Generation Interconnection
Facility Study Report

For

PJM Generation Interconnection Request
Queue Position AD1-152

Clover-Sedge Hill 230 kV
48 MW Capacity / 80 MW Energy

April, 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 Virginia Electric & Power Company, 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 Halifax County, Virginia. The installed facilities will have a total capability of 80 MW with 48 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is July 1, 2023. **This study does not imply an ITO commitment to either in-service date.**

Point of Interconnection

AD1-152 will interconnect with the Dominion transmission system via a new AD1-152 230 kV three breaker ring bus substation connecting to the Clove – Sedge Hill 230 kV line # 2068.

Cost Summary

The AD1-152 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$667,577
Direct Connection Network Upgrades	$7,596,615
Non Direct Connection Network Upgrades	$1,271,502
Allocation for New System Upgrades	$8,249,851
Contribution for Previously Identified Upgrades	$0
Total Costs	**$17,785,545**

A. Transmission Owner Facilities Study Summary

1. Description of Project

AD1-152 is a request to interconnect an 80 MW new solar generating facility to be located in Halifax County, Virginia. AD1-152 will interconnect with the Dominion transmission system at the new AD1-152 230 kV three breaker ring bus substation connecting to the Clove – Sedge Hill 230 kV line # 2068.

Attachment Facility and Network Upgrade construction is estimated to be 14-18 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 June 1, 2022
- Substantial site work completed August 1, 2022
- Delivery of major electrical equipment November 1, 2022
- Back Feed Power December 1, 2022
- Commercial Operation July 1, 2023

4. Scope of Customer's Work

Generator interconnection request AD1-152 is for an 80 MW Maximum Facility Output (MFO) solar generation plant.

5. Description of Facilities Included in the Facilities Study

The objective of this project is to build a 230 kV, 3-breaker ring bus to support the new 80 MW solar farm built by Virginia Electric & Power Company. The site is located along Dominion Energy's existing 230 kV, 2068 line from Clover substation to Sedge Hill 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 Virginia Electric & Power Company collector station for the new 80 MW solar farm.

The new 230 V three breaker ring substation will share a common footprint and fence line with Virginia Electric & Power Company collector station. The demarcation point between the two stations will be the 230 kV breaker disconnect switch 4-hole pad in the Virginia Electric & Power Company collector station by the common fence. The grounding systems for each station will be tied together. The developer will provide the property and access to the switching station. All substation permitting, site preparation and grading activity will be performed by the developer.

There will be drawing updates and transmission line protection work at the Clover and Sedge Hill 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	$350,565	$227,218	$60,880	$28,914	$667,577
Total Attachment Facilities Cost	$350,565	$227,218	$60,880	$28,914	$667,577
New Switching Station (n7853.2)	$2,923,533	$3,055,002	$1,048,152	$569,928	$7,596,615
Trans line #2068 (n7853.1)	$765,610	$268,896	$126,800	$37,750	$1,199,056
Total Remote Changes (n7853.3, n7853.4)	$42,664	$17,002	$10,249	$2,531	$72,446
Danville - East Danville 138 kV Rebuild (n6124)	$4,872,843	$1,494,393	$870,993	$211,622	$7,449,851
Danville Sub Conductor Upgrade (n7754.1)	$308,522	$124,826	$47,453	$19,199	$500,000
East Danville Sub Conductor Upgrade (n7754.1)	$185,113	$74,896	$28,472	$11,519	$300,000
Total Network Upgrades	$9,098,285	$5,035,015	$2,132,118	$852,549	$17,117,968
Total Project Costs	$9,448,850	$5,262,233	$2,192,998	$881,463	$17,785,545

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

Facilities are estimated to take 14-18 months from Interim ISA execution (October 2021) and is based on the ability to obtain outages to construct and test the proposed facilities.

