

***Generation Interconnection
Facility Study Report***

For

***PJM Generation Interconnection Request
Queue Position AE1-072***

***Shawboro-Sligo 230 kV
98.6 MW Capacity / 150 MW Energy***

July, 2023

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 Shawboro East Ridge 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 or Dominion).

The IC has proposed a solar generating facility located in Currituck County, Virginia. The installed facilities will have a capability of 150 MW with 98.6 MW of this output being recognized by PJM as Capacity. The proposed in-service date for the AE1-072 project is December 1, 2027. **This study does not imply an ITO commitment to either in-service date.**

Point of Interconnection

AE1-072 will interconnect with the ITO transmission system via a new three breaker ring bus switching station that connects on the Shawboro to Sligo 230 kV line #269.

Cost Summary

The AE1-072 project will be responsible for the following costs:

Description	Total Cost
Oversight for Attachment Facilities	\$135,204
Oversight for Direct Connect Facilities	\$1,058,454
Non Direct Connection Network Upgrades	\$4,323,618
Allocation for New System Upgrades	\$0
Contribution for Previously Identified Upgrades	\$4,112,100
Total Costs	\$9,629,376

NOTE: AE1-072 has a cost allocation to the Previously Identified Upgrade first to cause by AD1-076. For more details please refer to the System Impact Study report.

A. Transmission Owner Facilities Study Summary

1. Description of Project

Queue AE1-072 is a request to interconnect a 150 MW new solar generating facility to be located in Currituck County, Virginia. AE1-072 will interconnect with the ITO transmission system via a new three breaker ring switching station that connects on the Sligo-Shawboro 230 kV line #269. Attachment Facility and Network Upgrade construction is estimated to be 18-26 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 | December 1, 2026 |
| • Permits – state level Permit By Rule and county level final site plan approval complete | December 1, 2026 |
| • Substantial site work completed | June 1, 2027 |
| • Delivery of major electrical equipment | March 1, 2027 |
| • Back Feed Power | May 1, 2027 |
| • Commercial Operation | December 1, 2027 |

4. Scope of Customer's Work

Generator Interconnection Request AE1-072 is for a 150 MW Maximum Facility Output (MFO) solar generation plant. AE1-072 consists of 55 x 2.7764 MW SG3150U inverters connected in pairs to a 34.5/0.63 kV generator step up (GSU) transformer, each with a 3.15 MVA rating. It will then connect the GSU transformer to one 230/34.5/13.5 kV station transformers with a rating of 108/144/180 MVA.

5. Description of Facilities Included in the Facilities Study

Project number AE1-072 provides for the initial construction of a new 230 kV three breaker ring substation between transmission structures 269/155 and 269/156.

The Interconnection Customer has selected 'Option to Build' as is their right to do so under the PJM Interconnection Service Agreement. By selecting this construction process method, the Interconnection Customer shall secure all required real estate, obtain all necessary permits, perform site work, furnish equipment, construction personnel, and ancillary materials as found in the facility study for construction of the switching station in compliance with Virginia Electric and Power Company Substation Engineering Standards. Oversight by Virginia Electric and Power Company will include, but is not limited to, project management, engineering, permitting, survey, real estate, and construction methods when on site.

All equipment procured by Interconnection Customer will be reviewed and approved by Virginia Electric and Power Company Engineering teams.

The details of the Interconnection Customer and Dominion responsibilities and approval processes are described in the associated “Dominion Option to Build Execution Plan” document.

The objective of this project is to build a 230 kV, three breaker ring bus to support the new 150 MW solar generating facility. The site is located along Virginia Electric and Power Company’s existing 230 kV, 269 line from Shawboro Substation to Fentress Substation. The cut line will consume two of the positions in the ring bus. The third position will be for the 230 kV feed from Interconnection Customer’s collector station.

