Generation Interconnection
Facility Study Report

For

PJM Generation Interconnection Request
Queue Position AE1-084

Barterbrook-Stuarts Draft 115 kV
49.8 MW Capacity / 83 MW Energy

October, 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 Round Hill 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).

The IC has proposed a solar generating facility located in Riverheads (Augusta County), Virginia. The installed facilities will have a total capability of 83 MW with 49.8 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is October 31, 2023. **This study does not imply an ITO commitment to this in-service date.**

Point of Interconnection

AE1-084 will interconnect with the ITO transmission system via a new three breaker ring bus switching station that connects on the Barterbrook - Stuarts Draft 115 kV line.

Cost Summary

The AE1-084 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$537,969
Direct Connection Network Upgrades	$5,572,065
Non Direct Connection Network Upgrades	$1,036,539
Allocation for New System Upgrades	$0
Contribution for Previously Identified Upgrades	$0
Total Costs	**$7,146,573**

A. Transmission Owner Facilities Study Summary

1. Description of Project

Queue AE1-084 is a request to interconnect an 83 MW new solar generating facility to be located in Riverheads (Augusta County), Virginia. AE1-084 will interconnect with the ITO transmission system via a new three breaker ring bus switching station that connects on the Barterbrook-Stuarts Draft 115 kV line #117. 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

None

3. Interconnection Customer's Milestone Schedule

- Plan to break ground August 15, 2022
- Permits – state level Permit By Rule and county level final site plan approval complete July 15, 2022
- Substantial site work completed June 15, 2023
- Delivery of major electrical equipment April 15, 2023
- Back Feed Power April 30, 2023
- Commercial Operation October 31, 2023

4. Scope of Customer's Work

Generator Interconnection Request AE1-084 is for an 83 MW solar generation plant. AE1-084 consists of 108 x 0.77 MW TMEIC PVU-L0840GR solar inverters and will be connected to the Point of Interconnection (POI) via a 115/34.5/13.8 kV main transformer with ratings 57/76/95 MVA (OA/F1/F2) and 27 x 34.5/0.63 kV 3.36 MVA (ONAN) GSU transformers.

5. Description of Facilities Included in the Facilities Study

The ITO will connect the proposed generator lead via Attachment Facilities to a new AE1-084 three-breaker ring bus switching station adjacent to the #117 line between the existing Barterbrook-Stuarts Draft substations. The site is located along Dominion Energy's existing 115 kV, 117 Line from Dupont-Waynesboro substation to Dooms substation. The cut line will consume two of the positions in the ring bus. The third position will be for the 115 kV feed from the IC's Collector Station for the new 83 MW Solar Farm.

The new 115 kV Three Breaker Ring Substation will share a common footprint and fence line with the IC's Collector Station. The demarcation point between the two stations will be the 115kV Breaker Disconnect Switch 4-hole pad in the IC's Collector Station by the common fence. Dominion Energy will bring its bus to the demarcation point. The bus, structures, disconnect switch, metering accuracy CCVT's, metering accuracy CT's, protection and metering equipment will be Attachment Facilities. The grounding systems for each station will be tied together.

Transmission Lines to renumber the existing line segment between the new Three Breaker Ring Substation and Dooms Substation. The existing line segment between the new Three Breaker Ring Substation and Dupont-Waynesboro Substation shall remain Line 117.

Additional Work to be required at Dupont-Waynesboro and Dooms 115 kV Substations.

There will be drawing updates, transmission line protection and anti-islanding work required at the remote line terminals at the Dooms, Dupont-Waynesboro, Fishersville, Nibco and Stuarts Draft substations. 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	$311,177	$157,062	$52,548	$17,182	$537,969
Total Attachment Facilities Cost	$311,177	$157,062	$52,548	$17,182	$537,969
New Switching Station (n6764)	$2,597,161	$2,338,723	$395,528	$240,653	$5,572,065
Trans line #117 (n6765)	$454,608	$204,590	$64,400	$44,621	$768,219
Total Remote Changes (n6766)	$133,685	$91,528	$28,815	$14,292	$268,320
Total Network Upgrades	$3,185,454	$2,634,841	$488,743	$299,566	$6,608,604
Total Project Costs	$3,496,631	$2,791,903	$541,291	$316,748	$7,146,573

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

Facilities are estimated to take 14-24 months from ISA execution and 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 8-12 months

ITO requires the site to be fully graded and permitted site so they can start construction by March 2022.

