Generation Interconnection
Facility Study Report

For

PJM Generation Interconnection Request
Queue Position AE1-155

Garner DP – Northern Neck 115 kV
76.2 MW Capacity / 127 MW Energy

Jan, 2022

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 Bookers Mill 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).

Point of Interconnection

AE1-155 will interconnect with the ITO transmission system via a new three breaker ring substation located between Garner DP – Northern Neck 115kV line.

Cost Summary

The AE1-155 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$537,969
Direct Connection Network Upgrades	$5,413,918
Non Direct Connection Network Upgrades	$1,385,396
Allocation for New System Upgrades	$0
Contribution for Previously Identified Upgrades	$0
Total Costs	**$7,337,283**

A. Transmission Owner Facilities Study Summary

1. Description of Project

Queue AE1-155 is a request to interconnect a 127MW new solar generating facility to be located in Moon Corner (Richmond County), Virginia. AE1-155 will interconnect with the ITO transmission system via a new three breaker ring bus switching station that connects on the existing 115kV line #65 between Rappahannock Substation to Northern Neck substation. 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 1, 2022
- Permits – state level Permit By Rule and county level final site plan approval complete — August 1, 2022
- Substantial site work completed — January 1, 2023
- Delivery of major electrical equipment — April 15, 2023
- Back Feed Power — April 15, 2023
- Commercial Operation — December 31, 2023

4. Scope of Customer's Work

Generator Interconnection Request AE1-155 is for a 127MW Maximum Facility Output (MFO) solar generation plan.

5. Description of Facilities Included in the Facilities Study

The ITO will connect the proposed generator lead via Attachment Facilities to a new AE1-155 three-breaker ring bus switching station adjacent to the #65 line between the existing Rappahannock and Northern Neck substations. The cut line will consume two of the positions in the ring bus. The third position will be for the 115kV feed from Bookers Mill Solar, LLC Collector Station for the new 127MW solar farm.

The new 115kV three breaker ring substation will share a common footprint and fence line with Bookers Mill Solar, LLC collector station. The demarcation point between the two stations will be the 115kV breaker disconnect switch 4-hole pad in the Bookers Mill Solar, LLC 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.

The existing line segment between the new three breaker ring substation and Northern Neck substation will be renumbered. The existing line segment between the new three breaker ring substation and Rappahannock substation will remain Line 65.

Additional work is required at Northern Neck, Rappahannock, and Harmony Village substations.

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 (n7854.2)	$2,548,503	$2,246,490	$387,012	$231,913	$5,413,918
Transmission line (n7854.1)	$622,773	$311,025	$97,794	$35,628	$1,067,220
Total Remote Changes (n7854.3)	$156,231	$110,415	$34,289	$17,241	$318,176
Total Network Upgrades	$3,327,507	$2,667,930	$519,095	$284,782	$6,799,314
Total Project Costs	$3,638,684	$2,824,992	$571,643	$301,964	$7,337,283

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 (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 April 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. make-up (M.U) box
3. One (1), 1425 – 28" Dual SEL-735 transmission & generator interconnect metering panel
4. One (1), 4524 – Revenue metering C.T. make-up (M.U) box
5. One (1), 4506 – CCVT potential make-up (M.U) box
6. One (1), 1323 – 28" SEL-487E/735 PMU & PQ monitoring panel
7. Two (2), 4541 - Control cable make-up (M.U) box

2. Transmission Line – Upgrades

PJM Network Upgrade #n7854.1 - Re-arrange line #65 to loop into and out of the new three breaker AE1-155 115 kV switching station

Line 65 is an existing 115kV line that runs from Northern Neck substation to Harmony Village substation. AE1-155 provides for the construction of a new substation located in the existing Line 65 right-of-way between existing structures 65/498 and 65/499 in Farnham, VA.

The existing line segment between Northern Neck substation and the proposed substation will need to be renumbered, while the existing line segment between the proposed substation and Harmony Village substation shall remain Line 65.

The project work summary is described below:

PERMANENT FACILITIES TO BE INSTALLED

1. Install one (1) 55' 115kV steel backbone structure with foundations.
2. Install two (2) steel static poles with foundations.
3. Install two (2) SC tangent DOM H-Frame structures with x-braces.
4. Install approximately 0.16 miles, a total of three spans of 1-7#7 AW shield wire between the proposed backbone structure and static poles inside the proposed substation.

FACILITIES TO BE MODIFIED

1. Transfer one (1) span of existing 3-phase 1-477 ACSR (24/7) conductor and two (2) spans of existing 1-3#6 AW shield wire from existing structure 65/497 to proposed structure XXXX/498 and then to the proposed backbone structure
2. Transfer one (1) span of existing 3-phase 1-477 ACSR (24/7) conductor and two (2) spans of existing 1-3#6 AW shield wire from existing structure 65/499A to proposed structure 65/499 and then to the proposed backbone structure
3. Renumber approximately 89 existing structures between Northern Neck substation and the proposed AE1-155 substation

FACILITIES TO BE REMOVED

1. Remove two (2) existing SC wood tangent H-frame structures (ex. Strs. 65/498 & 499)

3. New Substation/Switchyard Facilities

PJM Network Upgrade #n7854.2 - Build a three breaker AE1-155 115 kV switching station.

