Generation Interconnection
Facility Study Report

For

PJM Generation Interconnection Request
Queue Position AB2-160

Reams DP 115kV
30.4 MW Capacity / 80 MW Energy

Revised February / 2019

Introduction

This Facilities Study has been prepared in accordance with the PJM Open Access Transmission Tariff §207, as well as the Facilities Study Agreement between First Solar Development, LLC, (Interconnection Customer (IC)) and PJM Interconnection, LLC (Transmission Provider (TP)). The Interconnected Transmission Owner (ITO) is Virginia Electric and Power Company (VEPCO).

General

IC has proposed a solar generating facility located in Dinwiddie County, VA. The installed facilities will have a total capability of 80 MW with 30.4 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is 12/31/2021. **This study does not imply an ITO commitment to this in-service date.**

Point of Interconnection

AB2-160 will interconnect with the transmission owner system via a new three breaker ring bus switching station adjacent to the Reams DP 115kV.

Cost Summary

The AB2-160 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$505,065
Direct Connection Network Upgrades	$5,283,245
Non Direct Connection Network Upgrades	$1,486,146
Allocation for New System Upgrades	$0
Contribution for Previously Identified Upgrades	$0
Total Costs	**$7,274,456**

A. Transmission Owner Facilities Study Summary

1. Description of Project

Queue AB2-160 is a request to interconnect an 80 MW new solar generating facility to be located near the intersection of Perkins Rd and Otter Run Dr in Templeton, Dinwiddie County, Virginia. The proposed generating facility will interconnect with the ITO's new AB2-160 115kV Switching Station via a new breaker bay (Line Terminal). The requested in-service date is December 31, 2021. Attachment Facility and Network upgrade construction is estimated to be 14 – 24 months.

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

None

3. Interconnection Customer's Submitted Milestone Schedule

- Plan to break ground September 4, 2020
- Permits – state level Permit By Rule and county level Final Site Plan approval complete by August 31, 2020
- Substantial site work completed July 31, 2021
- Delivery of major electrical equipment May 28, 2021
- Back Feed Power October 15, 2021
- Commercial Operation December 31, 2021

4. Scope of Customer's Work

IC will build a solar generating facility in Dinwiddie County, Virginia. The generating facility (Reams Solar) will be comprised of solar arrays. AB2-160 consists of 21 x 3.932 MW GE LV5 inverters. The 21 x 34.5/0.55 kV delta wye generator step up (GSU) transformers will connect to the solar inverters to the 34.5 kV collector system. The generating facility will connect to the Point of Interconnection (POI) via a 115 kV grounded wye / 34.5 kV grounded wye main power transformer with a rating of 52/70/86 MVA. The AB2-160 POI will be at a tap of the Reams DP – Sappony 115kV line #69 adjacent to Reams DP.

5. Description of Facilities Included in the Facilities Study

The ITO will connect the proposed generator lead via Attachment Facilities to a new AB2-160 ring bus switching station adjacent to the transmission right of way. The site is located along the ITO's 115kV Line #69 from Locks Substation to Clubhouse Substation (Normally open line switch near Fields Substation changes the line number to Line 148 between the line switch and Clubhouse). The switching station will be positioned in such a way that the new backbone will be between transmission structures 69/89 and 69/90, with about 30 foot offset from the transmission line. The cut lines will be attached to the new backbone and risers will be dropped from both sides of the backbone to the bus sections directly underneath the line. The lines will consume two of the three positions in the ring bus. The third position will be for the 115 kV feed from the collector station for the solar farm. The collector substation and ITO switching station will share a common fence. The demarcation point between the switching station and the

collector station will be the 4-hole pads on the ITO's disconnect switch. The IC will bring its bus over the common fence to the demarcation point. Metering equipment will be installed in the ITO Switching Station. The ground grid for two stations will be tied together. The IC will provide the property and access to the switching station. All substation permitting, site preparation and grading activity will be performed by the IC. There will be transmission line protection and anti-islanding work required at the remote lines terminals in Locks, Sapony, Clubhouse, and Reams D.P. 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

	Direct		Indirect		
Work Description	Labor	Material	Labor	Material	Total Cost
Attachment Facilities	$288,624	$149,157	$49,899	$17,385	$505,065
Total Attachment Facilities Cost	$288,624	$149,157	$49,899	$17,385	$505,065
AB2-160 115 kV Switching Station (n5809)	$2,347,028	$2,303,781	$386,850	$245,586	$5,283,245
Line #69 Transmission work (n5810)	$800,978	$338,107	$126,649	$37,609	$1,303,343
Remote relay (n5811)	$85,448	$67,733	$19,116	$10,506	$182,803
Total Network Upgrades	$3,233,454	$2,709,621	$532,615	$293,701	$6,769,391
Total Project Costs	$3,522,078	$2,858,778	$582,514	$311,086	$7,274,456

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

Facilities are estimated to take 14 - 24 months to construct and this is based on the ability to obtain outages to construct and test the proposed facilities.

