Facilities Study Report

For

Physical Interconnection of

PJM Generation Interconnection Request

Project ID AE2-283

Gladys-Stone Mill 69 kV

Introduction

This Facilities Study has been prepared in accordance with the PJM Open Access Transmission Tariff, as well as the Application and Studies Agreement between the Project Developer and PJM Interconnection, LLC (PJM or Transmission Provider (TP)). The Transmission Owner (TO) is Virginia Electric and Power Company (VEPCO or Dominion).

A. Transmission Owner Facilities Study Summary

1. PROJECT DESCRIPTION

The Project Developer (PD) has proposed a Solar Generating Facility located in Campbell, VA with a designated PJM Project ID of AE2-283. The installed facilities will have a total Maximum Facility Output (MFO) of 53 MW with 28 MW of this output being recognized by PJM as Capacity.

2. POINT OF INTERCONNECTION (POI)

AE2-283 is a new service request project that will interconnect with the Dominion transmission system via a newly constructed 69 kV single breaker tap.

AE2-283 will be tapping the Gladys–Stone Mill 69 kV line 35, near existing structure 35/369, approximately 5.21 miles from Gladys and 7.09 miles from Stone Mill. The new line number will be determined during the detailed engineering phase of the project.

The proposed generation interconnection is shown on the single line diagram in Attachment #1.

3. POINT OF CHANGE IN OWNERSHIP

The Point in Change of Ownership will be the 69kV disconnect switch 4-hole pad inside the Dominion station by the common fence.

4. SCOPE OF PROJECT DEVELOPER INTERCONNECTION FACILITIES

Project Developer will design, build, own, operate and maintain the Project Developer Interconnection Facilities on Project Developer's side of the Point of Change in Ownership (PCO). This includes, but is not limited to:

- Main Power Transformer (s) (MPT), Generation step-up (GSU) transformer(s) or final transformation, as applicable.
- Circuit breakers and associated equipment located between the high side of the MPT(s) or GSU(s) and the Point of Change in Ownership.
- Generator lead line from the Generating Facility to the Point of Change in Ownership.
- Relay and protective equipment, telecommunications equipment, and Supervisory Control and Data Acquisition (SCADA) to comply with the TO's Applicable Technical Requirements and Standards.

5. Supplemental Dominion Project

- A Dominion supplemental project has been proposed to construct a 3-breaker ring bus on the #35 line at the tap point near structure 35/302, approximately 7.9 miles from AE2-283. Relay protection scheme and equipment at AE2-283 may be modified from what is identified in this Facility Study Report. Coordination of construction and outages for these projects will be required.

B. Transmission Owner Facilities Study Results

The following is a description of the planned Transmission Owner facilities for the physical interconnection of the proposed AE2-283 project to the Dominion transmission system. These facilities shall be designed according to Dominion Applicable Technical Requirements and Standards. Once built, Dominion will own, operate, and maintain these Facilities.

1. TRANSMISSION OWNER INTERCONNECTION FACILITIES:

For new interconnection transmission:

The Transmission Owner Interconnection Facilities will include, but not be limited to, the following:

A 69 kV backbone structure and foundation within the fence of the Interconnection Substation, to terminate the Project Developer's generator lead line.

Line conductor from the backbone structure to the bus position in the switchyard of the interconnection substation.

Purchase and install substation material – Transmission Owner Interconnection Facilities:

1. One (1), 69kV, 2000A, 3-phase center break gang operated switch
2. Three (3), 69kV, metering accuracy CCVT
3. Three (3), 69kV, 500:5 metering accuracy CT
4. Conductor, connectors, conduits, control cables, foundations, steel structures and grounding material as per engineering standards

Purchase and install relay material – Transmission Owner Interconnection Facilities:

1. One (1), 1110 – 24" dual SEL-587Z/351A transmission bus panel
2. One (1), 4200_W1 – bus differential CT make-up box
3. One (1), 1425 – 24" dual SEL-735 transmission and generator interconnect metering panel
4. One (1), 4524 – revenue metering CT make-up box
5. One (1), 4506 – 3-phase CCVT potential make-up box with metering (P4)
6. One (1), 1323 – 24" SEL-487E/735 PMU and PQ monitoring panel
7. Two (2), 4541 – control cable make-up box
8. Two (2), 4528A – generation fiber make-up box

For new interconnection substation:

AE2-283 Interconnection Substation

A new 69 kV single breaker tap will be constructed along the Gladys–Stone Mill 69 kV transmission line 35 to interconnect the project with the Dominion transmission system.

