Generation Interconnection
Facility Study Report

For

PJM Generation Interconnection Request
Queue Position AC1-075/AC1-080

Perth – Hickory Grove DP 115 kV
51.1 MW Capacity / 80 MW Energy

August / 2019

Introduction

This Facilities Study has been prepared in accordance with the PJM Open Access Transmission Tariff §207, as well as the Facilities Study Agreement between Water Strider Solar, LLC, (Interconnection Customer (IC)) and PJM Interconnection, LLC (Transmission Provider (TP)). The Interconnected Transmission Owner (ITO) is Virginia Electric and Power Company (VEPCO).

General

The IC has proposed two solar generating facilities located in Halifax County, Virginia.
The project AC1-075 will have an installed capability of 60 MW (38.3 MW Capacity) and AC1-080 will have an installed capability of 20 MW (12.8 MW Capacity). The AC1-075 and AC1-080 projects will share the same point of interconnection and were evaluated as a single combined project. The installed AC1-075/AC1-080 facilities will have a total capability of 80 MW, with 51.1 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is December 31, 2021. **This study does not imply an ITO commitment to this in-service date.**

Point of Interconnection

AC1-075/AC1-080 will interconnect with the ITO transmission system via a 115 kV one breaker terminal station tapping the Perth – Hickory Grove 115 kV line #1022.

Cost Summary

The AC1-075/AC1-080 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 2694589
Direct Connection Network Upgrades	$ 0
Non Direct Connection Network Upgrades	$1,431,461
Allocation for New System Upgrades	$ 0
Contribution for Previously Identified Upgrades	$ 0
Total Costs	**$4,126,050**

A. Transmission Owner Facilities Study Summary

1. Description of Project

The IC has proposed two solar generating facilities located in Halifax County, Virginia.
The project AC1-075 will have an installed capability of 60 MW (38.3 MW Capacity) and AC1-080 will have an installed capability of 20 MW (12.8 MW Capacity). The AC1-075 and AC1-080 projects will share the same point of interconnection and were evaluated as a single combined project. The installed AC1-075/AC1-080 facilities will have a total capability of 80 MW, with 51.1 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is December 31, 2021. **This study does not imply an ITO commitment to this in-service date.** Attachment Facility and Network Upgrade construction is estimated to be **14 – 24 months**.

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

The ITO updated the ITO scope from a three breaker ring bus substation to a 115 kV one breaker terminal station. The estimates provided in the System Impact Study have been refined as part of the Facilities Study.

3. Interconnection Customer's Submitted Milestone Schedule

- Permits – state level Permit By Rule and county level Final Site Plan approval complete by: July 1, 2020
- Plan to break ground July 1, 2020
- Substantial site work completed October 1, 2020
- Delivery of major electrical equipment October 1, 2020
- Back Feed Power November 1, 2020
- Commercial Operation December 31, 2021

4. Scope of Customer's Work

IC will build a solar generating facility in Halifax County, Virginia. The generating facility will be comprised of solar arrays:
AC1-075 consists of 25 x Solar Ware PHV-L2700GR 2.5 MW inverters
AC1-080 consists of 9 x Solar Ware PHV-L2700GR 2.5 MW inverters
The (34) 0.6/34.5 kV generator step up (GSU) transformers, each with a rating of 2.7 MVA will connect the solar inverters to the 115kV collector system. The generating facility will connect to the Point of Interconnection (POI) via a 115/34.5/13.8 kV Wye grounded Wye Grounded Delta main power transformer with a rating of 53/70.5/88MVA.
The AC1-075/AC1-080 POI will be at a new 115kV one breaker terminal station taping the Perth – Hickory Grove DP, line #1022.

5. Description of Facilities Included in the Facilities Study

The scope of work for AC1-075/AC1-080 includes the construction of a new interconnection switching station and necessary network upgrades to tie a 80 MW capacity solar generating

facility into the ITO transmission network. The ITO work scope includes the construction, of a 115kV one breaker terminal station and the required 115kV transmission line modifications.

The solar generating facility will be located south west of the existing Perth Substation. The point of interconnection will be near Perth Substation, between the 115kV line structures 1022/508 and 1022/509. The station will be positioned in such a way that the 115kV tap line can be taken directly rolled onto the Substation Backbone. One 115kV Circuit Breaker will be installed at this terminal along with disconnect switches, arresters, & PT's.

Metering equipment, including metering accuracy CT's and metering accuracy CCVT's, will be installed in the ITO substation. The property and the access for the ITO station will be provided by the developer. All substation permitting, site preparation and grading activity will be performed by the developer.
The collector station will be located adjacent to the ITO Switching Station. The demarcation point between ITO substation and the collector station will be the 4-hole pads on the ITO disconnect switch.