Proposed Schedule

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

ITO requires the site to be fully graded and permitted site so they can start construction by September 2020.

B. Transmission Owner Facilities Study Results

1. Attachment Facilities

The Attachment Facilities include that portion of the interconnecting switching station which is associated solely with the single feed to the generating facilities. The Point of Interconnection with the generator will be the 4-hole pad on the ITO disconnect switch. The IC will bring its bus to the demarcation point. Metering equipment will be installed in the ITO Switching Station. The equipment associated with the Attachment Facilities includes the following.

Purchase and install (Attachment facilities):

1. One (1) 115 kV, 2000A, 3-phase Center Break Gang Operated Switches
2. Three (3) 115 kV metering accuracy CCVT's
3. Three (3) 115 kV metering accuracy CT's
4. Tubular bus, steel structures and foundations as required
5. Conductors, connectors, conduits, control cables, and grounding material

Purchase and install relay material (Attachment facilities):

1. One (1), 1109 – 28" Dual SEL-587Z Transmission Bus Panel
2. One (1), 4200 – Bus Differential C.T. M.U. Box
3. One (1), 1425 – 28" Dual SEL-735 Transmission & Generator Interconnect Metering Panel
4. One (1), 4524 – Revenue Metering C.T. M.U. Box
5. One (1), 4531 – Generator Interconnect CCVT Potential M.U. Box
6. One (1), 1323 – 28" SEL-487E/735 PMU & PQ Monitoring Panel
7. Two (2), 4541 - Control Cable M.U. Box

2. Transmission Line – Upgrades

PJM Network Upgrade #n5809 - Re-arrange Line #69 to loop into and out of the new three breaker AB2-160 115 kV switching station between transmission structures 69/89 and 69/90 between existing stations Reams and Sapony**.** The lines typical structure type is wood SC H-frames. The substation and backbone will be nearly lined up with the existing alignment, though offset approx. 30 feet to ensure clearance to the adjacent circuit. Due to system protection issues, Fiber optic wire will need to be installed between the proposed station and the other terminal station, Locks Substation. The project work summary is described below:

Existing Facilities to be Removed

1. Remove (4) Wood H-frame suspension structures 69/87, 69/88, 69/89 and 69/90

Existing Facilities to be Transferred

1. In total 3 transfers will be required. Transfer existing 3-phase 795 ACSR conductor and 1-3#6 static wire to new steel H-frames 69/89 and 69/90. Transfer existing 3-phase 795 ACSR conductor and 1-3#6 static wire to new backbone 69/89A
2. Transfer existing static wire to new backbone structure and DDE H-frames

Permanent Facilities to be Installed

1. Install (2) Steel DOM Pole DDE H-frame structures, 69/89 and 69/90
2. Install (2) Steel DOM Pole Suspension H-frame structures, 69/88, 69/87

3. Install (1) 115 kV Standard Backbones Structures 69/89A
4. Install (2) Engineered Static Poles 69/89B, 69/89C
5. Install *approximately 0.12 miles* of 7#7 ALWD static wire between the proposed backbone structures and the proposed static poles in a loop

3. New Substation/Switchyard Facilities

PJM Network Upgrade #n5810 - Build a three breaker AB2-160 115 kV switching station. The site is located along the ITO's 115kV Line #69 from Locks Substation to Clubhouse Substation (Normally open line switch near Fields Substation changes the line number to Line 148 between the line switch and Clubhouse). The switching station will be positioned in such a way that the new backbone will be between transmission structures 69/89 and 69/90, with about 30 FT offset from the transmission line. The cut lines will be attached to the new backbone and risers will be dropped from both sides of the backbone to the bus sections directly underneath the line. The lines will consume two of the three positions in the ring bus. The third position will be for the 115 kV feed from the collector station for the solar farm. The work required is as follows:

Purchase and install substation material:

1. Approximately 285' X 260' site preparation and grading as required for installation of the switching station (by the IC);
2. Approximately 1050 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. Full substation ground grid as per engineering standards:
4. One (1) 115 kV, Heavy Duty Steel Backbone (by Transmission);
5. Two (2) shield wire poles and two span of shield wires (by Transmission);
6. Three (3) 115 kV, 3000A, 40 kA SF6 Circuit Breakers;
7. Six (6) 115 kV, 2000A, 3-phase Center Break Gang Operated Switches;
8. Nine (9) 90 kV MO, 74 kV MCOV Station Class Arresters;
9. Six (6) 115 kV CCVTs, Relay Accuracy;
10. Two (2), 115 kV, 2000 Amps Wave Traps and Line Tuners;
11. One (1) 24' X 40' Control Enclosure;
12. One (1) 125 VDC, 200 Ah Station Battery and 50 Amp Charger (size to be verified);
13. Approximately 240 FT of Cable Trough, with a 20 FT road crossing section;
14. Four (4) 100 KVA Power Potential Transformers for station service;
15. Two (2) 115 kV, 2000A, 2-phase Center Break Gang Operated Switches;
16. Oil Containment system for the 115 kV PVTs.;
17. High Voltage Protection Cabinet;
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 and grounding materials.

Purchase and install relay material:

1. Three (3), 1510 – 28" Dual SEL-351-7 Transmission Breaker w/ Reclosing Panel;

2. Three (3), 4510 - SEL-2411 Breaker Annunciator;
3. One (1), 1320 – 28" Dual SEL-421-5 DCB Line Panel;
4. One (1), 1809 – 28" Dual SEL-311L Line Diff. w/ Reclosing Panel;
5. Two (2), 4506 – 3 Phase CCVT Potential M.U. Box;
6. One (1), 1603 – 28" SEL-451 Islanding Control Scheme Panel;
7. Two (2), 4000 – Station Service Potential M.U. 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 Three Phase Throwover Switch;
11. Two (2), 4016 – 600 A Disconnect Switch Fused @ 500A;
12. One (1), 4153 – Wall Mount Station Battery Monitor;
13. One (1), 5612 - SEL-3530 Data Concentrator 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 M.U. Box;
18. One (1), 5202 – 26" APP 601 Digital Fault Recorder;
19. One (1), 5603 – Station Network Panel 1;
20. One (1), 5603 – Station Network Panel 2;
21. One (1), 4523 – Security Camera Interface Box;
22. One (1), 5616 – Station Security Panel;
23. One (1), High Voltage Protection (HVP) Box (Provided by IT);
24. One (1), Telephone Interface Box.

4. Upgrades to Substation / Switchyard Facilities

PJM Network Upgrade #n5811 - Remote protection and communication work. ITO protection requirements to reliably interconnect the proposed generating facility with the transmission system determined that work is required at Clubhouse, Locks, Reams DP and Sapony 115kV substations. These costs include the following:

Clubhouse 115 kV Substation

Project Summary
Drawing work, relay resets, and field support necessary for the Line 148 protection at Clubhouse Substation to work with the new AB2-160 Generator Interconnect Substation. This work is required to allow the generator to stay online when the Normally Open Line Switch 69Y148 is closed. Also, install islanding and breaker failure Transfer Trip scheme. The estimated cost of this scope $77,160.

Purchase and install material:
1. One (1), 1604-24" Transmission Transfer Trip Panel;
2. One (1), CS-51C Breaker Failure Transfer Trip Set

Locks 115 kV Substation

Project Summary

Drawing work, relay resets, and field support necessary to change the Line 69 destination from Clubhouse Substation to the new AB2-160 Generator Interconnect Substation. Install Line 69 Islanding & Breaker Failure Transfer Trip schemes to work with the new AB2160 Substation. The estimated cost of this scope $89,831.

Purchase and install relay material:
1. One (1), 1604 – 24" Islanding Transfer Trip Panel
2. One (1), CS-51C Breaker Failure Transfer Trip Set

Reams DP 115 kV Substation

Project Summary

Drawing work, relay resets, and field support necessary to change the Line 69 destination from Clubhouse Substation to the new AB2-160 Generator Interconnect Substation.