The objective of this project is to build a new single breaker interconnect facility and the necessary network upgrades to support the new solar farm built by Project Developer. This site is located along Dominion's existing 69kV line 35 near structure 35/369 in Campbell County, Virginia. The station will be positioned in such a way that the 69kV backbone will accept the new line tap and terminate into this structure. A new 69kV circuit breaker will be installed at this terminal along with disconnect switches, arresters, and potential transformers.

The Project Developer will provide the property and access to the switching station. The grounding systems for each station will be tied together. All substation permitting, site preparation and grading activity will be performed by the Project Developer. All permits are the responsibility of the developer.

Substation design and relay protection are based on Dominion's Facility Interconnection Requirements, NERC Compliance Procedure FAC-001 (version 23), that is posted on PJM's website. This standard meets or exceeds the PJM Transmission and Substation Design Subcommittee Technical Requirements and the PJM Protection Standards (PJM Manual 7).

The scope of work includes the following:

Purchase and Install – Transmission Owner Interconnection Facilities:

1. Approximate station fence line dimensions of 250' x 200'. At a minimum, site preparation and grading will be required to extend 15' beyond these dimensions for station grounding. Additional property and site prep may be required for proper grading and stormwater management, etc.
2. Approximately 900 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. One (1), 69kV, 3000A, 40kAIC, SF-6 circuit breaker
4. One (1), 69kV, 2000A, 3-phase center break gang operated switch
5. Three (3), 69kV, relay accuracy CCVT
6. One (1), 69kV, 2000A wave trap
7. One (1), line tuner
8. Six (6), 60kV, 48kV MCOV surge arrester
9. One (1), 69kV, 2000A, 1-phase center break switch (for PVT's)
10. One (1), 69kV, 100KVA power PT's for station service
11. Two (2), 69kV, 10 in-lb., 125VDC motor operator
12. One (1), 100KW, 1PHS, 240/120VAC generator
13. One (1), 600A, 240VAC station service ATS
14. One (1), 24' x 40' control enclosure (with provisions for secondary station service generator connection)
15. One (1), 125 VDC, 200 Ah station battery and 50 Amp charger (size to be verified during detail engineering)
16. Approximately 100 ft of cable trough
17. One (1), 38" x 38" x 42" precast yard pull box
18. Station stone as required

19. Station lighting as required
20. Steel structures as required including switch stands, bus supports, station service transformers, CCVT and wave trap supports
21. Foundations as required including control house, equipment, and bus support stands
22. Conductors, connectors, conduits, control cables, cable trough, and grounding materials as per engineering standards

Purchase and Install - Transmission Owner Interconnection Relay Protection Equipment:

