Facilities Study Report

For

Physical Interconnection of

PJM Generation Interconnection Request

Project ID AG1-342

Dryburg 115 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 Halifax, VA with a designated PJM Project ID of AG1-342. The installed facilities will have a total Maximum Facility Output (MFO) of 36 MW with 21.6 MW of this output being recognized by PJM as Capacity.

2. POINT OF INTERCONNECTION (POI)

AG1-342 is a new service request project that will interconnect with the Dominion transmission system via a newly constructed 115 kV single breaker tap.

AG1-342 will be tapping the Chase City–Clays Mill 115 kV line 33, approximately 21 miles from Chase City and 12.07 miles from Clays Mill.

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 115kV disconnect switch 4-hole pad on the transmission line structure outside the AG1-342 station 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 #33 line at the Dryburg tap point near structure 33/901, approximately 5.9 miles from AG1-342. Relay protection scheme and equipment at AG1-342 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 AG1-342 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:

AG1-342 Interconnection Substation

A new 115 kV single breaker tap will be constructed along the Chase City–Clays Mill 115 kV transmission line 33 to interconnect the project with the Dominion transmission system.

The objective of this project is to add one new line position and one new 115kV breaker on line 33 near Dryburg Station to support the new solar farm built by Project Developer. The site is located along Dominion's existing 115kV, line 33 from Mt. Laurel Substation to Dryburg Substation.

A 115 kV backbone structure and foundation outside 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.

The Project Developer will provide the property and access to the switching station. 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).

Purchase and Install – Transmission Owner Interconnection Facilities:

1. Approximate station fence line dimensions of 180' x 190'. At a minimum, site preparation and grading will be required to extend 15' beyond these installation for station grounding. Additional property and site prep may be required for proper grading and stormwater management, etc.

2. Approximately 740’ 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), 115kV, 3000A, 40kAIC, SF-6 circuit breaker
4. Two (2), 115kV, 2000A, 3-phase center break gang operated switch
5. Six (6), 90kV, 74kV MCOV surge arrester
6. Three (3), 115kV, relay accuracy CCVT
7. One (1), 115kV, 2000A wave trap
8. One (1), line tuner
9. One (1), 115kV, 2000A, 1-phase center break switch (for PVT)
10. One (1), 115kV, 100KVA PVT
11. Two (2), 115kV, 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
15. One (1), Control Enclosure Signage
16. One (1), 125VDC, 300 Ah station battery and 50 Amp charger (size to be verified during detail engineering)
17. Approximately 100 ft of cable trough with a 20 ft road crossing section
18. One (1), 38” x 38” x 42” precast yard pull box
19. Station stone as required
20. Station lighting as required
21. Steel structures as required including switch stands, bus supports, station service transformers, and CCVT supports
22. Foundations as required including control house, equipment, and bus support stands
23. Conductors, connectors, conduits, control cables, cable trough, and grounding materials as per engineering standards

Purchase and Install – Transmssion 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 – 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. One (1), 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. Five (5), 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 – sec 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 – security fence panel
26. One (1), 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 MU Box
32. One (1), 4042_D1C – Sec Utility – gen ATS One (1), 1340 – 24" dual SEL-411L CD/Fiber line panel
33. One (1), 1425 – 24" dual SEL-735 transmission and generator interconnect metering panel
34. One (1), 4524 – revenue metering CT make-up box
35. One (1), 4506 – 3-phase CCVT potential make-up box with metering (P4)
36. One (1), 1323 – 24" SEL-487E/735 PMU and PQ monitoring panel

Purchase and install substation material – Transmission Owner Interconnection Facilities:

1. Three (3), 115kV, metering accuracy CCVT
2. Three (3), 115kV, 500:5 metering accuracy CT
3. Conductor, connectors, conduits, control cables, foundations, steel structures and grounding material as per engineering standards

Permanent Facilities to be Installed – Transmission Owner Interconnection Facilities:

1. Install one (1) 115kV single circuit heavy duty steel backbone structure with one (1) 2000A vertically mounted switch on foundations as follows:
    a. Structure 33/945D

2. STAND ALONE NETWORK UPGRADES

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

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.

