# *Generation Interconnection*
# *Facility Study Report*

## *For*

## *PJM Generation Interconnection Request*
## *Queue Position AE1-153*

## *Remington-Gordonsville 230 kV*
## *89.4 MW Capacity / 149 MW Energy*

**March, 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 Maroon 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

AE1-153 will interconnect with the ITO transmission system via a new three breaker ring bus switching station that connects on the Remington-Gordonville 230kV line.

## Cost Summary

The AE1-153 project will be responsible for the following costs:

| Description | Total Cost |
|---|---|
| Attachment Facilities | $646,603 |
| Direct Connection Network Upgrades | $6,250,572 |
| Non Direct Connection Network Upgrades | $1,148,936 |
| Allocation for New System Upgrades | $0 |
| Contribution for Previously Identified Upgrades | $0 |
| **Total Costs** | **$8,046,111** |

# A. Transmission Owner Facilities Study Summary

## 1. Description of Project

Queue AE1-153 is a request to interconnect a new 149MW solar generating facility to be located in Stevensburg (Culpepper County), Virginia. AE1-153 will interconnection with the ITO transmission system via a new three breaker ring bus switching station that connects on the Gordonsville to Remington 230kV line #2199.

Attachment Facility and Network Upgrade construction is estimated to be 18-24 months.

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

None

## 3. Interconnection Customer's Milestone Schedule

- Permits – state level Permit By Rule and county level final site plan approval complete December 31, 2022
- Substantial site work completed December 31, 2024
- Delivery of major electrical equipment September 30, 2025
- Back Feed Power January 1, 2026
- Commercial Operation May 30, 2026

## 4. Scope of Customer's Work

AE1-153 is a 149 MW Maximum Facility Output (MFO) solar generation plant. AE1-153 consists of 192 x 0.7854 MW TMEIC PVU-L0840GR solar inverters with a total capacity of 150.7968 MW. There are 4 inverters per skid. Each skid is connected to a 34.5/0.63kV generator step up (GSU) transformer, each with a 3.36MVA rating. The power from each GSU is brought via a 34.5 kV collector system to a 230/34.5/13.8kV station transformer with a rating of 100/133.3/166.7 MVA. The high-side of this transformer is directly connected to the POI located on the 230 kV transmission line between the Remington and Gordonsville substations.

## 5. Description of Facilities Included in the Facilities Study

The ITO will connect the proposed generator lead via Attachment Facilities to a new AE1-153 three-breaker ring bus switching station adjacent to the #2199 line between the existing Remington and Gordonsville substations. The cut line will consume two of the positions in the ring bus. The third position will be for the 230kV feed from Maroon Solar, LLC collector station for the new 149MW solar facility.

The new 230kV three-breaker ring substation will share a common footprint and fence line with Maroon Solar LLC Collector Station. The demarcation point between the two stations will be the 230kV breaker disconnect switch 4-hole pad in the Maroon 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 between the new three-breaker ring substation and Remington will be renumbered. The existing line segment between the new three-breaker ring substation and Gordonsville substation shall remain Line 2199.

Additional work to be required at Gordonsville & Remington 230kV substations.

The single line is shown in Attachment 1. Site plan was developed by the ITO during PJM's generation queue process and is shown in Attachment 2.

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

Cost estimates for Dominion to perform construction:

| Work Description | Direct | | Indirect | | Total Cost |
|---|---|---|---|---|---|
| | Labor | Material | Labor | Material | |
| | | | | | |
| Attachment Facilities | $353,511 | $211,693 | $58,358 | $23,041 | $646,603 |
| **Total Attachment Facilities Cost** | $353,511 | $211,693 | $58,358 | $23,041 | $646,603 |
| | | | | | |
| Generator Interconnect (n7983) | $2,850,501 | $2,691,720 | $426,446 | $281,905 | $6,250,572 |
| Transmission Line AE1-153 (n7984) | $706,145 | $270,486 | $106,268 | $31,861 | $1,114,760 |
| Total Remote Changes (n7985, n7986) | $27,658 | $0 | $6,518 | $0 | $34,176 |
| **Total Network Upgrades** | $3,584,304 | $2,962,206 | $539,232 | $313,766 | $7,399,508 |
| **Total Project Costs** | $3,937,815 | $3,173,899 | $597,590 | $336,807 | $8,046,111 |

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

Facilities are estimated to take 18-24 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 January 2025.