The Fence and Security Type will be Design 4.

Refer to the single line is shown in Attachment 1and Switching Station General Arrangement in Attachment 2 for additional details.

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

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
Attachment Facilities (N5939)	$1,132,328	$1,230,615	$191,628	$140,018	$2,694,589
Total Attachment Facilities Cost	$1,132,328	$1,230,615	$191,628	$140,018	$2,694,589
Direct Network Upgrade	$0	$0	$0	$0	$0
Total Direct Network Upgrade Costs	$0	$0	$0	$0	$0
Non-Direct Network Upgrade Line #1022 Transmission work, without MOAB (N5942)	$136,788	$439,230	$694,948	$75,352	$1,346,318
Non-Direct Network Upgrade Remote relay (N6129)	$67,323	$4,598	$12,734	$488	$85,143
Total Non-Direct Network Upgrade Costs	$204,111	$443,828	$707,682	$75,840	$1,431,461
Total Network Upgrades	$204,111	$443,828	$707,682	$75,840	$1,431,461
Total Project Costs	$1,336,439	$1,674,443	$899,310	$215,858	$4,126,050

* The above estimate assumes that the IC does not elect to install a Motorized Air Break (MOAB) Switch that can eliminate the possibility of the AC1-075/AC1-080 generation facility being taken off line due to a fault beyond the station on line 1022 tap towards the Hickory Grove DP station.

If the IC elects to have the MOAB installed, the Line #1022 Transmission work will be updated to:

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
Non-Direct Network Upgrade Line #1022 Transmission work, with MOAB (N5942)	**$136,788**	**$467,716**	**$971,866**	**$75,352**	**$1,651,722**

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

Facilities are estimated to take 14 - 24 months to construct and this is based on the ability to obtain outages to construct and test the proposed facilities.

Proposed Schedule

- Detailed design: 6-12 months
- Permitting: 6-12 months (Timeline runs concurrent with design)
- Construction 8 to 12 months

ITO requires the site to be fully graded and permitted site so they can start construction by April 1, 2020.

B. Transmission Owner Facilities Study Results

1. Attachment Facilities

PJM Network Upgrade # N5939: Install metering and associated protection equipment at the AC1-075/AC1-080 interconnection switching substation

Purchase and install substation material (Attachment Facilities):

1. Approximately 130' X 125' site preparation and grading as required for installation of the switching station (by the developer)
2. Approximately 510 linear FT of 5/8" Chain Link, 12 FT tall, perimeter fence around the station along with the security cameras and integrators (Design 4 Standard).
3. Full substation ground grid as per ITO engineering standards
4. One (1), 115kV, 3000A, 40 kA, SF_6 Circuit Breaker
5. One (1), 115 kV, 2000A, Vertically Mounted, Vertical Break Switch
6. One (1), 115 kV, 2000A, Horizontally Mounted, Center Break Switch
7. One (1), 115 kV, CCVT, Relay Accuracy
8. Six (6), 90 kV MO, 74 kV MCOV Station Class Arresters
9. One (1), 69kV, 50 KVA Power PT for Station Service
10. One (1), 24' x 30' Control Enclosure (w/ provisions for backup generator connection for secondary Station Service)
11. One (1), 135 VDC, 300 Ah Batteries and 50A Charger
12. Three (3), 115 kV, Metering Accuracy CCVT's
13. Three (3), 115 kV, Metering Accuracy CT's
14. Oil Containment system as required for the 69kV PVT.
15. Steel structures as required including switch stands, bus supports, station service transformer, CCVT and wave trap supports
16. Foundations as required including control house, equipment and bus support stands
17. Conductors, connectors, conduits, control cables and grounding materials as per engineering standards
18. One (1) 115 kV Backbone Structure

Purchase and install relay material (Attachment Facilities):

1. One (1), 1510 – 28" Dual SEL-351-7 Transmission Breaker w/ Reclosing Panel
2. One (1), 4510 - SEL-2411 Breaker Annunciator
3. One (1), 4000 – Station Service Potential M.U. Box
4. One (1), 4007 – 225A Outdoor Transmission Yard AC NQOD
5. One (1), 4019 – 225A Three Phase Throwover Switch
6. Three (3), 200A Disconnect Switch
7. One (1), 4153 – Wall Mount Station Battery Monitor
8. One (1), 5613 – Annunciator / RTU / Communications Panel
9. One (1), 5610 – Wall Mounted Fiber Optic Management Housing
10. One (1), 4526_A – Circuit Breaker Fiber Optic M.U. Box
11. One (1), 5603 – Station Network no. 1 Panel
12. One (1), 5603 – Station Network no. 2 Panel