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 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), 115kV, 2000A, 3-Phase Center Break Gang Operated Switch.
2. Three (3), 115kV, Metering Accuracy CCVT's.
3. Three (3), 115kV, 500:5 Metering Accuracy CT's.
4. Conductor, connectors, conduits, control cables, foundations, steel structures and grounding material as per engineering standards.

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 Transmission & Generator Interconnect Metering Pnl.
4. One (1), 4524 – Revenue Metering C.T. M.U. Box
5. One (1), 4506 – 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 #n6765 - Re-arrange line #117 to loop into and out of the new three breaker AE1-084 115 kV switching station

Project AE1-084 will tap into Dominion's Line #117 between Stuarts Draft and Barterbrook substations. The new substation will be located off the main line between structures 117/143 and 117/144 in Augusta County, Virginia.

The project work summary is described below:

PERMANENT FACILITIES TO BE INSTALLED

1. Install (1) 115kV galvanized steel backbone structure (no switches) with 31'-6" spacing and foundations.
2. Install (2) galvanized static pole structures and foundations.

CONDUCTOR/SHIELD WIRE INSTALLATIONS:

1. Cut and transfer (2) existing spans of 3-phase 636 ACSR conductor to the new backbone structures (one span will run from existing structure 117/144 – proposed backbone 117/143A, the other span will run from proposed backbone 117/143A – existing structure 117/143).
2. Cut and transfer (4) existing spans of 3#6 shield wire to the new backbone structure (two spans will run from existing structure 117/144 – proposed backbone 117/143A, the other two spans will run from proposed backbone 117/143A – existing structure 117/143).

3. Install approximately 0.12 miles (3 spans) of 1-7#7 shield wire from the proposed backbone structure to the proposed static poles.

3. New Substation/Switchyard Facilities

PJM Network Upgrade #n6764 - Build a three breaker AE1-084 115 kV switching station.

The facilities identified provides for the initial construction of a new 115 kV Three Breaker Ring Substation between Transmission Structures 117/143 and 117/143.

The objective of this project is to build a 115 kV, 3-breaker ring bus to support the new 83 MW Solar Farm. The site is located along Dominion Energy's existing 115 kV, 117 Line from Dupont-Waynesboro Substation to Dooms Substation. The cut line will consume two of the positions in the ring bus. The third position will be for the 115kV feed from the IC's Collector Station for the new 83MW Solar Farm.

The new 115 kV Three Breaker Ring Substation will share a common footprint and fence line with the IC's Collector Station. The demarcation point between the two stations will be the 115 kV Breaker Disconnect Switch 4-hole pad in the IC's Collector Station by the common fence. Dominion Energy will bring its bus to the demarcation point. The bus, structures, disconnect switch, metering accuracy CCVT's, metering accuracy CT's, protection and metering equipment will be Attachment Facilities. The grounding systems for each station will be tied together.

Transmission Lines to renumber the existing line segment between the new Three Breaker Ring Substation and Dooms Substation. The existing line segment between the new Three Breaker Ring Substation and Dupont-Waynesboro Substation shall remain Line 117.

Additional Work to be required at Dupont-Waynesboro & Dooms 115KV Substations.

Security and Fence Type – Design Level 4.

Note: Currently, the scope and estimate assume DVP standard spread footer foundations. Once the soil information is received and if it is decided to change that to "pile foundations" then DVP team should be informed at the earliest to adjust the project estimate.

The work required is as follows:

Purchase and install substation material – Direct Network Upgrade:

1. Approximately 294' x 265' site preparation and grading as required for installation of the switching station (by the developer). It is estimated that a significant amount of cut/fill will be required for this project site.
2. Approximately 1120 linear FT of 5/8" Chain Link, 12 FT tall, perimeter fence around the station along with the security cameras and integrators as per Design 4 fence standards.
3. Three (3), 115 kV, 2000A, 40kAIC, SF-6 Circuit Breakers.
4. Six (6), 115 kV, 2000A, 3-Phase Center Break Gang Operated Switches.
5. Six (6), 115 kV, Relay Accuracy CCVTs.
6. Two (2), 115 kV, 2000 A Wave Traps.
7. Two (2), Line Tuners.
8. Nine (9), 90 kV, 74 kV MCOV surge arresters.