# 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), 230kV, 3000A, 3-phase center break gang operated switch.
2. Three (3), 230kV, metering accuracy CCVT's.
3. Three (3), 230kV, 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 #n7984 - Re-arrange line #2199 to loop into and out of the new three breaker AE1-153 230 kV switching station**

Project AE1-153 will tap into Dominion's Line #2199 between Remington and Gordonsville substations between transmission structures 2199/144 and 2199/145. The transmission line shall connect to the substation within the existing line right-of-way. Installation of the substation shall require the line to be renumbered from the new substation to Remington substation. The existing line segment between the new substation to Gordonsville substation shall remain Line 2199.

The project work summary is described below:

**INSTALLATION:**

1. Install one (1) single circuit steel backbone (2199/144) with no switches inside the proposed substation. Transfer the existing DNO 10100 fiber and 2-636 ACSR conductor to the proposed backbone.
2. Install two (2) static poles within the proposed substation.
3. Install three (3) spans of 7#7 alumnoweld between the proposed backbone and the proposed static poles within the substation.

**REMOVAL:**

1. There is no removal required for this project.

**MISCELLANEOUS:**

1. This estimate includes the cost of 2 fiber splices for the proposed backbone.

## 3. New Substation/Switchyard Facilities

**PJM Network Upgrade #n7983 - Build a three breaker AE1-153 230 kV switching station**.

AE1-153 provides for the initial construction of a new 230kV three breaker ring substation between transmission structures 2199/144 and 2199/145.

The objective of this project is to build a 230kV, three-breaker ring bus to support the new 149MW solar farm built by Maroon Solar, LLC. The site is located along Dominion Energy's existing 230kV, 2199 line from Gordonsville substation to Remington substation. The cut line will consume two of the positions in the ring bus. The third position will be for the 230kV feed from Maroon Solar, LLC collector station for the new 149MW Solar Farm.

The new 230kV three-breaker ring substation will share a common footprint and fence line with Maroon Solar, LLC collector station. The demarcation point between the two stations will be the 230kV Breaker Disconnect Switch 4-hole pad in the Maroon 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.

Security and fence type – Design level 4.

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

The work required is as follows:

**Purchase and install substation material:**

1. Approximately 354' x 275' site preparation and grading as required for installation of the switching station (by the developer).
2. Approximately 1260 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 level 4 fence standards.
3. Three (3), 230 kV, 3000A, 63kAIC, SF-6 circuit breakers.
4. Six (6), 230 kV, 3000A, 3-phase center break gang operated switches.
5. Six (6), 230kV, Relay accuracy CCVTs.
6. Two (2), 230 kV, 3000 A wave traps.
7. Two (2), Line tuners.
8. Nine (9),180 kV, 144 kV MCOV surge arresters.
9. Two (2), 230kV, 3000A, 2-phase center break gang operated switches (for PVT's).
10. Two (2), 230kV, 100KVA power PT's for station service.

11. Oil containment for 230kV PVT's.
12. One (1), 24' x 40' control enclosure.
13. One (1), 125 VDC, 400 Ah station battery and 75 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:**

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. Two (2), 4000 – Station service potential make-up (M.U.) box
6. Two (2), 4018 – 500A Station service AC distribution panel
7. Two (2), 4007 – 225A Outdoor transmission yard AC NQOD
8. Two (2), 4019 – 225A Three phase throw over switch
9. Two (2), 4016 – 600A PVT disconnect switch
10. One (1), 4153 – Wall mount station battery monitor
11. One (1), 5618 - SEL-3555 communications 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 make-up (M.U.) box
16. One (1), 5202 – 26" APP 601 digital fault recorder
17. One (1), 5603 – Station network panel No. 1
18. One (1), 5603 – Station network panel No. 2
19. One (1), 4523 – Security camera interface box
20. One (1), 5616 – Station security panel
21. One (1), High voltage protection (HVP) box (Provided by IT)
22. One (1), Telephone interface box
23. One (1), 5616 - Security fence panel
24. Four (4), 4040 - Security fiber/power make-up (M.U.) box
25. One (1), 4044 – 225A 1Ø outdoor main security AC NQOD
26. Two (2), 4040 – 100A 1Ø outdoor security AC NQOD
27. Two (2), 4018 – 225A Station service AC distribution panel branch breaker

## 4. Upgrades to Substation / Switchyard Facilities

**PJM Network Upgrade #n7985, #n7986 - Remote protection and communication work.**

Additional work to be required at Gordonsville and Remington 230kV substations.

### Gordonsville 230 kV Substation

*Project Summary*
This project provides for the drawing work, relay resets and field support necessary to change Line 2199 destination from Remington substation to the new AE1-153 substation. This project is the non-direct connect for AE1-153.

*Purchase and install relay material:*

1. No relay material

### Remington 230 kV Substation

*Project Summary*
This project provides for the drawing work, relay resets and field support necessary to change Line 2199 destination from Gordonsville substation to the new AE1-153 substation. This project is the non-direct connect for AE1-153.

