Generation Interconnection

Impact Study Report

for

Queue Project AD2-085

MYRTLE-WINDSOR DP 115KV

19.38 MW Capacity / 51 MW Energy

February, 2019

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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 Carver 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).

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 IC has proposed a solar generating facility located in Isle of Wight County, VA. The installed facilities will have a total capability of 51 MW with 19.38 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.**

Queue Number	**AD2-085**
Project Name	MYRTLE-WINDSOR DP 115KV
Interconnection Customer	CARVER SOLAR I , LLC
State	Virginia
County	Isle of Wight
Transmission Owner	Dominion
MFO	51
MWE	51
MWC	19.38
Fuel	Solar
Basecase Study Year	2022

Point of Interconnection

AD2-085 will interconnect with the ITO transmission system via a new three breaker ring bus switching station that connects on the Myrtle – Windsor DP 115kV line #44.

Cost Summary

The AD2-085 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 AD2-085 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	$0

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

Note: 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.

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 AD2-085 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. 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. The total preliminary cost estimate for the Attachment work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
Generation Substation	$550,000
Transmission	$1,000,000
Total Attachment Facility Costs	$1,550,000

Direct Connection Cost Estimate

Substation: Establish the new 115 kV AD2-085 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.

Incremental Capacity Transfer Rights (ICTRs)

These network upgrades do not increase the CETL in the 2021/22 BRA case.

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 Section 8 of Attachment O Appendix 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 AD2-085 was evaluated as a 51 MW (Capacity 19.38 MW) injection as a tapped connection into Myrtle-Windsor 115kV in the ITO area. Project AD2-085 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD2-085 was studied with a commercial probability of 53%. Potential network impacts were as follows:

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)

None

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

Affected Systems

Duke Energy Progress

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

Anu to advise None

Short Circuit

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

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 AD2-085 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 as shown in Table 1.

Table 1: AD2-085 Reactive Power Capability Assessment

Generator	MFO (MW)	Required Power Factor Range		Maximum Lagging (MVAr)	Minimum Leading (MVAr)
		Lagging	Leading		
AD2-085	51	0.95	0.95		
Total Reactive Power Required				16.8	−16.8
Reactive Power from Generator				**Qmax**	**Qmin**
				17.2	−17.2
Customer Planned Compensation				0	0
Reactive Power Losses				−9.5	−9.5
Total Available Reactive Power at High Side of Main Transformer				7.7	−26.7
Deficiency in Reactive Power				9.1	Meet

Attachment 1

Single Line Diagram