9. Two (2), 115 kV, 2000A, 2-Phase Center Break Gang Operated Switches (for PVT's).
10. Two (2), 115 kV, 100KVA Power PT's for Station Service.
11. Oil Containment for 115kV PVT's.
12. One (1), 24' x 40' control enclosure.
13. One (1), 125 VDC, 300 Ah Station Battery and 50 Amp Charger (size to be verified during detail engineering).
14. Approximately 240 FT of Cable Trough, with a 20FT road crossing section.
15. Station Stone as required.
16. Station Lighting as required.
17. Steel structures as required including switch stands, bus supports, station service transformers, CCVT and wave trap supports.
18. Foundations as required including control house, equipment and bus support stands.
19. Conductors, connectors, conduits, control cables, cable trough, and grounding materials as per engineering standards.
20. One (1), 225A Single Phase Auto Throw-Over Switch (Security Station Service)

Purchase and install relay material – Direct Network Upgrade:

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), 1340 – 28" Dual SEL 411L 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 Throw over Switch
10. Two (2), 4016 – 600A PVT Disconnect Switch
11. One (1), 4153 – Wall Mount Station Battery Monitor
12. One (1), 5618 - SEL-3555 Communications 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 No. 1
19. One (1), 5603 – Station Network Panel No. 2
20. One (1), 4523 – Security Camera Interface Box
21. One (1), 5616 – Station Security Panel
22. One (1), High Voltage Protection (HVP) Box
23. One (1), Telephone Interface Box
24. One (1), 5616 - Security Fence Panel
25. Four (4), 4040 - Security Fiber/Power M.U. Box
26. One (1), 4044 – 225A 1Ø Outdoor Main Security AC NQOD
27. Two (2), 4040 – 100A 1Ø Outdoor Security AC NQOD
28. Two (2), 4018 – 225A Station Service AC Distribution Panel Branch Breaker

4. Upgrades to Substation / Switchyard Facilities

PJM Network Upgrade #n6766 - Remote protection and communication work.

Additional Work to be required at Dooms and Dupont-Waynesboro 115 kV Substations. Drawing updates and relay resets will be required at the Fisherville, Nibco, and Stuarts Draft substations. These costs include the following:

Dooms 115 kV Substation

Project Summary
AE1-084 provides for the drawing work, relay resets, and field support necessary to change Line 117 destination from Dupont Waynesboro to the new AE1-084 Generator Interconnect substation. Install Line 117 Islanding Transfer Trip scheme to work with the new AE1-084 GI and replace the Line 117 Breaker Failure Transfer Trip Transmitter with a Transfer Trip Transceiver to send/receive Breaker Failure Transfer Trip to/from AE1-084 GI. This project is the Non-Direct Connect Upgrade for the AE1084 Generator Interconnect project.

Purchase and install relay material:

1. One (1), 1603 – 24" SEL-451 Islanding Transfer Trip Panel
2. One (1), Breaker Failure Transfer Trip Transceiver

Dupont-Waynesboro 115 kV Substation

Project Summary
AE1-084 provides for the drawing work, relay resets, and field support necessary to change Line 117 destination from Dooms 115kV Substation to the new AE1-084 Generator Interconnect substation. Install Line 117 Islanding Transfer Trip scheme to work with the new AE1-084 GI and replace the Line 117 Breaker Failure Transfer Trip Receiver with a Transfer Trip Transceiver to send/receive Breaker Failure Transfer Trip to/from AE1-084 GI. This project is the Non-Direct Connect Upgrade for the AE1-084 Generator Interconnect project.

Purchase and install relay material:

1. One (1), 1603 – 24" SEL-451 Islanding Transfer Trip Panel
2. One (1), Breaker Failure Transfer Trip Transceiver

Fishersville 115 kV Substation

Project Summary:
AE1-084 provides for the drawing work, relay resets, and field support necessary to change the Line 117 destination from Dupont Waynesboro Substation to the new AE1-084 Generator Interconnect Substation. The line number may or may not be changed. This project is the Non-Direct Connect for the AE1-084 Generator Interconnect project.

Purchase and install substation material:

1. No Relay Material

Nibco 115 kV Substation

Project Summary:
AE1-084 provides for the drawing work, relay resets, and field support necessary to change the Line 117 destination from Dooms Substation to the new AE1-084 Generator Interconnect Substation. The line number may or may not be changed. This project is the Non-Direct Connect for the AE1-084 Generator Interconnect project.

Purchase and install substation material:

1. No Relay Material

Stuarts Draft 115 kV Substation

Project Summary:
AE1-084 provides for the drawing work, relay resets, and field support necessary to change the Line 117 destination from Dooms Substation to the new AE1-084 Generator Interconnect Substation. The line number may or may not be changed. This project is the Non-Direct Connect for the AE1-084 Generator Interconnect project.