The collector station will be located adjacent to the interconnect station. The demarcation point between this station and the collector station will be the 4-hole pads on the interconnect station disconnect switch. The grounding systems for both stations will be tied together. The Interconnection Customer will be responsible for all real estate permitting and site preparation and grading.

The existing line segment between the new three breaker ring substation and Shawboro substation will be renumbered by Virginia Electric and Power Company. The existing line segment between the new three breaker ring substation and Fentress Substation shall remain line 269.

Additional work is required at Fentress Substation and Shawboro Substation.

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

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

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
Transmission Line 269 (n8432.1)	\$2,375,163	\$1,006,882	\$379,635	\$128,881	\$3,890,561
Total Remote Changes (n8432.2)	\$241,508	\$101,712	\$71,920	\$17,917	\$433,057
Total Network Upgrades	\$2,616,671	\$1,108,594	\$451,555	\$147,798	\$4,323,618
Oversight for Attachment Facilities	\$91,509	\$17,351	\$23,760	\$2,584	\$135,204
Oversight for Direct Connect Facilities (n8432.3)	\$631,289	\$271,535	\$140,321	\$15,309	\$1,058,454
Total Option to Build Oversight	\$722,798	\$288,886	\$164,081	\$17,893	\$1,193,658
Total Project Costs	\$3,339,469	\$1,397,480	\$615,636	\$164,691	\$5,517,276

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

Facilities are estimated to take 18-26 months from Interconnection Service Agreement (ISA) execution and is based on the ability to obtain outages to construct and test the proposed facilities.

Proposed Schedule

- Detailed design: 6-8 months
- Permitting: 8-12 months (runs concurrent with design)
- Construction: 12-18 months

N6144 Upgrade Timeline 30–56 Months

- Detailed Design: 8-10 Months
- Real Estate/Permitting: 24-36 Months (some overlap with design)
- Construction: months 6 – 10 Months

ITO requires the site to be fully graded and permitted site so they can start construction by September 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 coupling capacitor voltage transformers (CCVT), metering accuracy current transformers (CT), disconnect switch, conductors and connectors.

Note: The Interconnection Customer has selected “Option to Build” as is their right to do so under the PJM Interconnection Service Agreement.

Option to Build, Attachment Facilities Physical Facilities & Oversight – Virginia Electric and Power Company:

1. All Physical Engineering related oversight and approvals of activities related to equipment procurement, design, construction, and energization of switching station.
2. All construction and methods oversight and approval of activities related to construction and energization of the switching station.
3. All project management oversight activities related to construction and energization of switching station.

Option to Build, Attachment Facilities Physical Facilities – Interconnection Customer:

1. One (1), 230 kV, 3000A, 3-phase center break gang operated switch.
2. Three (3), 230 kV, metering accuracy CCVTs.
3. Three (3), 230 kV, 500:5 metering accuracy CTs.
4. Conductor, connectors, conduits, control cables, foundations, steel structures and grounding material as per engineering standards.

Option to Build, Attachment Facilities Relay Protection Equipment & Oversight – Virginia Electric and Power Company:

1. All protection and controls engineering oversight and approval of activities related to equipment procurement, design, construction, and energization of the switching station.
2. All relay panel installation methods oversight and approval of activities related to construction and energization of the switching station.
3. All relay, communications, security settings related to the connection of the switching station to the Bulk Electric Transmission System.

Option to Build, Attachment Facilities Relay Protection Equipment – Interconnection Customer:

1. One (1), 1110 – 28” dual SEL-587Z transmission bus panel
2. One (1), 4200_W1 – Bus differential C.T make-up box
3. One (1), 1425 – 28” dual SEL-735 transmission & generator interconnect metering panel
4. One (1), 4524 – Revenue metering C.T make-up box
5. One (1), 4506 – CCVT potential make-up box
6. One (1), 1323 – 28” SEL-487E/735 PMU & PQ monitoring panel
7. Two (2), 4541 - Control cable make-up box
8. Two (2), 4528A – generation fiber make-up box

2. Transmission Line – Upgrades

PJM Network Upgrade #n8432.1 - Re-arrange line #269 to loop into and out of the new three breaker AE1-072 230 kV switching station

Project AE1-072 will tap into Dominion’s Line #269 between structures 269/155 and 269/156 in the section of line between Sligo and Shawboro substations.