Sapony 115 kV Substation

Project Summary

Drawing work, relay resets, and field support necessary to change the Line 69 destination from Locks Substation to the new AB2160 Generator Interconnect Substation.

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
Clubhouse	$32,213	$32,804	$7,096	$5,047	$77,160
Locks	$40,599	$34,929	$8,843	$5,459	$89,830
Reams DP	$6,064	$0	$1,551	$0	$7,615
Sapony	$6,523	$0	$1,626	$0	$8,198
Total Remote Relay Upgrades	$85,448	$67,733	$19,116	$10,506	$182,803

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 Sections 24.1 and 24.2.

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 publically 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

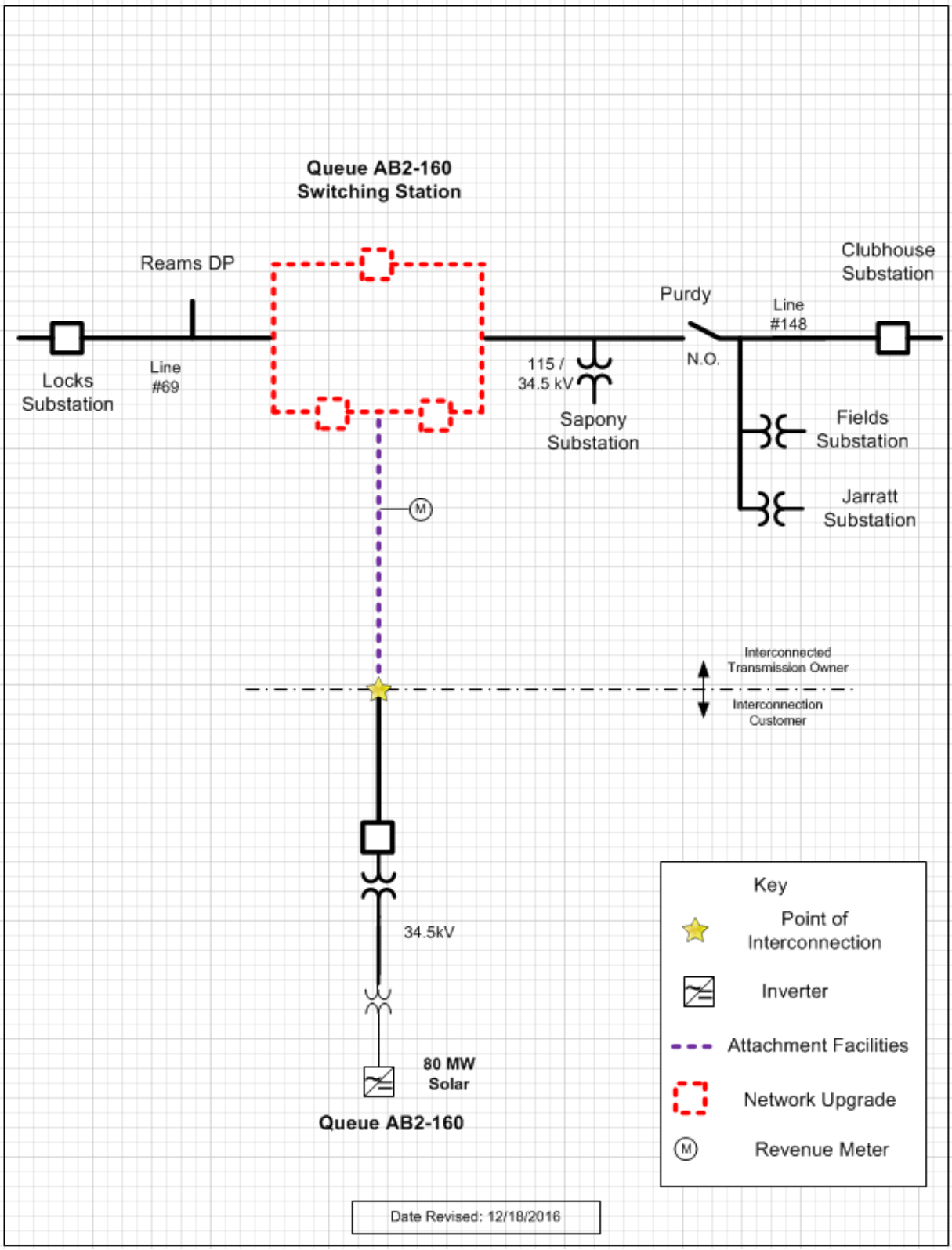
The IC would be responsible for the following expectations in the area of Environmental, Real Estate and Permitting:

- 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.