Proposed Schedule

- Detailed design: 6-8 months (ongoing)
- Permitting: 6-12 months (ongoing)
- Construction 7-12 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), 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. Three (3), 180 kV, 144 kV MCOV surge arresters
5. 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 pnl.
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. Customer interface box

2. Transmission Line – Upgrades

PJM Network Upgrade #n7853.1 - Re-arrange line #1012 to loop into and out of the new three breaker AD2-063 115 kV switching station

A new three breaker ring bus substation will be installed between structures 2068/446 and 2068/447.

The project work summary is described below:

EXISTING FACILITIES TO BE REMOVED

1. Remove (2) direct embed wood H-frames (2068/446 and 2068/447).
2. Remove (1) span (approximately 705 ft) of 3-phase (2) 477 ACSR (24/7) "FLICKER" conductor from existing structure 2086/446 to existing structure 2068/447.
3. Remove (1) span (approximately 705 ft) of (2) 3#6 Alumoweld shield wire from existing structure 2086/446 to existing structure 2068/447.

PERMANENT FACILITIES TO BE INSTALLED

1. Install (1) 230kV backbone structure (2068/446A) on foundations within the new substation. This will include the installation of (6) conductor deadend assemblies and (6) shield wire deadend assemblies.
2. Install (2) 230kV engineered steel H-Frames (new 2068/446 and 2068/447) on foundations. This will include the installation of (6) conductor deadend assemblies and (4) shield wire deadend assemblies per each structure.
3. Install (2) steel static poles (2068/446B and 2068/446C) on foundations within the new substation. This will include the installation of (2) shield wire assemblies per each structure.
4. Install (1) span (approximately 355 ft) of 3-phase (2) 636 ACSR (24/7) "ROOK" conductor from new structure 2068/446 to new structure 2068/446A.
5. Install (1) span (approximately 380 ft) of 3-phase (2) 636 ACSR (24/7) "ROOK" conductor from new structure 2068/446A to new structure 2068/447.
6. Install (1) span (approximately 355 ft) of (2) 3#6 Alumoweld shield wire from new structure 2068/446 to new structure 2068/446A.
7. Install (1) span (approximately 380 ft) of (2) 3#6 Alumoweld shield wire from new structure 2068/446A to new structure 2068/447.
8. Install (1) span (approximately 275 ft) of (1) 3#6 Alumoweld shield wire from new structure 2068/446A to new structure 2068/446B.
9. Install (1) span (approximately 200 ft) of (1) 3#6 Alumoweld shield wire from new structure 2068/446A to new structure 2068/446C.
10. Install (1) span (approximately 300 ft) of (1) 3#6 Alumoweld shield wire from new structure 2068/446B to new structure 2068/446C.
11. Transfer (1) span (approximately 555 ft) of 3-phase (2) 477 ACSR (24/7) "FLICKER" to new H-frame structure 2068/446 from 2068/445.
12. Transfer (1) span (approximately 555 ft) of (2) 3#6 Alumoweld shield wire to new H-frame structure 2068/446 from 2068/445.
13. Transfer (1) span (approximately 580 ft) of 3-phase (2) 477 ACSR (24/7) "FLICKER" to new H-frame structure 2068/447 from 2068/448.
14. Transfer (1) span (approximately 580 ft) of (2) 3#6 Alumoweld shield wire to new H-frame structure 2068/447 from 2068/448.

3. New Substation/Switchyard Facilities

PJM Network Upgrade #n7853.2 - Build a three breaker AD1-152 230 kV switching station.

AD1-152 provides for the initial construction of a new 230 kV three breaker ring substation between transmission structures 2068/446 and 2068/447.

The objective of this project is to build a 230 kV, 3-breaker ring bus to support the new 80 MW solar farm built by Virginia Electric & Power Company. The site is located along Dominion Energy's existing 230 kV, 2068 line from Clover substation to Sedge Hill 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 Virginia Electric & Power Company collector station for the new 80 MW solar farm.

