Generation Interconnection
Facility Study Report

For

PJM Generation Interconnection Request
Queue Position AC1-221 / AD1-058

Person – Sedge Hill 230kV
51.2 MW Capacity / 75.1 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 Alton Post Office Road, Halifax County, Virginia. The installed facilities will have a total capability of 75.1 MW with 51.2 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

AC1-221 \ AD1-058 will interconnect with the ITO transmission system via a new three breaker ring bus switching station that connects onto the Person – Sedge Hill 230kV line # 296.

Cost Summary

The AC1-221 \ AD1-058 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 614,674
Direct Connection Network Upgrades	$ 5,800,636
Non Direct Connection Network Upgrades	$ 838,461
Allocation for New System Upgrades	$ 0
Contribution for Previously Identified Upgrades	$ 0
Total Costs	$ 7,253,771

A. Transmission Owner Facilities Study Summary

1. Description of Project

Queue AC1-221 \ AD1-058 is a request to interconnect a 75.1 MW new solar generating facility to be located in Halifax County, Virginia. The proposed generating facility will interconnect with the ITO's new AC1-221 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

None

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. AC1-221 \ AD1-058 consists of 29 x 2.7 MVA TMEIC Solar Ware 2700 PVH-L2700GR inverters. The 29 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 230/34.5 kV wye ground/delta main power transformer with a rating of 54/72/90 MVA. The AC1-221 \ AD1-058 POI will be at a tap of the Person – Sedge Hill 230kV line # 296.

5. Description of Facilities Included in the Facilities Study

The ITO will connect the proposed generator lead via Attachment Facilities to a new AC1-221 ring bus switching station directly underneath the 296 line. The site is located along the ITO's 230kV Line #296 between existing Sedge Hill and Person substations. The switching station will be positioned in such a way that the new backbone will be replace the existing 2-pole weathering steel suspension H-frame structure # 296/165. 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 230 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 230kV 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 terminal in Sedge Hill 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	$293,935	$242,364	$49,593	$28,782	$614,674
Total Attachment Facilities Cost	$293,935	$242,364	$49,593	$28,782	$614,674
AC1-221 230 kV Switching Station (n6357)	$2,322,170	$2,798,921	$377,060	$302,485	$5,800,636
Line #296 Transmission work (n6356)	$494,344	$173,992	$73,721	$27,193	$769,250
Remote relay (n6355)	$27,190	$30,949	$6,293	$4,779	$69,211
Total Network Upgrades	$2,843,704	$3,003,862	$457,074	$334,457	$6,639,097
Total Project Costs	$3,137,639	$3,246,226	$506,667	$363,239	$7,253,771

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 230kV 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) 230 kV, 3000A, 3-phase Center Break Gang Operated Switches
2. Three (3) 230 kV metering accuracy CCVT's
3. Three (3) 230 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), 1421 – Generation/NUG/PJM/IPP Metering Panel
4. One (1), 4524 – Revenue Metering C.T. M.U. Box
5. One (1), 4506 – 3 Phase CCVT Potential M.U. Box
6. One (1), 1611 – 28" SEL-451 PMU Panel w/SEL 735/735
7. One (1), Customer Interface Box

2. Transmission Line – Upgrades

PJM Network Upgrade #n6356 - Re-arrange Line #296 to loop into and out of the new three breaker AC1-221 230 kV switching station between existing Person 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 weathering steel suspension H-frame Str. # 296/165.

ESTIMATE – FACILITIES TO BE INSTALLED:

1. Install (1) 230 kV Galvanized Steel Backbone Structure with 38' 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 2-571 ACSS/TW/HS-285 and 2-3#6 ALWD to proposed backbone.

3. New Substation/Switchyard Facilities

PJM Network Upgrade #n6357 - Build a three breaker AC1-221 230 kV switching station. The site is located along the ITO's 230 kV line #296 from Person 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 weathering steel suspension H-frame structure # 296/165. 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 230 kV feed from the collector station for the solar farm.