1. One (1), 1510 – 24" dual SEL-351-7 transmission breaker with reclosing panel
2. One (1), 4510 – SEL-2411 breaker annunciator
3. One (1), 1340 – 24" dual SEL-411L DCB/PLC line panel
4. One (1), 4506 – 3-phase CCVT potential make-up box
5. One (1), 1603 – 24" SEL-451 islanding control scheme panel
6. One (1), 4000 – station service potential make-up box
7. One (1), 4548 – non-earthing switch MOAB control box
8. One (1), 4103 – non-earthing switch MOAB AC/DC distribution box
9. One (1), 4018 – 500A station service AC distribution panel
10. Two (2), 4007 – 225A outdoor transmission yard AC NQOD
11. One (1), 4019 – 225A 3-phase throw over switch
12. One (1), 4016 – 600A PVT disconnect switch
13. One (1), 4153c – wall mount station battery monitor
14. One (1), 5613 – annunciator / RTU / communication panel
15. One (1), 5609 – fiber optic management panel
16. One (1), 4526_A – circuit breaker fiber optic make-up box
17. One (1), 5202 – 26" APP 601 digital fault recorder
18. Six (6), 4040 – security fiber/power make-up box
19. One (1), 5603 – station network panel no. 1
20. One (1), 5603 – station network panel no. 2
21. One (1), 4051 – power block
22. One (1), 4042_D1B – security utility – utility ATS
23. One (1), 4044 – 225A 1Ø outdoor main security AC NQOD
24. One (1), 5616 – station security panel
25. One (1), 5616 – station security fence panel
26. Two (2), 4018 – 225A station service AC distribution panel branch breaker
27. One (1), high voltage protection (HVP) box (provided by IT) (to be verified during detail engineering)
28. One (1), telephone interface box (to be verified during detail engineering)
29. One (1), 4821 – generator & ATS interface box
30. One (1), 4533 – security generator monitor
31. One (1), 4526_G – generator monitor fiber make-up box
32. One (1), 4042_D1C – sec utility – gen ATS

For new interconnection substation:

The Project Developer has the option to select 'Option to Build' as is their right under the PJM Generator Interconnection Agreement.

If “Option to Build” is selected, the Project Developer becomes responsible for the purchase and install of the TOIF facilities listed above, as well as the oversight costs included in 4. OTHER SCOPE OF WORK.

2. STAND ALONE NETWORK UPGRADES

The Stand Alone Network Upgrades will include, but not be limited to, the following:

No Stand Alone Network Upgrades have been identified in this facility studies report.

The Project Developer has the option to select ‘Option to Build’ as is their right under the PJM Generator Interconnection Agreement.

By selecting this construction process method, the Project Developer shall secure all required real estate, obtain all necessary permits, perform site work including site preparation and grading, furnish equipment, construction personnel and ancillary materials as found in the facility study for construction of the switching station in compliance with Dominion Energy Substation Engineering Standards.

If the Project Developer selects “Option to Build”, the work required is as follows:

Option to Build, Transmission Owner Interconnection Physical Facilities – Project Developer:

1. Approximate station fence line dimensions of 250’ x 200’. At a minimum, site preparation and grading will be required to extend 15’ beyond these dimensions for station grounding. Additional property and site prep may be required for proper grading and stormwater management, etc.
2. Approximately 900 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. One (1), 69kV, 3000A, 40kAIC, SF-6 circuit breaker
4. One (1), 69kV, 2000A, 3-phase center break gang operated switch
5. Three (3), 69kV, relay accuracy CCVT
6. One (1), 69kV, 2000A wave trap
7. One (1), line tuner
8. Six (6), 60kV, 48kV MCOV surge arrester
9. One (1), 69kV, 2000A, 1-phase center break switch (for PVT’s)
10. One (1), 69kV, 100KVA power PT's for station service
11. Two (2), 69kV, 10 in-lb., 125VDC motor operator
12. One (1), 100KW, 1PHS, 240/120VAC generator
13. One (1), 600A, 240VAC station service ATS
14. One (1), 24’ x 40’ control enclosure (with provisions for secondary station service generator connection)
15. One (1), 125 VDC, 200 Ah station battery and 50 Amp charger (size to be verified during detail engineering)
16. Approximately 100 ft of cable trough
17. One (1), 38” x 38” x 42” precast yard pull box
18. Station stone as required
19. Station lighting as required

20. Steel structures as required including switch stands, bus supports, station service transformers, CCVT and wave trap supports
21. Foundations as required including control house, equipment, and bus support stands
22. Conductors, connectors, conduits, control cables, cable trough, and grounding materials as per engineering standards

Option to Build, Transmission Owner Interconnection Relay Protection Equipment – Project Developer:

1. One (1), 1510 – 24" dual SEL-351-7 transmission breaker with reclosing panel
2. One (1), 4510 – SEL-2411 breaker annunciator
3. One (1), 1340 – 24" dual SEL-411L DCB/PLC line panel
4. One (1), 4506 – 3-phase CCVT potential make-up box
5. One (1), 1603 – 24" SEL-451 islanding control scheme panel
6. One (1), 4000 – station service potential make-up box
7. One (1), 4548 – non-earthing switch MOAB control box
8. One (1), 4103 – non-earthing switch MOAB AC/DC distribution box
9. One (1), 4018 – 500A station service AC distribution panel
10. Two (2), 4007 – 225A outdoor transmission yard AC NQOD
11. One (1), 4019 – 225A three phase throw over switch
12. One (1), 4016 – 600A PVT disconnect switch
13. One (1), 4153c – wall mount station battery monitor
14. One (1), 5613 – annunciator / RTU / communication panel
15. One (1), 5609 – fiber optic management panel
16. One (1), 4526_A – circuit breaker fiber optic make-up box
17. One (1), 5202 – 26" APP 601 digital fault recorder
18. Six (6), 4040 – security fiber/power make-up box
19. One (1), 4051 – power block
20. One (1), 4042_D1B – security utility – utility ATS
21. One (1), 4044 – 225A 1Ø outdoor main security AC NQOD
22. Two (2), 4018 – 225A station service AC distribution panel branch breaker
23. One (1), 4821 – generator & ATS interface box
24. One (1), 4533 – security generator monitor
25. One (1), 4526_G – generator monitor fiber make-up box
26. One (1), 4042_D1C – sec utility – gen ATS

3. NETWORK UPGRADES

The Network Upgrades will include, but not be limited to, the following:

Transmission Line Tie-in for new interconnection substation:

This project serves to tap existing 69 kV line 35 into a new substation called AE2-283, which is to be located in Campbell County, VA. The tap spans will be located near existing structure 35/369, which is to be removed and replaced with two (2) double deadend structures: 35/369A and 35/369B. Existing structures 35/368 and 35/370 are to be replaced with double deadend structures, and self-supporting switch structures are to be installed in the transmission line right of way.

The proposed structures to be installed are two (2) 115kV single circuit engineered steel H-Frame double deadend structures, two (2) 115kV single circuit engineered steel 3-Pole double deadend

structures, two (2) self-supporting switch structures, one (1) 115kV single circuit steel backbone, and one (1) steel static pole. The new conductor to be used will be (1) 768.2 ACSS/TW/HS (20/7) “Maumee” conductor, and the shield wire to be used is 7#7 Alumoweld and DNO-11410 OPGW. 7#7 Alumoweld will be utilized for shielding within AE2-283 Substation.

Existing Facilities to be Removed:

1. Remove three (3) existing 69kV single circuit weathering steel suspension monopole structures as follows:
    a. Structure 35/368-370
2. Remove approximately 0.30 miles of 3-phase 1-336.4 ACSR (26/7) 90 MOT conductor from structure 35/368 to 35/370.
3. Remove approximately 0.30 miles of one (1) 7#7 Alumoweld shield wire from structure 35/368 to 35/370.

Modification to Existing Facilities:

1. Cut and transfer the existing 1-336.4 ACSR for Line 35 from ahead side of existing structure 35/368 to the backside of proposed structure 35/368.
2. Cut and transfer the existing 1-336.4 ACSR for Line 35 from back side of existing structure 35/370 to the ahead side of proposed structure 35/370.
3. Cut and transfer the existing 7#7 Alumoweld shield wire for Line 35 from ahead side of existing structure 35/368 to the backside of proposed structure 35/368.
4. Cut and transfer the existing 7#7 Alumoweld shield wire for Line 35 from back side of existing structure 35/370 to the ahead side of proposed structure 35/370.