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 Facilities – Project Developer:

1. Approximate station fence line dimensions of 180’ x 190’. 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 740’ 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), 115kV, 3000A, 40kAIC, SF-6 circuit breaker
4. Two (2), 115kV, 2000A, 3-phase center break gang operated switch
5. One (1), 115kV, 2000A wave trap
6. One (1), line tuner
7. Three (3), 115kV, relay accuracy CCVT
8. Six (6), 90kV, 74kV MCOV surge arrester
9. One (1), 115kV, 2000A, 1-phase center break switch (for PVT)
10. One (1), 115kV, 100KVA PVT
11. Two (2), 115kV, 10 in-lb., 125VDC motor operator
12. One (1), 100kW, 1PHS, 240/120VAC generator
13. One (1), 600A, 240VAC station service ATS
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15. One (1), Control Enclosure Signage
16. One (1), 125 VDC, 300 Ah station battery and 50 Amp charger (size to be verified during detail engineering)
17. Approximately 100 ft of cable trough with a 20 ft road crossing section
18. One (1), 38” x 38” x 42” precast yard pull box
19. Station stone as required
20. Station lighting as required
21. Steel structures as required including switch stands, bus supports, station service transformers, and CCVT supports
22. Foundations as required including control house, equipment, and bus support stands
23. Conductors, connectors, conduits, control cables, cable trough, and grounding materials as per engineering standards

Option to Build, Transmission Owner Interconnection Facilities 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 – 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. One (1), 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
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16. One (1), 4526_A – circuit breaker fiber optic make-up box
17. One (1), 5202 – 26" APP 601 digital fault recorder
18. Five (5), 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. One (1), 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 construct a new single breaker tap, located in Halifax County, VA. The new single breaker tap will not create a new line. Line #33 will be tapped between proposed structure 33/945 and Dryburg Substation. The wire will continue onto new developer structure 33/945D outside the substation fence and be the point of change of ownership structure. The developer will own the 115 kV Line from the ahead side of the point of change of ownership structure to their substation.

The proposed structures to be installed are one (1) single circuit steel 3-pole double deadend structure and one (1) steel static pole. The new conductor and shield wire to be used will be 3 phase single (1) 768.2 ACSS/TW/HS (20/7) "Maumee" and additional shielding of 7#7 Alumoweld.

Existing Facilities to be Removed:

1. Remove one (1) existing direct embedded wood single circuit 3-pole double deadend structure 33/945.

Modification to Existing Facilities:

1. Cut and transfer the existing 3-phase single (1) 246.9 AAAC (7 5005/0) conductor for Line 33 from the ahead side of existing H-frame structure 33/944 to the back side of proposed 3-pole structure 33/945.
2. Cut and transfer the existing two (2) 3#6 Alumoweld shield wire for Line 33 from the ahead side of existing H-frame structure 33/944 to the back side of proposed 3-pole structure 33/945.

Permanent Facilities to be Installed:

1. Install one (1) 115kV single circuit steel 3-pole double deadend structure on foundations as follows:
    a. Structure 33/945
2. Install one (1) steel static poles on foundations as follows:
    a. Structures 33/945C
3. Install approximately 0.05 miles of 3-phase single (1) 768.2 ACSS/TW/HS (20/7) "Maumee" conductor as follows:

a. From the ahead side of proposed 3-pole structure 33/945 to the back side of Dryburg backbone inside the substation.

4. Install approximately 0.19 miles of one (1) 7#7 Alumoweld shield wire as follows:
    a. Approximately 0.05 miles from proposed 3-pole structure 33/945 to existing static pole structure 33/945A.
    b. Approximately 0.05 miles from proposed 3-pole structure 33/945 to existing static pole structure 33/945B.
    c. Approximately 0.04 miles from proposed 3-pole structure 33/945 to proposed backbone structure 33/945D.
    d. Approximately 0.02 from proposed backbone structure 33/945D to proposed static pole 33/945C
    e. Approximately 0.03 miles from existing static pole 33/945B to proposed static pole 33/945C.

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 Facility & 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 Interconnectio 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)
9. One (1), telephone interface box

Option to Build, Transmission Owner Interconnection Facilities; Physical 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 Construction and Methods oversight and approval of activities related to construction and energization of switching station
3. All Project Management oversight activities related to construction and energization of switching station

5. MILESTONE SCHEDULE FOR COMPLETION OF TO WORK

Facilities outlined in this report are estimated to take 37 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	29
Construction	27	37

6. ASSUMPTIONS IN DEVELOPING SCOPE/COST/SCHEDULE

1. A proposed Dominon supplemental project SXXXX has been identified to construct a 3 breaker ring bus as the existing dryburg tap point on line #33. This project will have a similar milestone schedule. Outage coordination will be required for these projects.

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 POCO structure will be located outside of the single breaker tap station.
4. Given that there is only one station service source (PVT), a second onsite generator source will be required.
5. 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 AG1-342 Facility Study Report.