*Purchase and install relay material:*

1. No relay material

| Work Description | Direct | | Indirect | | Total Cost |
|---|---|---|---|---|---|
| | Labor | Material | Labor | Material | |
| Gordonsville substation (n7985) | $13,829 | $0 | $3,259 | $0 | $17,088 |
| Remington substation (n7986) | $13,829 | $0 | $3,259 | $0 | $17,088 |
| Total Remote Relay Upgrades | $27,658 | $0 | $6,518 | $0 | $34,176 |

## 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

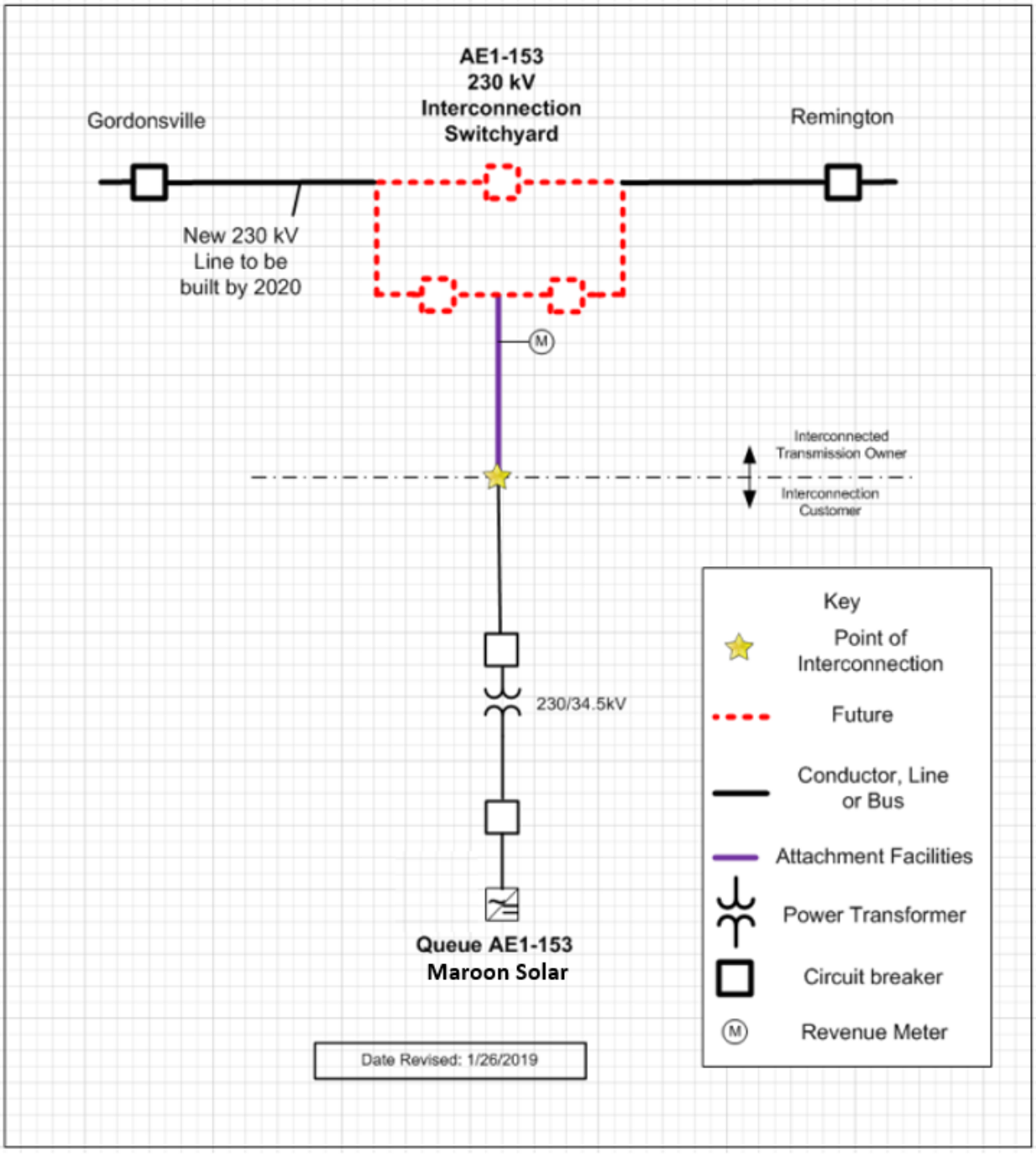
The IC would be responsible for the following expectations in the area of Environmental, Real Estate and Permitting:

- 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 354' x 275' 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 January 2024.
    - 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 AE1-153*



# *Attachment 2.*
## *AE1-153 Switching Station General Arrangement*