Permanent Facilities to be Installed:

1. Install two (2) 115kV engineered steel H-frame single circuit double deadend structures on foundations as follows:
    a. Structures 35/368 and 35/370.
2. Install two (2) 115kV engineered steel 3-Pole single circuit steel double deadend 3-Pole structures on foundations as follows:
    a. Structures 35/369A and 35/369B.
3. Install one (1) 115kV single circuit steel backbone on foundations as follows:
    a. Structures 35/369C.
4. Install one (1) steel static pole on a foundation as follows:
    a. Structure 35/369D.
5. Install approximately 0.30 miles of 3-phase single (1) 768.2 ACSS/TW/HS (20/7) “Maumee” conductor as follows:
    a. Approximately 0.15 miles from proposed structure 35/368 to proposed backbone 35/369C.
    b. Approximately 0.15 miles from proposed backbone 35/369C to proposed structure 35/370.
6. Install approximately 0.30 miles of one (1) DNO-11410 OPGW as follows:
    a. Approximately 0.15 miles from proposed structure 35/368 to proposed backbone 35/369C.
    b. Approximately 0.15 miles from proposed backbone 35/369C to proposed structure 35/370.

c. This includes the installation of four (4) splices as follows:
    i. One (1) splice, on proposed structure 35/368.
    ii. One (1) splice, on proposed structure 35/370.
    iii. Two (2) splices, on proposed backbone 35/369C.
7. Install approximately 0.35 miles of one (1) 7#7 Alumoweld shield wire as follows
    a. Approximately 0.15 miles from proposed structure 35/368 to proposed backbone 35/369C.
    b. Approximately 0.15 miles from proposed structure 35/370 to proposed backbone 35/369C.
    c. Approximately 0.05 miles between the static pole 35/369D and proposed backbone 35/369C inside of AE2-283.
8. Install two (2) self-supporting switches on foundations as follows:
    a. Structure 35/368A and 35/370A

Upgrades to neighboring facilities:

Additional work is required at Stone Mill Substation.

Stone Mill Substation

Project AE2-283 provides for drawing work, relay resets, islanding panel addition, and field support necessary to change line 35 destination from Gladys DP to AE2-283 Generator Interconnect.

Purchase and install relay material:

1. One (1), 1603 – 24" SEL-451 islanding control panel
2. One (1), 1340 – 24" dual SEL411L DCB/PLC line panel
3. One (1), panel retirement (Panel 5)

4. OTHER SCOPE OF WORK

The Project Developer 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 GIA.

If the Project Developer selects “Option to Build”, the oversight required is as follows:

Option to Build, Transmission Owner Interconnection Facilities & Oversight – Dominion:

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 switching station
3. All Permitting related oversight and approval of activities related to construction of switching station
4. All Survey related oversight and approval of activities related to construction of 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. Review and approve all riser conductor, connectors, spacers, and bolts related to connection of the switching station to the Bulk Electric Transmission System
8. Review and approve all material related to the integration of the security fence software package back to the Corporate Security Fusion Center

Option to Build, Transmission Owner Interconnection Facilities Relay Protection Equipment – Dominion:

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 – station network panel no. 1
7. One (1), 5603 – station network panel no. 2
8. One (1), high voltage protection (HVP) box (Provided by IT) (to be verified during detail engineering)
9. One (1), telephone interface box (to be verified during detail engineering)

5. MILESTONE SCHEDULE FOR COMPLETION OF TO WORK

Facilities outlined in this report are estimated to take 39 months to construct, from the time the Generator Interconnection Agreement is fully executed. This schedule may be impacted by the timeline for procurement and installation of long lead items, the ability to obtain outages to construct and test the proposed facilities.