Conceptual Design Notes:

1. Security and fence type – design level 4.
2. 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.
3. Engineered steel pole costs were determined based off typical wind and weight spans, line angles, and average structure heights for each voltage.
4. Engineered 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.
5. Survey costs were determined based on substation proposed expansion location, fiber installation, and impacts on existing line.
6. The conceptual estimate assumes that a laydown yard is required for this project.
7. Dominion has determined a three-breaker ring at the line 33 tap point is needed for transmission line protection for IBR's with multi-terminal lines.

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 AG1-342 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

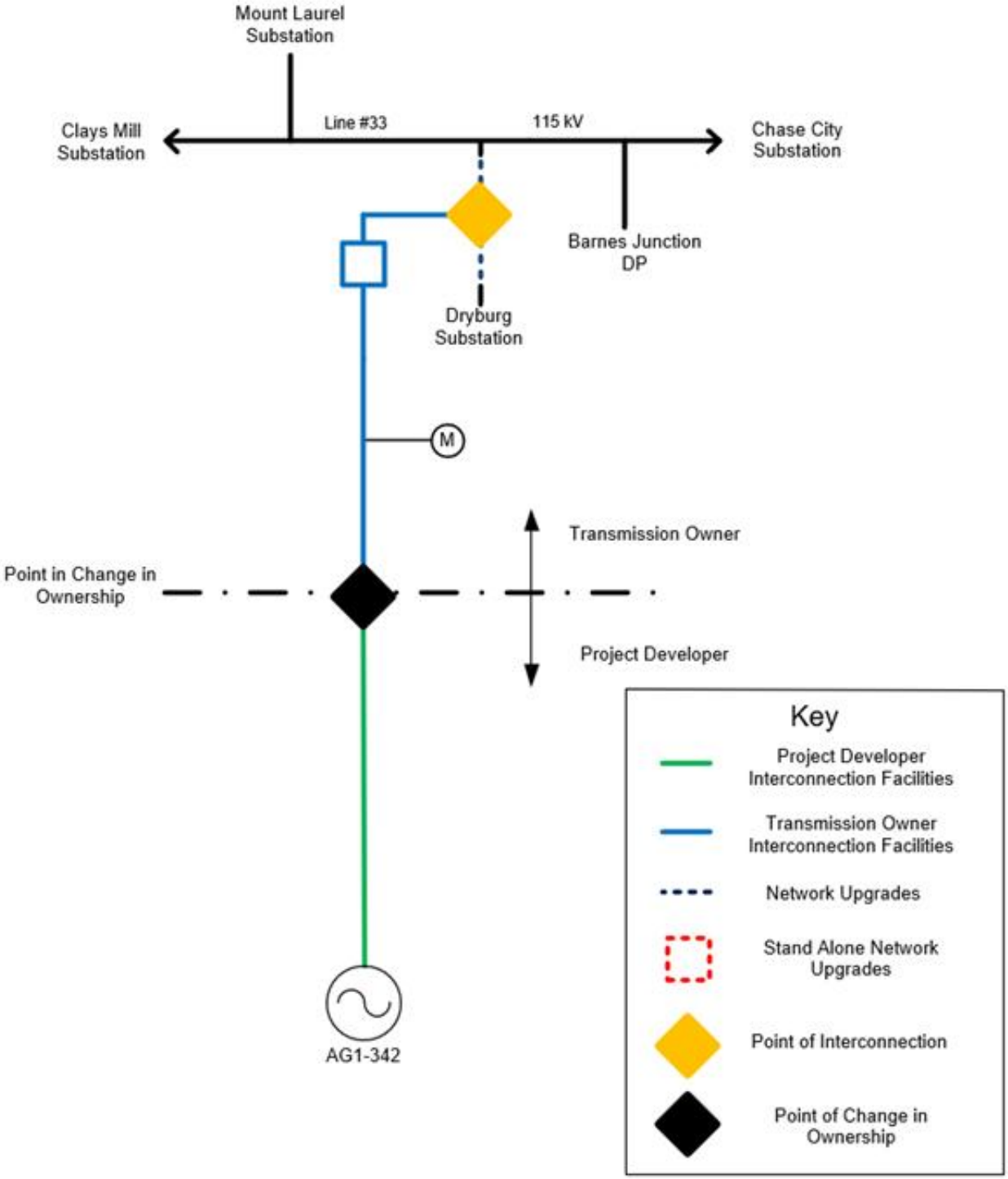
- Dominion will require a stormwater easement for substation specific stormwater design BMP's to allow access to and use of the facilities.

  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