The following scope of work is for the construction of a new substation with transmission work to include the installation of one (1) 230 kV standard backbone with anchor bolts, two (2) standard static poles with anchor bolts, and four (4) single circuit three pole DDE engineered structures with anchor bolts. Additionally, this will include the installation of one (1) direct embedded (DOM) H-frame anchor structure and two (2) direct embedded (DOM) braced H-frame suspension structures, and one (1) existing wood pole structure will be modified to accommodate the 1.57 miles of OPGW being installed as part of this project.

The project work summary is described below:

Permanent Facilities to be Installed:

1. Install one (1) 230 kV single circuit DDE backbone structure with foundations (structure 269/155C).
2. Install two (2) galvanized steel static poles with foundations (structures 269/155B and 2XX/155D).

3. Install four (4) Corten steel single circuit DDE engineered three pole structures with foundations (structures 269/155, 259/155A, 2XXX/155E and 2XXX/156).
4. Install one (1) direct embed (DOM) H-frame anchor structure (structure 2XXX/164)
5. Install two (2) direct embed (DOM) H-frame suspension structures (2XXX/160 and 2XXX/162).
6. Transfer the existing bundled (2) 545 ACAR conductor to the two (2) proposed DDE three pole structures (269/155 and 2XXX/156).
7. Transfer the two (2) existing 3#6 Alumoweld static wires to proposed DDE three pole structure 269/155.
8. Transfer one (1) existing 3#6 Alumoweld static wire to proposed DDE three pole structure 2XXX/156.
9. Install two (2) spans of new 3#6 Alumoweld static wire from DDE structure 269/155 to DDE structure 269/155A.
10. Install approximately 0.21 miles (4 spans) of three-phase bundled (2) 768 kcmil ACSS/TW/HS (20/7) "Maumee".
11. Install approximately 0.38 miles (6 spans) of new 7#7 Alumoweld static wire
12. Install approximately 1.57 miles of OPGW from the new backbone inside the station to Structure 2XXX/165A inside Shawboro substation.
13. Renumber all structures from the proposed backbone to Shawboro substation.

Estimated Permanent Facilities to be Removed:

1. Remove four (4) existing wood H-frame suspension structures, 269/155, 2XXX/156, 2XXX/160, and 2XXX/162.
2. Remove one (1) existing wood three pole DDE structure, 2XXX/164. This shall include the removal of existing guys and anchors to 18" below grade.
3. Remove one (1) span of three phase bundled (2) 545 ACAR between structures 269/155 and 269/156.
4. Remove two (2) spans of existing 3#6 Alumoweld static wire between structures 269/155 and 259/156.
5. Remove approximately 1.46 miles of single 3#6 Alumoweld between structure 259/156 and Shawboro substation.

Miscellaneous Notes:

1. Additional right of way will need to be obtained for the spans that leave the main line and go into the station.
2. The new OPGW will be 48-fiber, DNO111410.
3. There will be an OPGW splice at the new backbone, structure 2XXX/155C, and one at the backbone inside of Shawboro substation, 2XXX/165A. It should be assumed that one (1) additional splice point could be identified during detailed engineering.
4. Existing structures 2XXX/160, 2XXX/162, and 2XXX/164 will need to be replaced in order to facilitate installing the OPGW. These structures are included in the installation and removal notes.
5. Existing structure 2XXX/163 shall be modified in order to facilitate the installation of the OPGW by removing the existing knee braces and adding a span guy and guy braces.