Description	Start month	Finish month
Detailed Design	1	8
Permitting	3	31
Construction	29	39

6. ASSUMPTIONS IN DEVELOPING SCOPE/COST/SCHEDULE

General Assumptions:

1. The estimated procurement lead time for breakers is based on current Dominion pre-ordered breaker production slots. These production slots will be assigned after the agreement is executed.
2. The preliminary construction schedule is dependent on outage availability.
3. The developer's collector station will share a fence with Dominion's substation.
4. The Dominion supplemental project (SXXXX) will require a islanding scheme. The protections scheme will be developed during the detailed design and is not included as part of the AE2-283 Facility Study Report.
5. Proposed Generation Interconnection projects AE2-185 and AF2-404 are connection to the Gladys DP line. Outage and construction coordination may be required.

TOIF/SANU Conceptual Design Notes:

1. Currently, the scope and estimate assume Dominion standard spread footer foundations. Once the soil information is available and it is prudent to change the design to "helical pile foundations" the Dominion team should be informed to adjust the project estimate at the earliest possible opportunity.
2. Security and fence type – design level 4.

Network Upgrades Conceptual Design Notes:

1. Engineered steel pole costs were determined based off typical wind and weight spans, line angles, and average structure heights for each voltage.
2. Engineered steel pole foundation costs were based off the projects' location and structure type in the regional soil profile map. The regional soil profile map used for this project is Piedmont.
3. Survey costs were determined based on substation proposed location, fiber installation, and impacts on existing line.

7. REVENUE METERING REQUIREMENTS

All revenue metering needed for this interconnection project must meet the metering requirements stated in Appendix 2, section 8 of the AE2-283 GIA, and in PJM Manuals M01 and M14D. The details of applicable revenue metering requirements are given in section 4.1.6 Metering and Telecommunications of Dominion's Facility Interconnection Connection Requirement NERC Standard FAC-001 posted on PJM website.

The revenue metering will be installed on the Transmission Owner side of the Point of Change in Ownership will be installed, owned and maintained by Transmission Owner.

a. Hourly compensated MWh received from the Generating Facility to the TO;
b. Hourly compensated MVARh received from the Generating Facility to the TO;
c. Hourly compensated MWh delivered from the TO to the Generating Facility; and

d. Hourly compensated MVARh delivered from the TO to the Generating Facility.

The Project Developer will access revenue meter via wireless transceivers or fiber cabling to meter with RS-485 or Ethernet communication port for dial-up reads. Project Developer must provide revenue and real time data to PJM from Project Developer Market Operations Center per "PJM Telemetry Data Exchange Summary" document available at PJM.com.

8. LAND REQUIREMENTS FOR INTERCONNECTION SUBSTATION

Land requirements for the Interconnection Substation needed for this interconnection project must meet the requirements in Dominion's Facility Interconnection Requirements, NERC Compliance Procedure FAC-001 (version 23), that is posted on PJM's website.

The Project Developer would be responsible for the following expectations in the area of Real Estate.

- The land required for Dominion's substation and project specific areas around must be deeded over title-in-fee.
- Any additional land needed for Storm Water Management, Landscaping, and Wetlands/Wetlands Mitigation.
- Dominion Real Estate and Counsel will provide standard real estate checklist word document. Process needs to start at least 6 months prior to closing date.
- Required subdivision plat and associated documentation to be reviewed prior to subdividing parcel with the county.
- Suitable Access Road from Substation to a Virginia/North Carolina State Maintained Roadway.
- Dominion will require access road, transmission line and utilities easement to the Substation.
- Any other Land/Permitting requirements required by the Substation.

9. ENVIRONMENTAL AND PERMITING

The Project Developer would be responsible for the following expectations in the area of Environmental and Permitting.

