Generation Interconnection
Facility Study Report

For

PJM Generation Interconnection Request
Queue Position AC1-0222 / AD1-055

Crystal Hill – Sedge Hill 115kV
38.8 MW Capacity / 64.7 MW Energy

January, 2020

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 Urban Grid Solar Projects LLC, (Interconnection Customer (IC)) and PJM Interconnection, LLC (Transmission Provider (TP)). Virginia Electric and Power Company is the Interconnected Transmission Owner (ITO) and provided the input to develop this study.

The IC has proposed a solar generating facility located on Crystal Hill Road, Halifax County, Virginia. The installed facilities will have a total capability of 64.7 MW with 38.8 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is 07/31/2021. **This study does not imply an ITO commitment to this in-service date.**

Point of Interconnection

AC1-222 \ AD1-055 will interconnect with the ITO transmission system via a new three breaker ring bus switching station that connects onto the Crystal Hill – Sedge Hill 115kV line # 1016.

Cost Summary

The AC1-222 \ AD1-055 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 486,675
Direct Connection Network Upgrades	$ 5,143,526
Non Direct Connection Network Upgrades	$ 870,200
Allocation for New System Upgrades	$ 0
Contribution for Previously Identified Upgrades	$ 0
Total Costs	**$ 6,500,401**

A. Transmission Owner Facilities Study Summary

1. Description of Project

Queue AC1-222 \ AD1-055 is a request to interconnect a 64.7 MW new solar generating facility to be located in Halifax County, Virginia. The proposed generating facility will interconnect with the ITO's new AC1-222 115kV switching station via a new three breaker ring-bus switching station. The requested in-service date is July 31, 2021. Attachment Facility and Network upgrade construction is estimated to be 8 – 12 months.

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

The AC1-222 \ AD1-055 stability study was completed during the Facilities Study phase and no mitigations were found to be required.

3. Interconnection Customer's Submitted Milestone Schedule

- Plan to break ground April 15, 2020
- Permits – state level Permit By Rule and county level Final Site Plan approval complete April 15, 2020
- Substantial site work completed January 15, 2021
- Delivery of major electrical equipment December 31, 2020
- Back Feed Power April 15, 2021
- Commercial Operation July 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. AC1-222 \ AD1-055 consists of 25 x 2.7 MVA TMEIC Solar Ware 2700 PVH-L2700GR inverters. The 25 x 34.5 / 0.600 kV grounded wye delta 2.7 MVA generator step up (GSU) transformers will connect to the solar inverters to the 34.5 kV collector system. The collector bus will also have 2 x 12 MVar and 1x 6 MVar capacitor banks. The generating facility will connect to the Point of Interconnection (POI) via a 115/34.5 kV wye ground/delta main power transformer with a rating of 48/64/80 MVA. The AC1-222 \ AD1-055 POI will be at a tap of the Crystal Hill – Sedge Hill 115kV line # 1016.

5. Description of Facilities Included in the Facilities Study

The ITO will connect the proposed generator lead via Attachment Facilities to a new AC1-222 ring bus switching station directly underneath the 1016 line. The site is located along the ITO's 115kV Line #1016 between existing Sedge Hill and Crystal Hill substations. The switching station will be positioned in such a way that the new backbone will be replace the existing 2-pole wood suspension H-frame structure # 1016/35. The cut lines will be attached to the new backbone and risers will be dropped from both sides of the backbone to the bus sections directly underneath the line. The lines will consume two of the three positions in the ring bus. The third position will be for the 115 kV feed from the collector station for the solar farm. The Point of Interconnection between the switching station and the collector station will be the 115kV breaker

disconnect switch 4-hole pad in the IC's collector station by the common fence. The ITO will bring its bus to the demarcation point. Metering equipment will be installed in the ITO Switching Station. The grounding systems for both stations will be tied together. The IC will provide the property and access to the switching station. All substation permitting, site preparation and grading activity will be performed by the IC. There will be transmission line protection and anti-islanding work required at the remote line terminals in Sedge Hill and Perth substation. Site plan (Attachment 2) was developed by the ITO during PJM's Generation Queue Process. The single line is shown in Attachment 1.