Purchase and install substation material:

1. No Relay Material

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
Dooms Change Line 117	$46,099	$45,764	$9,519	$7,146	$108,528
Dupont-Waynesboro Change Line 117	$46,099	$45,764	$9,519	$7,146	$108,528
Fisherville Change Line 117	$13,829	$0	$3,259	$0	$17,088
Nibco Change Line 117	$13,829	$0	$3,259	$0	$17,088
Stuarts Draft Change Line 117	$13,829	$0	$3,259	$0	$17,088
Total Remote Relay Upgrades	$133,685	$91,528	$28,815	$14,292	$268,320

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 publicly 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

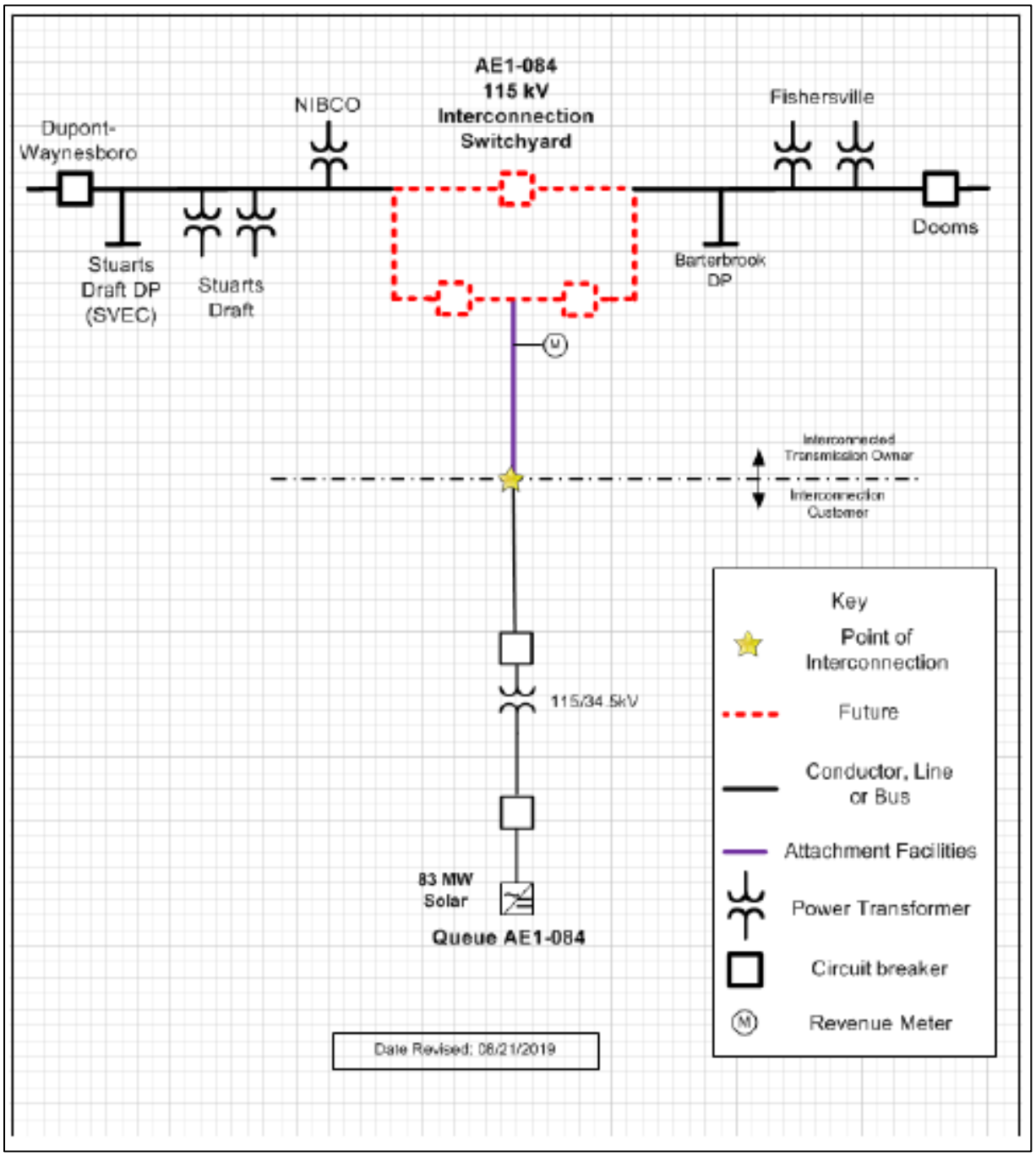
The IC would be responsible for the following expectations in the area of Environmental, Real Estate and Permitting:

- 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 294' x 265' 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 March 2022.
    - The size of the station assumes ITO will not need a separate storm water management system for the substation. If the county rules differently than 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.
AE1-084 Switching Station General Arrangement