The facilities identified provides for the initial construction of a new 115 kV three breaker ring substation between structures 65/498 and 65/499.

The objective of this project is to build a 115kV three-breaker ring bus to support the new 127MW solar farm built by Bookers Mill, LLC. The site is located along Dominion Energy's existing 115kV, 65 Line from Rappahannock substation to Northern Neck substation. The cut line will consume two of the positions in the ring bus. The third position will be for the 115kV feed from Bookers Mill LLC, collector station for the new 127MW solar farm.

The new 115kV three breaker ring substation will share a common footprint and fence line with Bookers Mill, LLC collector station. The demarcation point between the two stations will be the 115kV breaker disconnect switch 4-hole pad in the Booker Mill, LLC 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.

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 260' x 175' site preparation and grading as required for installation of the switching station (by the developer)
2. Approximately 870 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), 115kV, 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), 115kV, 2000A, 2-Phase center break gang operated switches (for PVT's)
10. Two (2), 115kV, 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 280 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. One (1), 225A Single phase auto throw-over switch (Security Station Service)
20. Conductors, connectors, conduits, control cables, cable trough, and grounding materials as per engineering standards

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 make-up (M.U.) box
5. One (1), 1603 – 28” SEL-451 Islanding control scheme panel
6. One (1), 1604 – 28” Transmission transfer trip panel
7. Two (2), 4000 – Station service potential make-up (M.U.) box
8. Two (2), 4018 – 500A Station service AC distribution panel
9. Two (2), 4007 – 225A Outdoor transmission yard AC NQOD
10. Two (2), 4019 – 225A Three phase throw over switch
11. Two (2), 4016 – 600A PVT Disconnect switch
12. One (1), 4153 – Wall mount station battery monitor
13. One (1), 5618 - SEL-3555 Communications panel
14. One (1), 1255 – Station annunciator panel
15. One (1), 5021 – SEL-2411 RTU panel
16. One (1), 5609 – Fiber optic management panel
17. Three (3), 4526_A – Circuit breaker fiber optic make-up (M.U.) box
18. One (1), 5202 – 26” APP 601 Digital fault recorder
19. One (1), 5603 – Station network panel No. 1
20. One (1), 5603 – Station network panel No. 2
21. One (1), 4523 – Security camera interface box
22. One (1), 5616 – Station security panel
23. One (1), High voltage protection (HVP) box (Provided by IT)
24. One (1), Telephone interface box
25. One (1), 5616 - Security fence panel
26. Two (2), 4018 – 225A Station service AC distribution panel branch breaker

4. Upgrades to Substation / Switchyard Facilities

PJM Network Upgrade #n7854.2 - Remote protection and communication work.

Additional work is required at Northern Neck, Rappahannock, and Harmony Village substations. Drawing work, relay resets, and field support necessary to change the line 65 destinations at Garner DP, Lancaster, Ocran & White Stone substations will also be completed.

These costs include the following:

Northern Neck 115 kV Substation

Project Summary
AE1-155 provides for the drawing work, relay resets, and field support necessary to change the Line 65 destination at Northern Neck substation. The line number may or may not be changed. Consult the construction one line. Install islanding transfer trip to work with AE1-155. Remove breaker failure transfer trip receive from Lancaster substation's transmission capacitor bank. This function will be moved to AE1-155.

Purchase and install relay material:

1. One (1), 1603 – 24" SEL-451 Islanding control scheme panel

Rappahannock 115 kV Substation

Project Summary
AE1-155 provides for the drawing work, relay resets, and field support necessary to change the Line 65 destination at Rappahannock substation. The line number may or may not be changed. Consult the construction one line. Install islanding transfer trip to work with AE1-155 (receive islanding from Harmony Village via fiber and transmit islanding to AE1-155 via PLC).

Purchase and install relay material:

1. One (1), 1603 – 24" SEL-451 Islanding control scheme panel w/ SEL-2506 & PLC

Harmony Village 115kV Substation

Project Summary
AE1-155 provides for the installation of islanding transfer trip to work with AE1-155 via Rappahannock substation.

Purchase and install relay material:

1. One (1), 1603 – 24" SEL-451 Islanding control scheme panel w/ SEL-2506 fiber modem

Garner Dp, Lancaster, Ocran & White Stone Substation Remote End Work

Project Summary:
AE1-155 provides for the drawing work, relay resets, and field support necessary to change the line 65 destinations at Garner DP, Lancaster, Ocran & White Stone substations. The line number may or may not be changed. Consult the construction one line.