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

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
Attachment Facilities	$274,537	$147,897	$45,511	$18,730	$486,675
Total Attachment Facilities Cost	$274,537	$147,897	$45,511	$18,730	$486,675
AC1-222 115 kV Switching Station (n6333)	$2,442,218	$2,062,843	$387,988	$250,477	$5,143,526
Line #1016 Transmission work (n6332)	$415,259	$178,719	$64,504	$27,931	$686,413
Remote relay (n6331)	$84,720	$71,745	$19,330	$7,992	$183,787
Total Network Upgrades	$2,942,197	$2,313,307	$471,822	$286,400	$6,013,726
Total Project Costs	$3,216,734	$2,461,204	$517,333	$305,130	$6,500,401

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 September 2020.

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 Point of Interconnection between the switching station and the collector station will be the 115kV breaker disconnect switch 4-hole pad in the IC's collector station by the common fence. The ITO will

bring its bus to the demarcation point. Metering equipment will be installed in the ITO Switching Station. The equipment associated with the Attachment Facilities includes the following. 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) 115 kV, 2000A, 3-phase Center Break Gang Operated Switches
2. Three (3) 115 kV metering accuracy CCVT's
3. Three (3) 115 kV metering accuracy CT's
4. Conductors, connectors, conduits, control cables, foundations, steel structures and grounding material

Purchase and install relay material:

1. One (1), 1109 – 28" Dual SEL-587Z Transmission Bus Panel
2. One (1), 4200 – Bus Differential C.T. M.U. Box
3. One (1), 1425 – 28" Dual SEL-735 Metering Panel (Transmission & Generation Interconnect)
4. One (1), 4524 – Revenue Metering C.T. M.U. Box
5. One (1), 4531 – Generator Interconnect CCVT Potential M.U. Box
6. One (1), 1323 – 28" SEL-487E/735 PMU & PQ Monitoring Panel
7. Two (2), 4541 - Control Cable M.U. Box

2. Transmission Line – Upgrades

PJM Network Upgrade #n6332 - Re-arrange Line #1016 to loop into and out of the new three breaker AC1-222 115 kV switching station between existing Crystal Hill and Sedge Hill substations. The line connection will require the installation of (1) backbone structure, two (2) static pole structures, and the removal of the existing 2-pole wood suspension H-frame. The conceptual design and estimate includes costs for the following:

ESTIMATE – FACILITIES TO BE REMOVED:

1. Remove existing 2-pole wood suspension H-frame Str. # 1016/35.

ESTIMATE – FACILITIES TO BE INSTALLED:

1. Install (1) 115KV Galvanized Steel Backbone Structure with 31'-6" spacing inside the Switching Station.
2. Install (2) Galvanized Static Pole Structures inside Switching Station.
3. Install three spans of 1-7#7 ALWD shield wire (approximately 0.10 miles) from Proposed Backbone to each Proposed Static Pole and between the two Proposed Static Poles.
4. Transfer existing three-phase 2-545 ACAR and 2-3#6 ALWD to proposed backbone.

3. New Substation/Switchyard Facilities

PJM Network Upgrade #n6333 - Build a three breaker AC1-222 115 kV switching station. The site is located along the ITO's 115kV line #1016 from Crystal Hill and Sedge Hill substations. The switching station will be positioned in such a way that the new backbone will be

replace the existing 2-pole wood suspension H-frame structure # 1016/35. The cut lines will be attached to the new backbone and risers will be dropped from both sides of the backbone to the bus sections directly underneath the line. The lines will consume two of the three positions in the ring bus. The third position will be for the 115 kV feed from the collector station for the solar farm.

Detail engineering to inquire if pre-ordered material is available, otherwise the project will follow the current long lead time material ordering process.

Currently, the scope and estimate assumes the use of ITO standard spread footer foundations. Once the soil information is received and pile foundations may be required. The change to pile foundations will require adjustment to the project cost estimate.

