# *Generation Interconnection*
# *Facility Study Report*

## *For*

## *PJM Generation Interconnection Request*
## *Queue Position AB1-173 / AB1-173A*

## *Brink – Trego 115kV*
## *27 MW Capacity / 39.6 MW Energy*

**Revised April / 2018**

# 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 Meherrin Solar LLC, (Interconnection Customer (IC)) and PJM Interconnection, LLC (Transmission Provider (TP)). IC has proposed a solar generating facility located at 1119 Pine Logging Rd, Skippers, VA (Greensville County). The installed facilities will have a total capability of 39.6 MW with 27 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is May 15, 2020. **This study does not imply an ITO commitment to this in-service date.**

## Point of Interconnection

AB1-173 / AB1-173A will interconnect with the ITO transmission system via a new single breaker tap switching station that connects on the Brink - Trego 115kV line.

## Cost Summary

The AB1-173 / AB1-173A project will be responsible for the following costs:

| Description | Total Cost |
|---|---|
| Attachment Facilities | $3,514,981 |
| Direct Connection Network Upgrades | $0 |
| Non Direct Connection Network Upgrades | $1,358,175 |
| Allocation for New System Upgrades | $0 |
| Contribution for Previously Identified Upgrades | $0 |
| **Total Costs** | **$4,873,156** |

# A. Transmission Owner Facilities Study Summary

## 1. Description of Project

Queue AB1-173 is a request to interconnect 39.6 MW (Capacity 27 MW) of energy from a new solar facility to be located near Emporia VA in Greensville County. The proposed facility will interconnect with ITO's existing Brink - Trego 115 kV Tap Line off of the Carolina-Clubhouse 115 kV Line via a new Meherrin Substation with one new 115 kV breaker. The requested in-service date is May 15, 2020. Attachment Facility and Direct Connection Network upgrade construction is estimated to be 7 - 12 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 on November 15, 2019
- Turn over flat, graded site with one inch of gravel to ITO for new Meherrin switching station on February 1, 2020
- Permits – state level Permit By Rule and county level Final Site Plan approval complete by September 1, 2019
- Substantial site work completed August 15, 2020
- Delivery of major electrical equipment October 15, 2020
- Back Feed Power target November 15, 2020
- Commercial Operation target December 31,2020

## 4. Scope of Customer's Work

IC will build a solar generating facility in Greensville County, Virginia. The generating facility (Meherrin Solar) will be comprised of solar arrays. AB1-173 and AB1-173A consists of a total number of 12 Power Electronics HEC-US-FS3000CU 3.33MW solar inverters and 12 three MVA 34.5 kV delta / 690 V wye generator step up transformers. AB1-173 and AB1-173A will be connected to the POI via a 115 kV wye / 34.5kV wye grounded main collector transformer. AB1-173 and AB1-173A connect at a tap of the Brink – Trego 115 kV line at the new Meherrin 115kV substation.

## 5. Description of Facilities Included in the Facilities Study

The ITO will connect the proposed generator lead via Attachment Facilities to a new Meherrin 115kV switching station adjacent to the 115kV transmission right of way on a property provided by the IC. The ITO work scope involves the construction of a new 115 kV substation with one 115 kV breaker and associated equipment and the required 115 kV transmission line modifications. The solar generating facility will be located near Emporia Virginia, in Greensville County. The position of the substation will be adjacent to the right of way of the 115 kV transmission Line # 130, between structure 130/344 and 130/345 near Brink DP. All substation permitting, site preparation and grading activity will be performed by IC. An Anti-islanding Transfer Trip schemes will require upgrades at Carolina, Clubhouse and Emporia Substations.

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

| Work Description | Direct | | Indirect | | Total Cost |
|---|---|---|---|---|---|
| | Labor | Material | Labor | Material | |
| | | | | | |
| Meherrin substation | $1,008,499 | $1,299,451 | $181,910 | $123,302 | $2,613,162 |
| Transmission | $485,042 | $272,973 | $95,212 | $48,592 | $901,819 |
| **Total Attachment Facilities Cost** | $1,493,541 | $1,572,424 | $277,122 | $171,894 | $3,514,981 |
| | | | | | |
| Line #130 Transmission work (n5257) | $573,214 | $415,831 | $93,304 | $63,514 | $1,145,863 |
| Remote relay (n5475) | $90,098 | $87,986 | $20,971 | $13,257 | $212,312 |
| | | | | | |
| **Total Network Upgrades** | $663,312 | $503,817 | $114,275 | $76,771 | $1,358,175 |
| **Total Project Costs** | $2,156,853 | $2,076,241 | $391,397 | $248,665 | $4,873,156 |

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

Facilities are estimated to take 11 - 18 months to construct and this is based on the ability to obtain outages to construct and test the proposed facilities.

Proposed Schedule

- Engineering 4 - 6 months
- Construction 7 - 12 months

Engineering and construction timelines are based on the IC providing a graded and permitted site to the ITO at the time of executing ICSA. The estimated time to construct and build the proposed facilities is based on typical permitting timelines actual permitting requirements required by local zoning conditions may impact this schedule.