The new 230 V three breaker ring substation will share a common footprint and fence line with Virginia Electric & Power Company collector station. The demarcation point between the two stations will be the 230 kV breaker disconnect switch 4-hole pad in the Virginia Electric & Power Company collector station by the common fence. The grounding systems for each station will be tied together. The developer will provide the property and access to the switching station. All substation permitting, site preparation and grading activity will be performed by the developer.

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 310' x 285' site preparation and grading as required for installation of the switching station (by the developer).
2. Approximately 1150 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), 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. Four (4), 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, 200 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. Full substation ground grid as per engineering standards.
16. Station access driveway and tone as required.
17. Station lighting as required.
18. Steel structures as required including switch stands, bus supports, station service transformers, CCVT and wave trap supports.
19. Foundations as required including control house, equipment and bus support stands.
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), 1320 – 28” Dual SEL-421-5 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. Two (2), 4000 – Station service potential make-up (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), 5612 - SEL-3530 Data concentrator 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 make-up (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 (Provided by IT)
23. One (1), Telephone interface box

4. Upgrades to Substation / Switchyard Facilities

PJM Network Upgrade #n7853.3, n7853.4 - Remote station work.

There will be drawing updates and transmission line protection work at the Clover and Sedge Hill substations.

Clover Substation

Project Summary
Project AD1-152 provides for drawing work, relay resets and field support necessary to change Line 2068 destination from Sedge Hill substation to the AD1-152 substation. The existing islanding transfer trip scheme between Sedge Hill and Clover Substations will remain intact but will now pass through AD1-152 GI. The AD1-152 islanding transfer trip scheme will operate on the same path. Replace the islanding transfer trip set at Clover with a CS-51C Transceiver.

Purchase and install relay material:

1. CS-51C Islanding Transfer Trip Transceiver

Sedge Hill Substation

Project Summary
Project AD1-152 provides for the drawing work, relay resets, and field support necessary to change the Line 2068 destination from Clover Substation to the new AD1-152 substation. This project is the Non-Direct Connect for the AD1-152 project.

Purchase and install relay material:

1. No relay material

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
Sedge Hill Substation: Drawing Work	$13,006	$0	$2,965	$0	$15,971
Clover Substation: Drawing and relay work	$29,658	$17,002	$7,284	$2,531	$56,475
Total Remote Relay Upgrades	$42,664	$17,002	$10,249	$2,531	$72,446

5. Affected Transmission Owner (AEP)

Project Description:

The Interconnection Customer, proposes to install PJM project AD1-152, a new generator connecting with the Virginia Electric and Power Company ("Virginia Power") at a new station cut into the Clover - Sedge Hill 230 kV circuit. Due to adverse impacts caused by AD1-152 on the AEP transmission system, Network Upgrades are required to maintain the reliability of the AEP/PJM system.

Danville – East Danville 138 kV Rebuild (n6124):

- AEP will wreck and rebuild 2.84 miles of the Danville - East Danville 138 kV circuit. Other than a reroute around the Dan Chem facility, the majority of the proposed work is expected to be completed within the existing ROW, with most of the structures being replaced. Installation is expected to include ACSR Pheasant 1272 (54/19) overhead conductor and 96ct OPGW shield wire.
- AEP will relocate Danville - East Danville 69 kV circuit conductors from structure 19-303 on the Danville - East Danville 138 kV circuit to newly installed 69 kV pole structures. AEP will also install new ADSS fiber-optic cable between 69 kV Structures 479-16 and 479-18 to maintain fiber connectivity between Danville and East Danville Stations.
- AEP will install underground ADLT Fiber-Optic cable to terminate the new OPGW at the Danville and East Danville Stations.
- AEP will review the protection settings at the Danville 138 kV station and adjust as needed.
- AEP will review the protection settings at the East Danville 138 kV station and adjust as needed.
- It is understood that the Interconnection Customer is connecting PJM project AD1-087 to the Virginia Power transmission system. Therefore, the Virginia Power-related interconnection costs of the Interconnection Customer's generating facility are not included in this report.