- Assessment of environmental impacts related to the Interconnection Facility and/or Network Upgrades including:

  Environmental Impact Study requirements

  Environmental Permitting

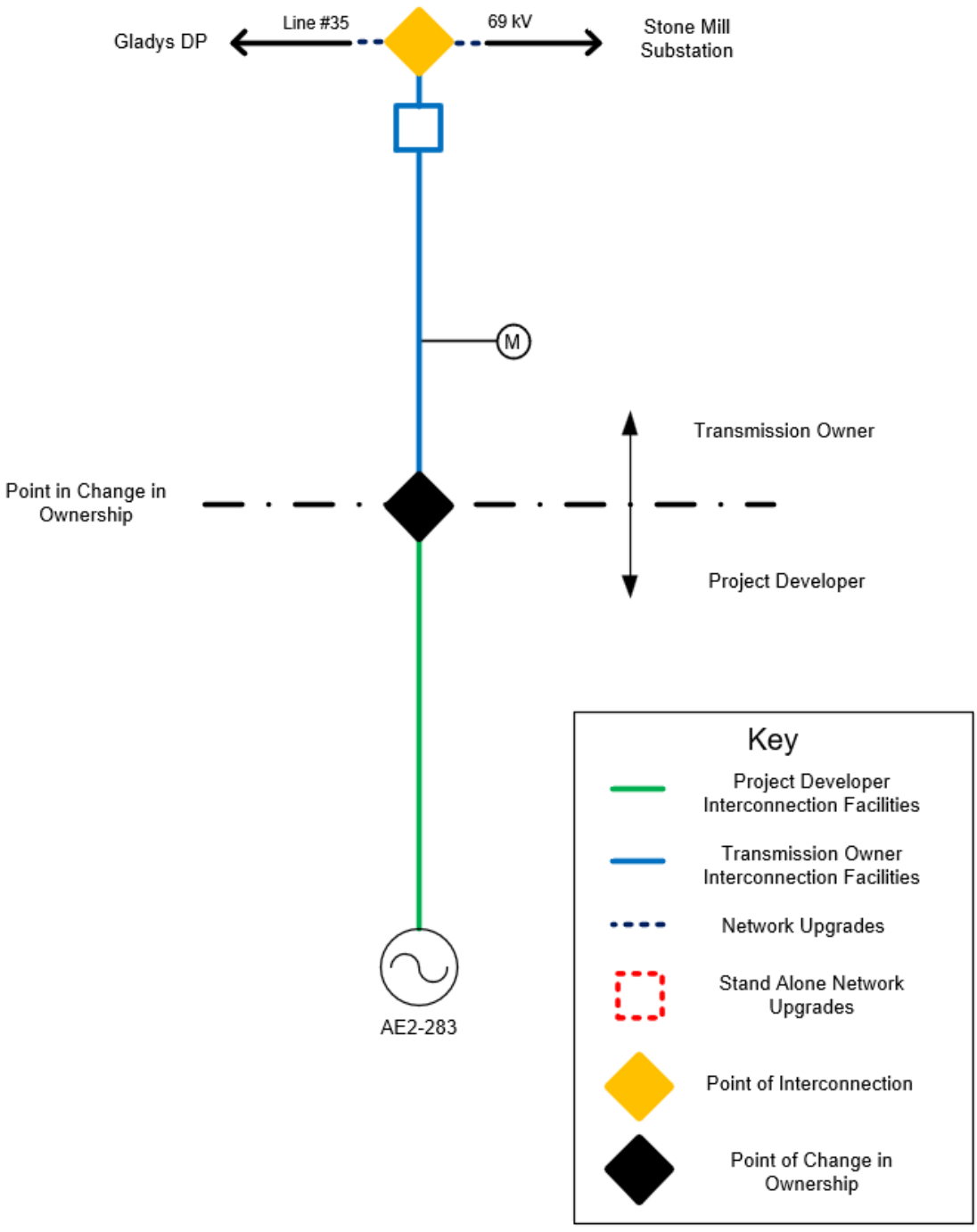
- Dominion will require a stormwater easement for substation specific stormwater design BMP's to allow access to and use of the facilities.

  A maintenance agreement should be in place in perpetuity for said stormwater facilities.

- Conditional Use Permit for Substation
- Any additional land needed for Storm Water Management, Landscaping, and Wetlands/Wetlands Mitigation
- Any other Permitting requirements required by the Substation

C. APPENDICES

Attachment #1: Single line Diagram for the Physical Interconnection



Attachment #2: Substation General Arrangement