Because the AC1-221 project switching station splits the existing 296 line between Sedge Hill substation and Person substation (Duke Energy/Progress), zonal, tie-line revenue metering will need to be relocated from Sedge Hill substation to the AC1-221 switching station. Metering class CTs and CCVTs will be required on the switching station line terminal in the AC1-221 switching station.

Duke Energy/Progress will be asked to install islanding transfer trip transmit and breaker failure transfer trip transmit at Person substation to work with the new AC1-221 substation. Breaker failure receive transfer trip currently exists between Person and Sedge Hill and should be leveraged to move the remote end at Person substation from Sedge Hill to the AC1-221 switching station. The work at Person substation is not part of the scope of this study and the costs for that work are not represented here. This work will occur under a separate agreement between Duke/Energy Progress and the IC.

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 304’ X 185’ site preparation and grading as required for installation of the switching station (by the IC)
2. Three (3), 230-kV, 3000A, 50 kA SF-6 Circuit Breakers
3. Six (6), 230-kV, 3000A Center Break Switches
4. Two (2), 230-kV, 3000A, 2-Pole Center Break Switches (for PVT’s)
5. Three (3), 230-kV, CCVT's relay accuracy
6. Three (3), 230-kV, CCVT's metering accuracy
7. Three (3), 230-kV, 2000/5, TR2.5 metering accuracy CTs
8. Two (2), 3000A, Vertically Mounted, 115-300Hz Wave Traps
9. Two (2), Line Tuners
10. Six (6), 180-kV, 144 kV MCOV Surge Arresters
11. Four (4) 230-kV, 167 kVA Power PT's for Station Service
12. One (1), 24' x 40' Control Enclosure, prewired by Trachte
13. One (1), 135VDC, 577 Ah Batteries with Charger (capacity requirements to be verified)
14. Oil Containment as required for 230kV PVT’s.
15. Fence as required
16. Steel Structures as required

17. Install two (2) sets of 3-phase connections for connection of Risers to substation tubular Bus
18. 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. One (1), 4153 – Wall Mount Station Battery Monitor
11. One (1), 5612 - SEL-3530 Data Concentrator Panel
12. One (1), 1255 – Station Annunciator Panel
13. One (1), 5021 – SEL-2411 RTU Panel
14. One (1), 5609 – Fiber Optic Management Panel
15. Three (3), 4526_A – Circuit Breaker Fiber Optic M.U. Box
16. One (1), 5202 – 26" APP 601 Digital Fault Recorder
17. One (1), 5603 – Station Network Panel
18. One (1), 4523 – Security Camera Interface Box
19. One (1), 5603 – Station Network Panel
20. One (1), 5611 – Transmission Fiber Patch Panel
21. One (1), Telephone Interface Box

4. Upgrades to Substation / Switchyard Facilities

PJM Network Upgrade #n6355 - 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 the Sedge Hill 230 kV substation. These costs include the following:

Sedge Hill 115 kV Substation

Project Summary
Drawing work, relay resets, and field support necessary to change the line 296 destination from Person substation to AC1-221 substation. Also install line 296 islanding and breaker failure transfer trip schemes to now work with the new AC1-221 substation (replace the existing CT-51C breaker failure transmitter with a CS-51C to send/receive breaker failure transfer trip to/from AC1-221). Also remove line 296 tie line revenue metering from the Sedge Hill substation, as this function will be moved to the new AC1-221 substation. The estimated cost of this scope is $69,211.