Danville Substation Conductor Upgrade (n7754.1):

- AEP will replace 5 Sub cond 2000 AAC 91 Str at Danville2 138kV station.

East Danville Substation Conductor Upgrade (n7754.2):

- AEP will replace 3 Sub cond 2000 AAC 91 Str at East Danville2 138kV station.

Typical Schedule for AEP Network Upgrade Scope Indicated (Actual schedule to be determined at PJM Project kick off meeting)

Task	Dates(Notes)
Engineering Start	Day 1*
Material Ordered	Starts Day 60
Construction Start (Grading & Below Grade)	Starts Day 435
Construction Start (Above Grade)	Starts Day 540
Outage Requests Made By	Starts Day 180
Outage (Structure Foundations, and Conductoring)**	Starts Day 540
Outage (Cut-in & Testing)**	N/A
Ready For Back Feed (TO In-Service Date)	N/A
In-Service Date	Day 630

*Day 1 will be determined at the PJM kick off meeting.
**Scheduled Outages are contingent upon outage availability. Longer duration outages are not available during peak load periods.

Notes Regarding the Schedule

- All transmission outages are subject to PJM and AEP Operations outage scheduling requirements.
- Significant scope of work changes will impact the schedule.

Assumptions

- Estimates provided are based on a table top process without the benefit of site specific engineering studies (e.g., soil borings, environmental survey, ground grid, etc.), unless otherwise provided by the interconnection customer.
- System conditions must allow scheduled outages to occur.
- All transmission outages are subject to PJM and AEP Operations outage scheduling requirements.
- Assumes Outages can be obtained.
- Assumes timely execution of a Right-of-Way Agreement with Dan Chem for the proposed line re-route.
- Assumes local approval can be obtained for the rebuild and the relocation around Dan Chem.
- Assumes that three (3) existing poles - 301A, 303A and 306A - are appropriate for reuse.
- Assumes permits can be obtained for railroad crossing and for within 1% annual change FEMA Flood Hazard Zone.
- Assumes no special soil handling in the vicinity of Dan Chem will be required.
- Assumes that access to portion of the Dan Chem parcel between railroad tracks and river can be developed.
- Clearing has to be completed in 2022 or bat studies will be needed due to change in regulations.

Environmental, Real Estate, and Permitting

As noted in the "Assumptions" above, the Scope, Schedule and Estimates documented in this report rely on the following assumptions regarding Environmental, Real Estate and Permitting:

- Timely execution of a Right-of-Way Agreement with Dan Chem for the proposed line re-route.
- Local approval can be obtained for the rebuild and the relocation around Dan Chem.
- Permits can be obtained for railroad crossing and for within 1% annual change FEMA Flood Hazard Zone.
- No special soil handling in the vicinity of Dan Chem will be required.
- Any clearing will be completed in 2022, or bat studies will be needed due to changing regulations.

6. 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.

