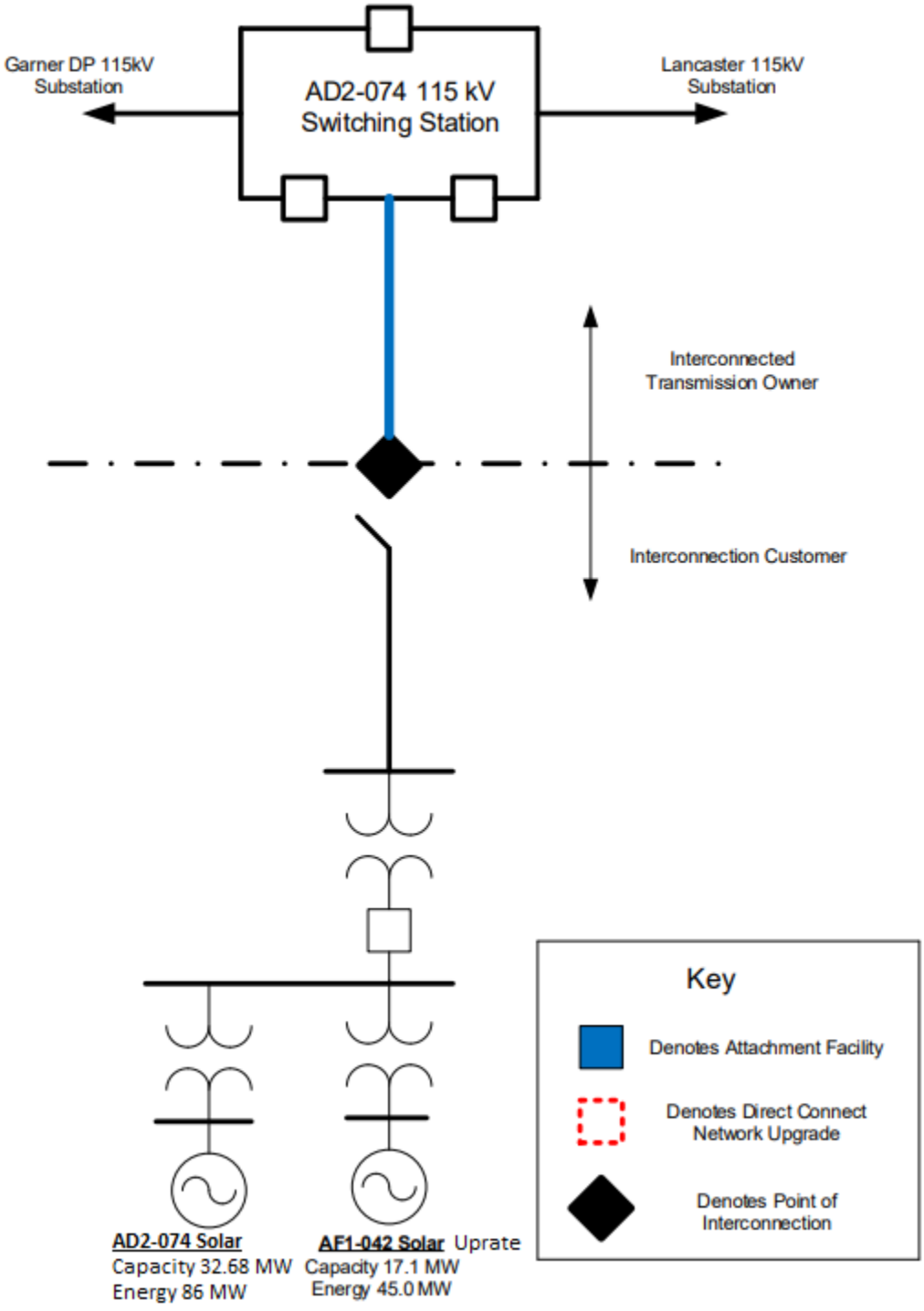
The reactive power capability of AD2-074 does not meet the 0.95 lagging PF requirement whereas leading PF requirement was met at the high side of the main transformer as shown in Table 2.

Table 1: AD2-074 Reactive Power Capability Assessment

Generator	MFO (MW)	Required Power Factor Range		Maximum Lagging (MVAr)	Minimum Leading (MVAr)
		Lagging	Leading		
AD2-074	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

15 Attachment 1

Single Line Diagram



16 Stability Study Executive Summary

Generator Interconnection Request AD2-074 is for an 86 MW Maximum Facility Output (MFO) solar generation plant. AD2-074 consists of 42 × 2.09 MW, SMA Sunny Central SC2200 solar PV inverters. The Point of Interconnection (POI) is a tap on Garner DP -Lancaster 115 kV circuit in the Dominion Virginia Power (DVP) transmission system, Lancaster County, Virginia.

This report describes a dynamic simulation analysis of AD2-074 as part of the overall system impact study.

The load flow scenario for the analysis was based on the RTEP 2021 peak load case, modified to include applicable queue projects. AD2-074 has been dispatched online at maximum power output, with 1.0 pu voltage at the generator bus.

AD2-074 was tested for compliance with NERC, PJM, Transmission Owner and other applicable criteria. Steady-state condition and 46 contingencies were studied, each with a 20 second simulation time period. Studied faults included:

a) Steady state operation (30 second);

b) Three phase faults with normal clearing time;

c) Single phase bus faults with normal clearing time;

d) Single phase faults with stuck breaker;

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

f) Single-phase fault with loss of multiple-circuit tower line.

No relevant high-speed reclosing (HSR) contingencies were identified for this study.

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

For all of the fault contingencies tested on the 2021 peak load case:

a) AD2-074 was able to ride through the faults (except for faults where protective action trips a generator(s)),

b) Post-contingency oscillations were positively damped with a damping margin of at least 3% for interarea modes and 4% for local modes.

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

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

e) Surry 500 kV bus voltage is within 510 kV – 530 kV range with less than 4.5% voltage drop for all contingencies, per PJM M03.

The reactive power capability of AD2-074 does NOT meet the 0.95 lagging PF requirement whereas 0.95 leading PF requirement was met at the high side of the main transformer.

No mitigations were found to be required due to instability. The project is deficient in meeting the lagging PF requirement by 10.72 MVAr.