Purchase and install relay material:

1. One (1), CT-51C Islanding Transfer Trip Set

2. One (1), SEL-2411 Maintenance Switch
3. One (1), CS-51C Breaker Failure Transfer Trip Set

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
Sedge Hill	$27,190	$30,949	$6,293	$4,779	$69,211
Total Remote Relay Upgrades	$27,190	$30,949	$6,293	$4,779	$69,211

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:

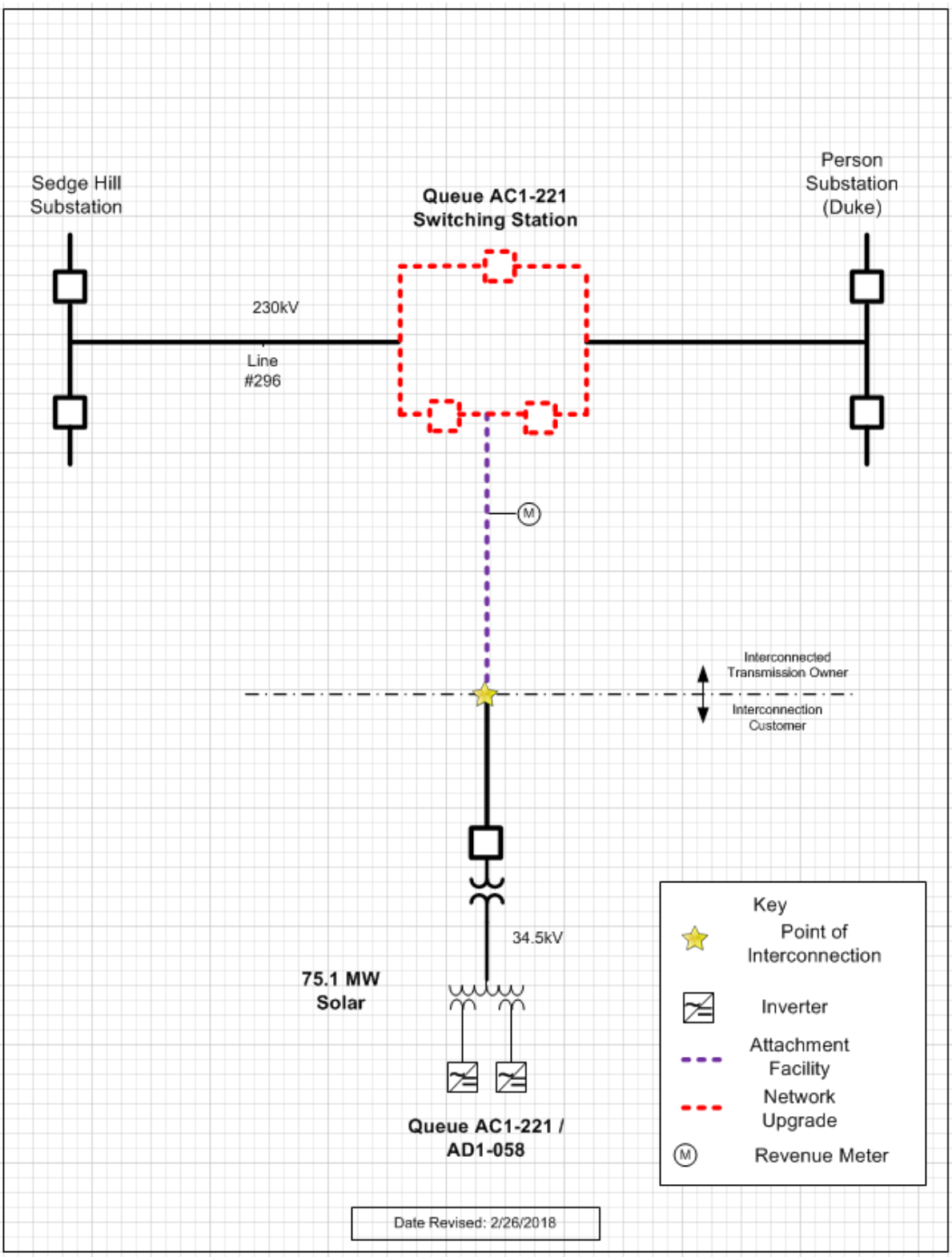
- Suitable Access Road from Substation to a Virginia State Maintained Roadway.

- 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 304'x 185' 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.
AC1-221 \ AD1-058 Switching Station General Arrangement