13. One (1), 5616 – Station Security Panel
14. One (1), High Voltage Protection (HVP) Box
15. One (1), Telephone Interface Box
16. One (1), 1109 – 28" Dual SEL-587Z Transmission Bus Panel
17. One (1), 1425 – Generation/NUG/PJM/IPP Metering Panel
18. One (1), 4524 – Revenue Metering C.T. M.U. Box
19. One (1), 4506 – Generator Interconnect CCVT Potential M.U. Box
20. One (1), 1323 – 28" SEL-451 PMU Panel w/SEL 735/735
21. Two (2), 4541 - Control Cable M.U. Box
22. One (1), 7609 – SEL-2505 Transfer Trip Receive Package
23. One (1), 4507 - Single Phase CCVT Potential M.U. Box

2. Transmission Line – Upgrades

PJM Network Upgrade # N5942 – Modifications to the Perth – Hickory Grove DP 115kV, line #1022

Constructed in 1971 on wood H-Frame structures, the 1022 line is an existing 115 kV line that runs from Perth Substation to Hickory Grove DP.
Project AC1-075/AC1-080 will build a short tap line from the 1022 mainline to the proposed Stage Coach (Interconnection Switching) substation in Halifax County, VA and will install a one breaker substation that will provide a connection point for the solar generator.

The following estimate is for the construction of a new substation connection on Transmission Line 1022 between Perth Substation and Hickory Grove DP.
The line connection will require the installation of:

- one (1) backbone structure, one (1) static pole structure
- one (1) Double Deadend tap Structure
- one (1) Dom-pole suspension structure,
- one (1) optional Motor-operated switch and
- OPGW to Perth Substation.

A separate ITO project, Project 943049, will occur on the 1022 line simultaneously with this Generator Interconnect project. Project 943049 will rebuild the 1022 line from the junction near Perth substation to Hickory Grove D.P. Although the tap rebuild is a totally separate project from the Generator Interconnect, a certain degree of coordination is necessary between the two projects.

The conceptual design and estimate includes costs for the following:

ESTIMATE – FACILITIES TO BE INSTALLED:

1. Install one (1) 115 kV SC Heavy-Duty Steel DDE Backbone structure (no switches) with foundations.
2. Install one (1) Galvanized Steel Static Pole with foundations.
3. Install one (1) Steel DDE tap structure on the main 1022 line.

4. Install one (1) Dom-pole H-Frame structure on the tap line between the 1022 mainline and Stage Coach Substation.
5. Install approximately 1.28 miles of one (1) OPGW cable from Perth Substation to the new AC1-075/AC1-080 substation.
6. Install approximately 0.20 miles of new 1-7#7 static wire.
7. Install approximately 0.17 miles of new 636 ACSR 24/7 "Rook" conductor from the new DDE tap structures to the new Backbone Structure.

Note: Conductor and static wire on the 1022 mainline will be connected to the tap structure under tap rebuild Project 943049.

ESTIMATE – OPTIONAL FACILITIES TO BE INSTALLED:

This estimate has been developed with an option to install a motor-operated switch on the 1022 main-line (see Attachment 1). Motor-operated switches are typically installed inside a substation, and there are some technical challenges involved with installing it in the Right of Way relatively far from a station. These challenges contribute to the substantial cost estimate. The switch will only be installed if the developer decides to pursue this option.

ESTIMATE – MISCELLANEOUS:
1. Additional permanent Right of Way will need to be obtained for the tap line from the 1022 Mainline to Stage Coach Substation. This estimate assumed that the developer will grant Dominion this easement at no cost.
2. OPGW to Perth is a 24-fiber OPGW.

CONCEPTUAL DESIGN NOTES:
1. Stage Coach Substation may be designed with a security fence up to 15' AGL.

3. New Substation/Switchyard Facilities

The cost for the one breaker switching station is included in the Attachment Facilities Scope above.

4. Upgrades to Substation / Switchyard Facilities

PJM Network Upgrade # N6129 - Remote protection and communication work.

ITO protection requirements to reliably interconnect the proposed generating facility with the transmission system determined that work is required at Perth 115kV substation. These costs include the following:

Project Summary

Project AC1-075/AC1-080 provides for the necessary drawing updates, Transfer trip and Fiber Installation to support the new AC1075/AC1-080 substation and the installation of necessary conduit to terminate new fiber into the control enclosure panel.

Purchase and install:

1. Install any necessary conduit, grounding, and control cable per Dominion Substation Engineering Standards

Purchase and install relay material:

1. One (1), 7609 – SEL-2505 Transfer Trip Send Package
2. One (1), Transmission Fiber Patch Panel

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
Perth Substation Upgrades	$67,323	$4,598	$12,734	$488	$85,143
Total Remote Relay Cost	$67,323	$4,598	$12,734	$488	$85,143

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 Sections 24.1 and 24.2.