7. Environmental, Real Estate and Permitting Issues

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

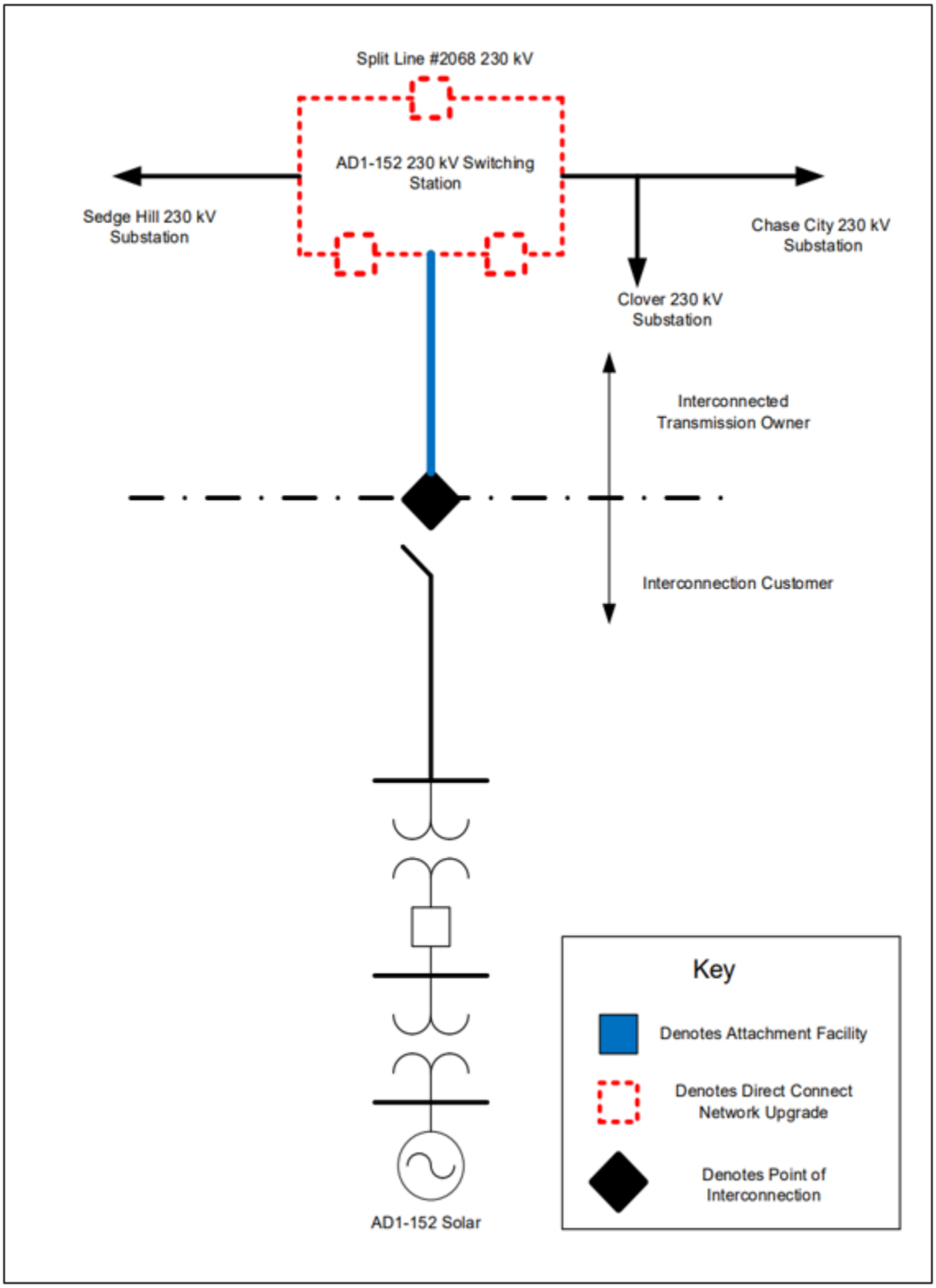
- Suitable Access Road from Substation to a Virginia State Maintained Roadway.
- Any additional land needed for Storm Water Management, Landscaping, and Wetlands/Wetlands Mitigation.
- Conditional Use Permit for Substation.
- Any other Land/Permitting requirements required by the Substation.