6. Adjacent existing structures 269/154 and 2XXX/157 do have existing swing violations. Structure 2XXX/157 is improved by the proposed structures but there are still violations. Should it be deemed necessary to correct these violations, it can be done by moving the cross braces down on each structure and by adding weights at structure 2XXX/157.
7. There are other existing structures on this line that have swing violations under existing conditions that are not being addressed as part of this scope of work. Only conductor swing violations on existing structures adjacent to proposed structures are identified in note 6.
8. Existing structures have been analyzed under National Electric Safety Code (NESC) medium and proposed structures have been analyzed under NESC heavy.
9. Line switches, switch structures and wave traps have not been included in the transmission scope of this work but can be added should they be deemed necessary.

3. New Substation/Switchyard Facilities

PJM Network Upgrade #n8432.3- Build a three breaker AE1-072 230 kV switching station.

Project number AE1-072 provides for the initial construction of a new 230 kV three breaker ring substation between transmission structures 269/155 and 269/156.

The objective of this project is to build a 230 kV, three breaker ring bus to support the new solar farm built by Interconnect Customer. The site is located along Virginia Electric and Power Company's existing 230 kV, 269 line from Shawboro Substation to Fentress Substation. The cut line will consume two of the positions in the ring bus. The third position will be for the 230 kV feed from Interconnection Customer's Collector Station for the new solar farm.

The collector station will be located adjacent to the interconnect station. The demarcation point between this station and the collector station will be the 4-hole pads on the interconnect station disconnect switch. The grounding systems for both stations will be tied together. The Interconnection Customer will be responsible for all real estate, permitting, and site preparation and grading.

The existing line segment between the new three breaker ring substation and Shawboro substation will be renumbered by Virginia Electric and Power Company. The existing line segment between the new three breaker ring substation and Fentress Substation shall remain line 269.

Additional work is required at Fentress Substation and Shawboro Substation.
Security and Fence Type – Design Level 4.

Note: The Interconnection Customer has selected "Option to Build" as is their right to do so under the PJM Interconnection Service Agreement.

The work required is as follows:

Option to Build, Direct Network Physical Facilities & Oversight – Virginia Electric and Power Company:

1. All physical engineering related oversight and approvals of activities related to equipment, procurement, design, construction, and energization of switching station.
2. All real estate related oversight and approval of activities related to construction of the switching station.
3. All permitting related oversight and approval of activities related to construction of the switching station.
4. All survey related oversight and approval of activities related to construction of the switching station.
5. All Construction and Methods oversight and approval of activities related to construction and energization of switching station
6. All Project Management oversight activities related to construction and energization of switching station.
7. All riser conductor, connectors, spacers, and bolts related to connection of the switching station to the Bulk Electric Transmission System.
8. All material related to the integration of the security fence software package back to the Corporate Security Fusion Center.

Option to Build, Direct Network Physical Facilities – Interconnection Customer:

1. Approximate station fence line dimensions 370' x 320'. At a minimum, site preparation and grading will be required to extend 10' beyond these dimensions for station grounding. Additional property and site prep may be required for proper grading and stormwater management, etc.
2. Approximately 1,380 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), 230kV, 3000A, 63kAIC, SF-6 circuit breaker
4. Six (6), 230kV, 3000A, 3-phase center break gang operated switch
5. Six (6), 230kV, relay accuracy CCVT
6. One (1), 230kV, 3000A wave trap
7. One (1), line tuner
8. Nine (9), 180kV, 144kV MCOV surge arrester
9. Two (2), 230kV, 3000A, 2-phase center break switch (for PVT's)
10. Two (2), 230kV, 100KVA power PT's for station service
11. One (1), 24' x 40' control enclosure, CE1
12. One (1), 125 VDC, 400 Ah station battery and 75 amp charger (size to be verified during detail engineering)
13. Approximately 240 ft. of cable trough, with a 20 ft. road crossing section
14. Two (2), 36" x 36" x 42" precast yard pull box
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

Option to Build, Direct Network Relay Protection Equipment & Oversight – Virginia Electric and Power Company:

1. All Protection & Controls Engineering oversight and approval of activities related to equipment procurement, design, construction, and energization of switching station.
2. All relay panel installation methods oversight and approval of activities related to construction and energization of switching station.
3. All relay, communications, security settings related to the connection of the switching station to the Bulk Electric Transmission System.
4. One (1), 5616 – station security panel
5. One (1), 5616 – station security fence panel
6. One (1), 5603 – network panel no. 1
7. One (1), 5603 – network Panel no. 2
8. One (1), high voltage protection (HVP) box (provided by IT)
9. One (1), telephone interface box
10. One (1), 4523 – security camera interface box

Option to Build, Direct Network Relay Protection Equipment – Interconnection Customer:

1. Three (3), 1510 – 28” dual SEL-351-7 transmission breaker with reclosing panel
2. Three (3), 4510 – SEL-2411 breaker annunciator
3. One (1), 1340 – 28” Dual SEL 411L DCB line panel
4. One (1), 1340 – 28” Dual SEL 411L CD/Fiber line panel
5. Two (2), 4506 – 3-phase CCVT potential make-up box
6. One (1), 1603 – 28” SEL-451 islanding control scheme panel
7. Two (2), 4000 – station service potential make-up 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 3-phase throw over switch
11. Two (2), 4016 – 600A PVT disconnect switch
12. One (1), 4153c – 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 box
18. One (1), 5202 – 26” APP 601 digital fault recorder
19. Five (5), 4040 – security fiber/power make-up box
20. One (1), 4042_D1B – security utility – utility ATS
21. One (1), 4044 – 225A 1Ø outdoor main security AC NQOD
22. Two (2), 4040 – 100A 1Ø outdoor security AC NQOD
23. Two (2), 4018 – 225A station service AC distribution panel branch breaker

4. Upgrades to Substation / Switchyard Facilities

PJM Network Upgrade #n8432.2- Remote protection and communication work.

Additional work is required at Fentress and Shawboro 230 kV substations.

These costs include the following:

Fentress 230 kV Substation

Project Summary

Project AE1-072 provides for drawing work, islanding panel addition, relay resets, and field support necessary to change Line 269 destination from Shawboro substation to AE1-072 generator interconnect.

Purchase and install relay material:

1. One (1), 1603 – 24” SEL-451 islanding control scheme panel

Shawboro 230 kV Substation

Project Summary

Project AE1-072 provides for the drawing work, islanding addition, relay resets, and field support necessary to change the line 269 destination from Fentress substation to the new AE1-072 generator interconnect substation. Due to the short distance between the new GI and Shawboro, the line 269 relays will be replaced with line current differential relaying using fiber optics and the wave trap will be removed. Transmission line engineering to provide estimate to install the fiber. Install islanding transfer trip to work with the new generator interconnect.

Purchase and install substation material:

1. Remove – One (1), 230 kV, 3000A wave trap
2. Two (2) runs of 2” conduits from backbone leg to the cable trough
3. Conduit tracer wires, 1/C #10, green
4. Miscellaneous conductors, connectors as per engineering standards

Purchase and install relay material:

1. One (1), 1603 – 28” SEL-451 islanding control scheme panel
2. One (1), 1340 – 28” SEL-411L CD/fiber line panel
3. One (1), panel retirement (panel 10)

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
Fentress Substation: Protection Work	\$87,133	\$28,814	\$26,165	\$5,133	\$147,245
Shawboro Substation: Protection Work	\$154,375	\$72,898	\$45,755	\$12,784	\$285,812
Total Remote Relay Upgrades	\$241,508	\$101,712	\$71,920	\$17,917	\$433,057

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:

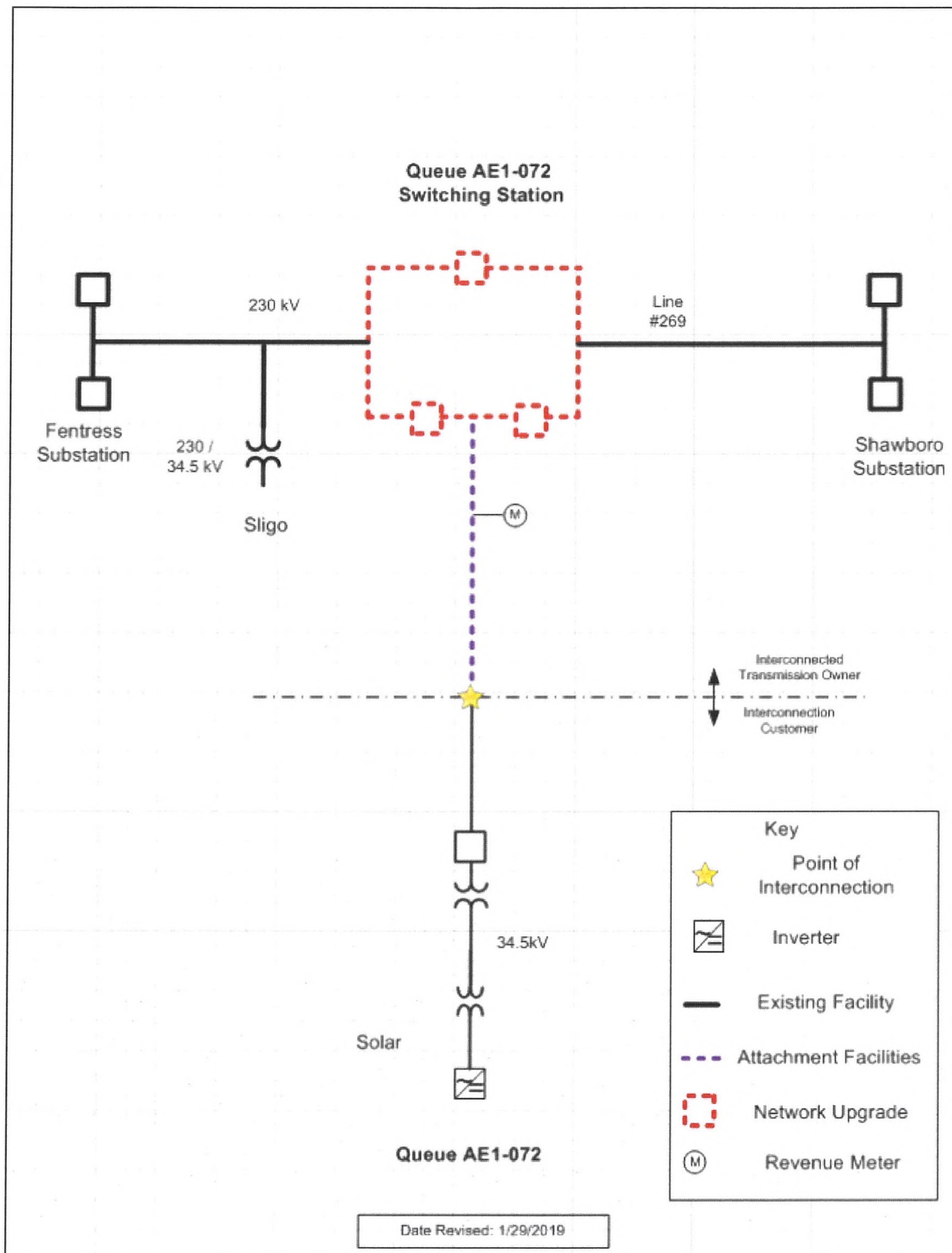
- Suitable Access Road from Substation to a Virginia State Maintained Roadway.
- Any additional land needed for Storm Water Management, Landscaping, and Wetlands/Wetlands Mitigation.
- Conditional Use Permit for Substation.
- Any other Land/Permitting requirements required by the Substation.

ITO Real Estate Needs:

- The substation layout is complete and ITO requires a 370' x 320' 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 2025.

- 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



[illegible]