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 publically 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

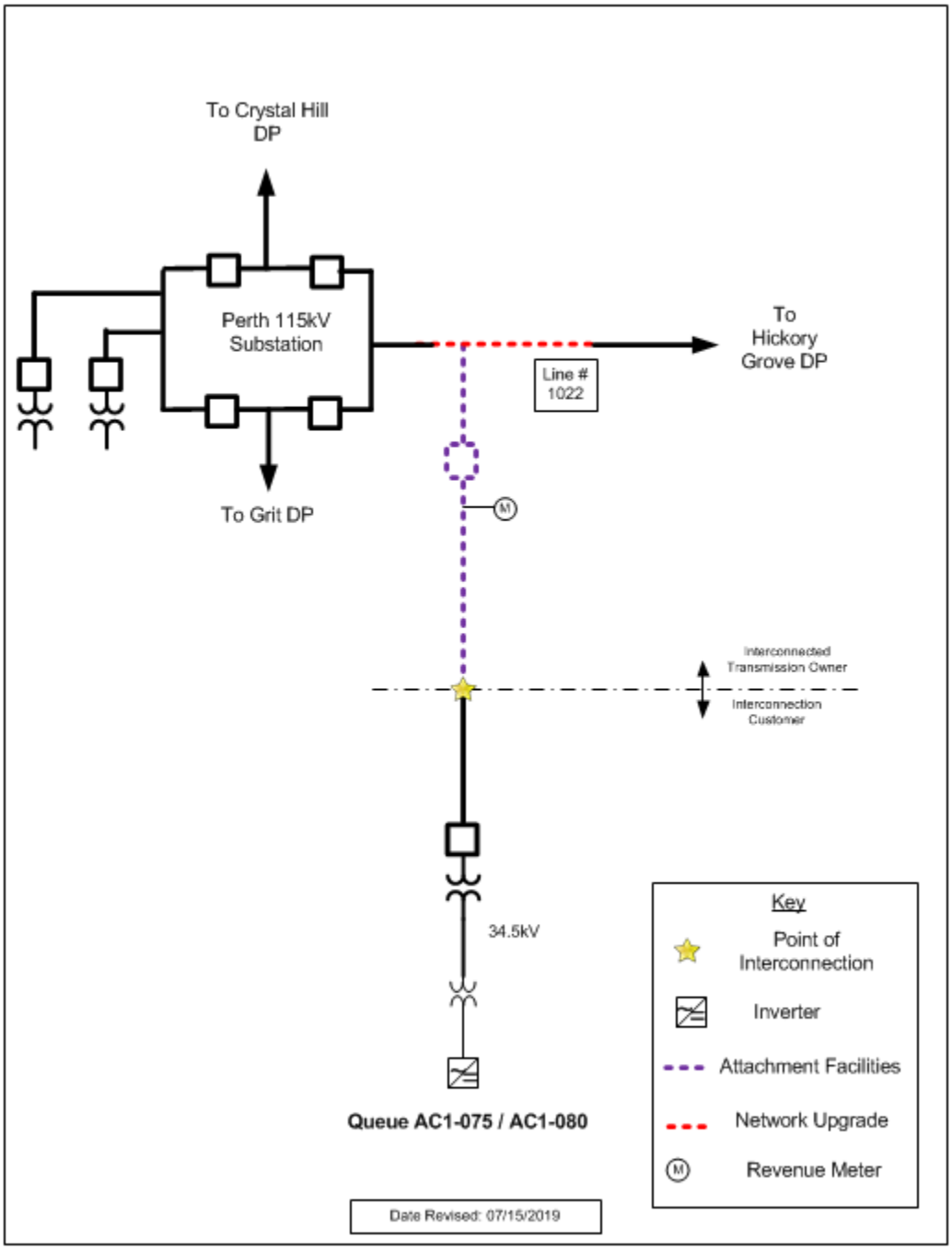
The IC would be responsible for the following expectations in the area of Environmental, Real Estate and Permitting:

- 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 switching station layout is complete and ITO requires a 130' x 125' piece of property (title in fee) to build the switching station. The property includes the piece of property between the substation and collector station for the strain bus.
    - ITO requires ownership transfer of the switching station site before they start construction. Target for the deed by April 1, 2020.
    - The size of the switching station assumes ITO will not need a separate storm water management system for the switching station. If the county rules differently, then 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 switching station will remain.

Attachment 1.
Single Line



Attachment 2.

AC1-075/AC1-080 Switching Station General Arrangement