ITO Real Estate Needs:

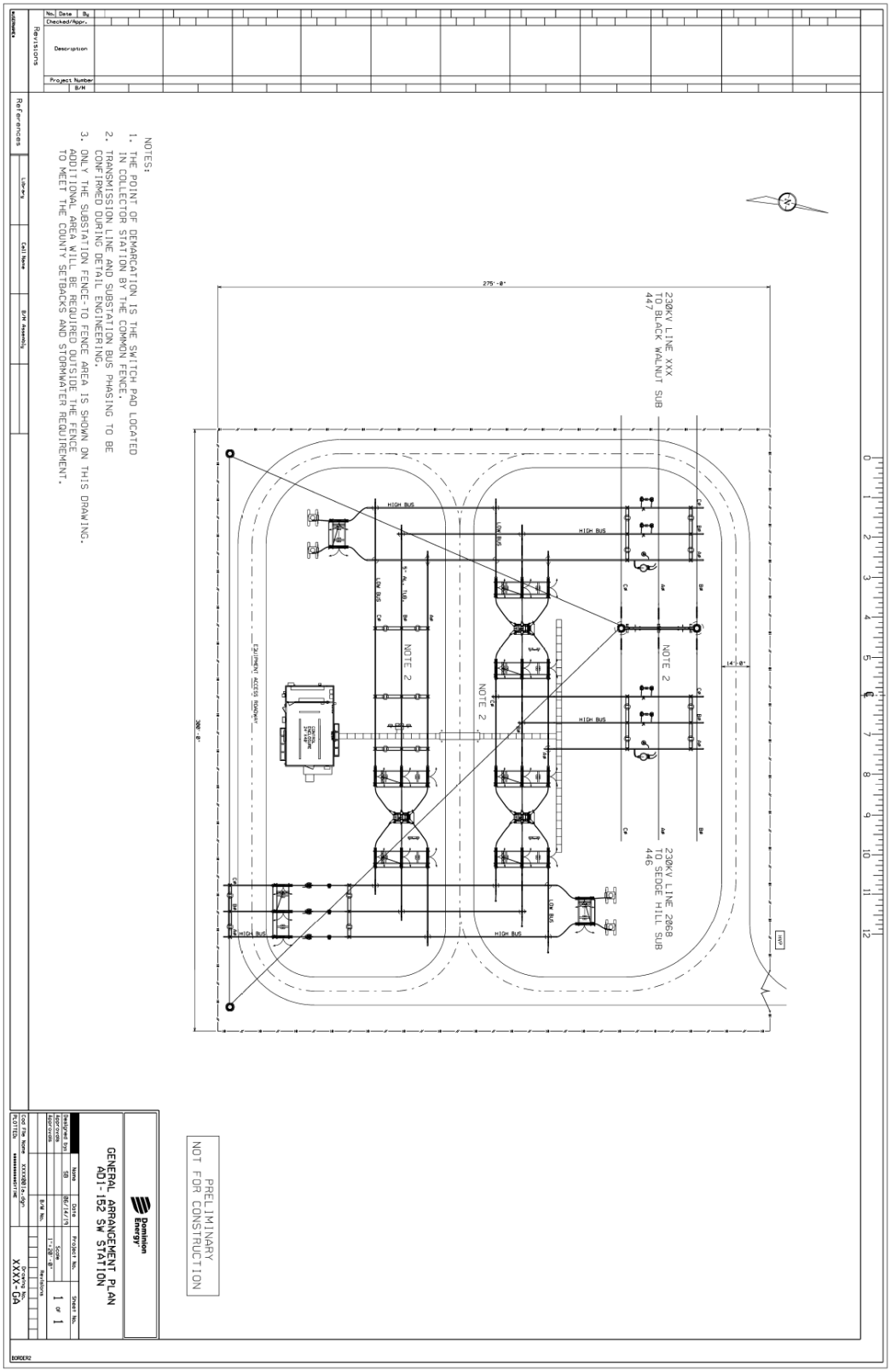
- The substation layout is complete and ITO requires a 310' x 285' piece of property (title in fee) to build the substation. The property includes the piece of property between the substation and collector station for the strain bus.
    - ITO requires ownership transfer of the substation site before they start construction. Target for the deed by January 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.
AD1-152 Switching Station General Arrangement



Attachment 3.

Danville – East Danville 138 kV Network Upgrade

AD1-087 Danville – East Danville 138 kV Line Rebuild

(Stations Not Completely Shown)