Modify Lancaster transmission capacitor bank carrier blocking and transfer trip schemes to work with AE1-155 instead of Northern Neck substation.

Modify Ocran DG Transfer Trip to work with AE1-155 instead of Northern Neck.

Purchase and install substation material:

1. No Relay Material

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
Rappahannock	$36,527	$36,805	$7,618	$5,747	$86,697
Northern Neck	$36,527	$36,805	$7,618	$5,747	$86,697
Harmony Village	$27,862	$36,805	$6,016	$5,747	$76,430
Garner Dp, Lancaster, Ocran & White Stone Substation Remote End Work	$55,315	$0	$13,037	$0	$68,352
Total Remote Relay Upgrades	$156,231	$110,415	$34,289	$17,241	$318,176

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

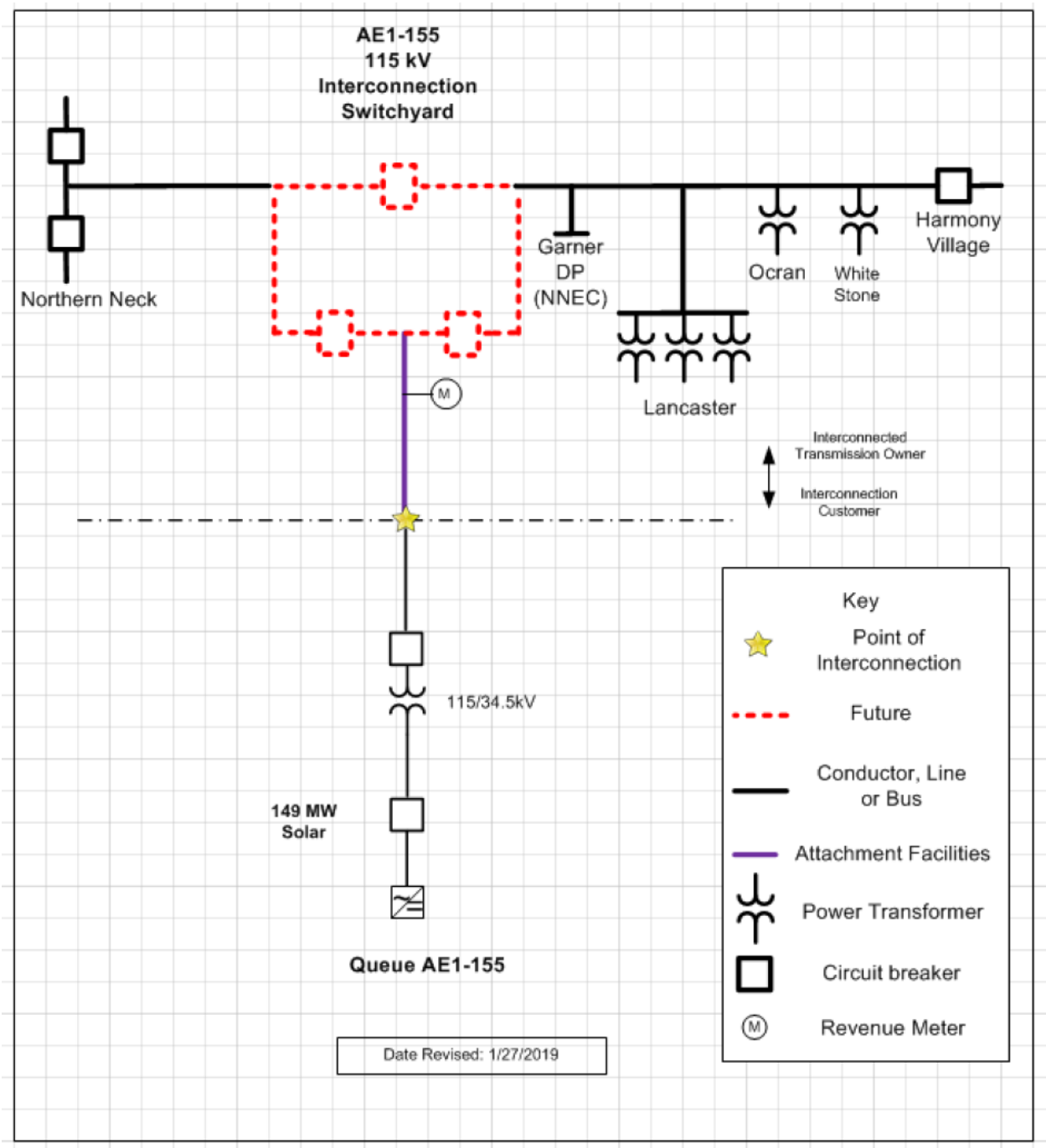
The IC would be responsible for the following expectations in the area of Environmental, Real Estate and Permitting:

- 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 260' x 175' 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 April 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.
AE1-155 Switching Station General Arrangement