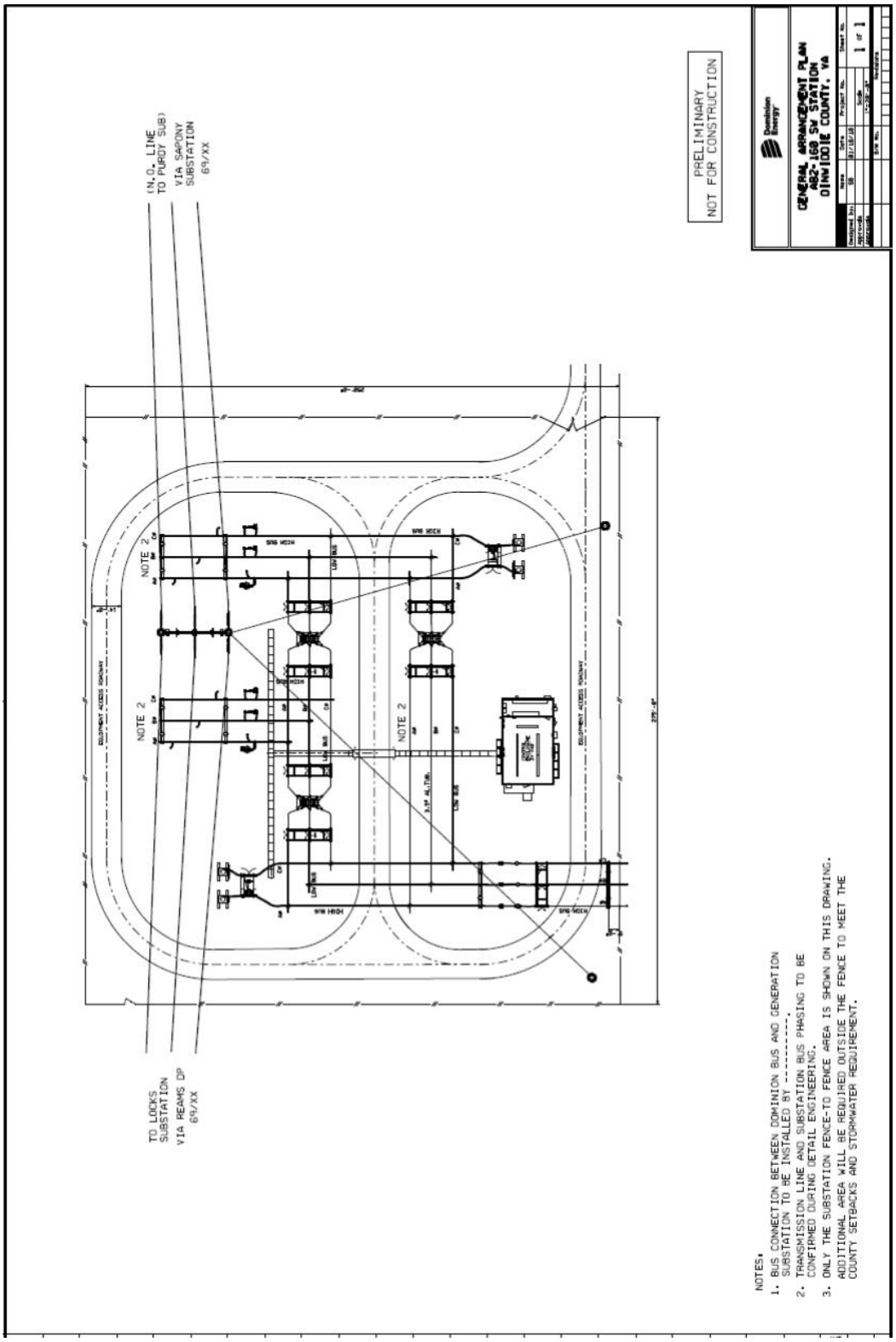
ITO Real Estate Needs:

- The substation layout is complete and ITO requires a 260'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 September 2020.
    - The size of the station assumes ITO will not need a separate storm water management system for the substation. If the county rules differently then 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.
Site Plan



Attachment 3.
Site Plan