The work required is as follows:

Purchase and install substation material:

1. Approximately 260’ X 170’ site preparation and grading as required for installation of the switching station (by the IC)
2. Three (3), 115kV, 3000A, 40 kA, SF-6 Circuit Breakers
3. Six (6), 115kV, 2000A Center Break Switches
4. Two (2), 115kV, 2000A, 2-Pole Center Break Switches (for PVT’s)
5. Six (6), 115kV, CCVT's relay accuracy
6. Two (2), 2000A, Vertically Mounted, Wave Traps
7. Two (2), Line Tuners
8. Six (6), 90kV MO, Station Class, 74kV MCOV Surge Arresters
9. Four (4), 115kV, 100KVA Power PT's for Station Service
10. One (1), 24' x 40' Control Enclosure, prewired by Trachte
11. One (1), 135VDC, 577Ah Batteries with Charger
12. Oil Containment as required for 115kV PVT’s.
13. Tubular bus as required
14. Fence as required (Security Design Level 4)
15. Steel Structures as required
16. Conductor, connectors, conduit, control cable, foundations and grounding material as required per engineering standards

Purchase and install relay material:

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), 1320 – 28” Dual SEL-421-5 DCB Line Panel
4. Two (2), 4506 – 3 Phase CCVT Potential M.U. Box
5. One (1), 1603 – 28” SEL-451 Islanding Control Scheme Panel
6. Two (2), 4000 – Station Service Potential 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 Throwover Switch
10. Two (2), 4016 – 600A PVT Disconnect Switch
11. One (1), 4153 – Wall Mount Station Battery Monitor
12. One (1), 5612 - SEL-3530 Data Concentrator 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 M.U. Box
17. One (1), 5202 – 26" APP 601 Digital Fault Recorder
18. One (1), 5603 – Station Network Panel 1
19. One (1), 5603 – Station Network Panel 2
20. One (1), 5616 – Station Security Panel
21. One (1), Telephone Interface Box
22. One (1), High Voltage Protection (HVP) Box (Provided by IT)

4. Upgrades to Substation / Switchyard Facilities

PJM Network Upgrade #n6331 - 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 and Sedge Hill 115kV substations. These costs include the following:

Perth 115 kV Substation

Project Summary
Drawing work, relay resets, and field support necessary to change line #1016 destination from Sedge Hill substation to the AC1-222 substation. Also install line #1016 breaker failure & islanding transfer trip scheme to work with the new AC1-222 substation. The estimated cost of this scope is $91,894.

Purchase and install relay material:
1. One (1), 1604 – Islanding Transfer Trip Panel 24"
2. One (1), CS-51C Breaker Failure Transfer Trip Set

Sedge Hill 115 kV Substation

Project Summary
Drawing work, relay resets, and field support necessary to change line #1016 destination from Perth substation to the AC1-222 substation. Also install line #1016 breaker failure & islanding transfer trip scheme to work with the new AC1-222 substation. The estimated cost of this scope is $91,893.

Purchase and install relay material:
1. One (1), 1604 – Islanding Transfer Trip Panel 24"
2. One (1), CS-51C Breaker Failure Transfer Trip Set

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
Perth	$51,981	$27,462	$12,156	$295	$91,894
Sedge Hill	$32,739	$44,283	$7,174	$7,697	$91,893

Total Remote Relay Upgrades	$84,720	$71,745	$19,330	$7,992	$183,787

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 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:

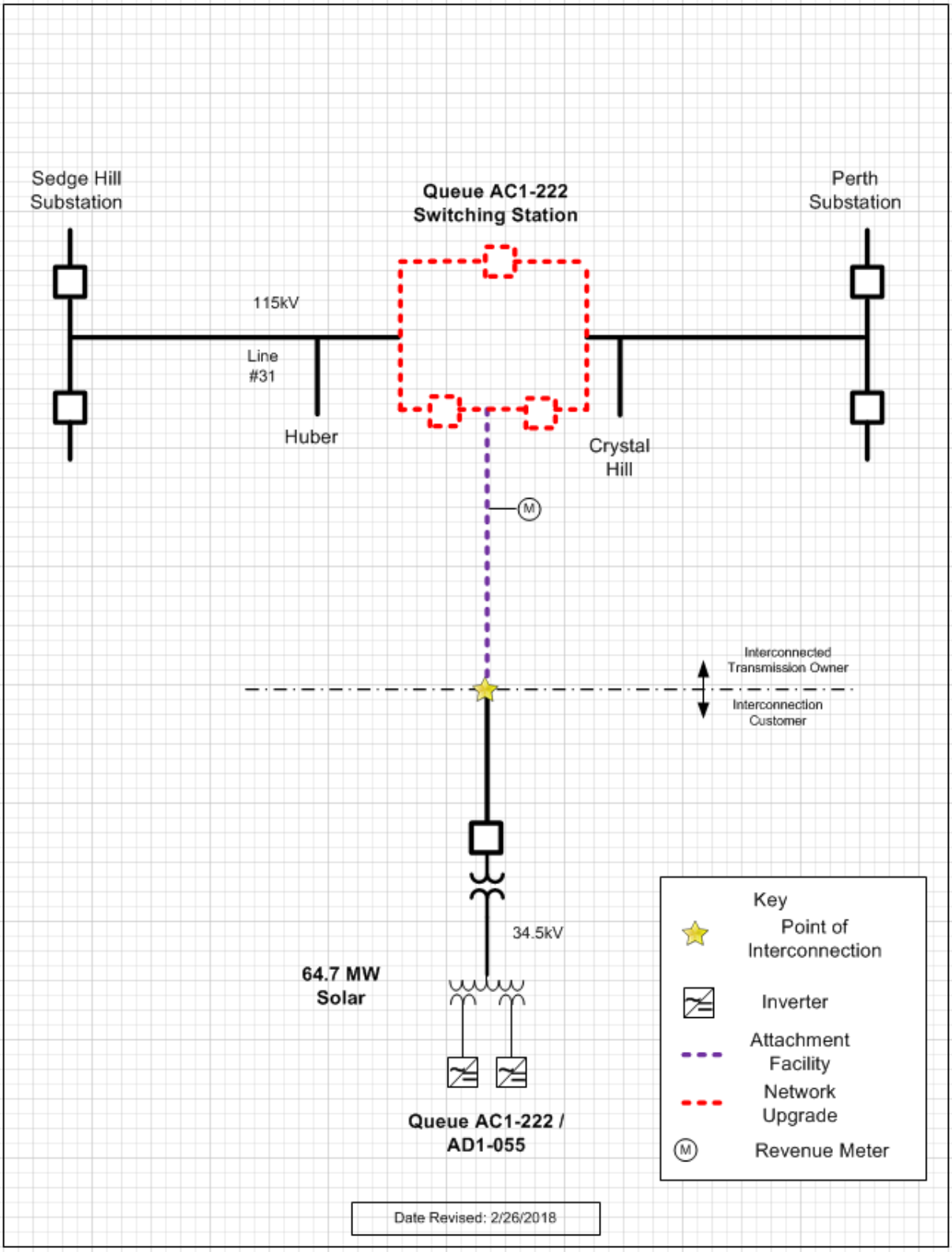
- Suitable Access Road from Substation to a Virginia State Maintained Roadway.
- Any additional land needed for Storm Water Management, Landscaping, and Wetlands/Wetlands Mitigation.
- Conditional Use Permit for Substation.
- Any other Land/Permitting requirements required by the Substation.

ITO Real Estate Needs:

- The substation layout is complete and ITO requires a 260'x 170' 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 September 2020.
    - The size of the station assumes ITO will not need a separate storm water management system for the substation. 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 substation will remain.

Attachment 1.
Single Line



Attachment 2.

AC1-222 \ AD1-055 Switching Station General Arrangement