# B. Transmission Owner Facilities Study Results

## 1. Attachment Facilities

### Meherrin 115kV Substation

The Attachment Facilities include that portion of the interconnecting switching station which is associated solely with the single feed to the generating facilities. The equipment associated with the Attachment Facilities includes the following:

Substation Purchase and install:

1. Approximately 125’ X 130’ site preparation and grading as required for installation of the switching station (by IC) not including any added land as required for storm water management, etc
2. Approximately 510 linear FT of 5/8” Chain Link, 12 FT tall, perimeter fence around the station along with the security cameras and integrators (Design 4 Standard).
3. Full substation ground grid as per engineering standards
4. One (1), 115 kV Light Duty, Single Circuit Backbones (included in Transmission Line upgrade)
5. One (1) shield wire pole and one span of shield wires (included in Transmission Line upgrade)
6. One (1), 115kV, 3000A, 40 kA, SF6 Circuit Breaker
7. Three (3), 115kV, 2000A Center Break Switches
8. One (1), 115kV, CCVT, relay accuracy
9. One (1), 1600A, Vertically Mounted, Wave Traps along with one (1) Line Tuner
10. Six (6), 90kV MO, 74kV MCOV Station Class Arresters
11. One (1), 115kV, 100 KVA Power PT's for Station Service
12. One (1), 24' x 30' Control Enclosure (w/ provisions for secondary Station Service generator connection)
13. One (1), 135VDC, 300Ah Batteries and 50A Charger
14. Three (3), 115kV, Metering Accuracy CCVT’s
15. Three (3), 115kV, Metering Accuracy CT’s
16. Oil Containment system for the 115kV PVT.
17. High Voltage Protection Cabinet
18. Cable Trough, concrete w/cover, 2’ 6’’ wide, approximately 20 FT, with a 40 FT road crossing section.
19. Steel structures as required including switch stands, bus supports, station service transformers, CCVT and wave trap supports
20. Foundations as required including control house, equipment and bus support stands
21. Conductors, connectors, conduits, control cables and grounding materials

Substation Purchase and install relay material:

1. One (1), 1510 – 28” Dual SEL-351-7 Transmission Breaker w/ Reclosing Panel
2. One (1), 4510 - SEL-2411 Breaker Annunciator
3. One (1), 4000 – Station Service Potential M.U. Box
4. One (1), 4007 – 225A Outdoor Transmission Yard AC NQOD
5. One (1), 4019 – 225A Three Phase Throwover Switch
6. Three (3), 200A Disconnect Switch

7. One (1), 4153 – Wall Mount Station Battery Monitor
8. One (1), 5613 – Annunciator / RTU / Communications Panel
9. One (1), 5610 – Wall Mounted Fiber Optic Management Housing
10. One (1), 4526_A – Circuit Breaker Fiber Optic M.U. Box
11. One (1), 5603 – Station Network Panel
12. One (1), 5616 – Station Security Panel
13. One (1), Telephone Interface Box
14. One (1), 1109 – 28" Dual SEL-587Z Transmission Bus Panel
15. One (1), 1421 – Generation/NUG/PJM/IPP Metering Panel
16. One (1), 4524 – Revenue Metering C.T. M.U. Box
17. One (1), 4531 – Generator Interconnect CCVT Potential M.U. Box
18. One (1), 1611 – 28" SEL-451 PMU Panel w/SEL 735/735
19. Two (2), 4541 - Control Cable M.U. Box
20. One (1), 1604 – 28" Transmission Transfer Trip Panel
21. One (1), 1605 – 28" Carrier Blocking & Transfer Trip Panel
22. One (1), 4507 - Single Phase CCVT Potential M.U. Box
23. One (1), 1603 – 28" SEL-451 Islanding Control Scheme Panel

**Attachment Transmission Facilities Include:**

1. One (1) 115kV 3-pole DOM-Type guyed double dead ended structure.
2. One (1) 115kV 3-pole DOM-Type dead end terminal structure.
3. Two (2) DOM-Type dead end Static Poles.
4. One (1) 115kV Engineered Backbone structure to be located inside proposed Meherrin
1. Substation.
5. One (1) Standard Steel Static Pole inside proposed Meherrin Substation.
6. Three (3) self supporting switch structures, switches and risers.
7. Three (3) Single Phase Floating Dead End assemblies
8. Install *approximately 0.3 miles* of 2-3#6 ALW.
9. Install *approximately 0.3 miles* of 3-Phased 1-636 ACSR (24/7) conductor.
10. Install one (1) sets of 3-phase risers to connect main line to tap line
11. One (1) DOM-Type Wave Trap Structure outside of Brink Substation
12. One (1) DOM-Type Wave Trap Structure outside of Trego Substation (wavetrap to be relocated from structure at the beginning of this Tap line to the new structure outside of Trego Substation).

## 2. Transmission Line – Upgrades

Complete the following activities for PJM Network Upgrade n5257, which consists of adding three transmission line structures, two line switches and a wave trap on the Trego – Brink 115kV line:

**Transmission Line # 130 Upgrade**

The following estimate is for the construction of a new tap line and substation connection on Trego – Brink 115kV line # 130 between structures 130/344 and 130/345 near Brink DP substation. The line connection will require the following installations:

1. Install (1) Single pole DOM-Type Temporary Suspension Structures
2. Install (1) 3-Pole DOM-Type Temporary Terminal Structures

3. Install (1) Single Pole DOM-Type Temporary DDE Structures
4. Install (1) 3-Pole DOM-Type Temporary DDE Structures
5. Install *approximately 0*.16 Miles of 3-phase 7#7 AWLD Temporary conductor
6. Install *approximately 0*.16 Miles of 1-3#6 ALWD Temporary Static
7. Install (1) Set of 3-phase 115KV Temporary in-line disconnected switches, in first span of tap and
1. first span after Trego
8. Install (2) Sets of 3-phase 7#7 ALWD Temporary Risers to tie main line conductor to temporary line
2. conductor.
9. Install (1) Set of underground temporary cables at Brink DP.
10. Remove all temporary line facilities post permanent line construction.
11. Three (3) self supporting switch structures, switches and risers.
12. Three (3) Single Phase Floating Dead End assemblies
13. Replace Structure 130/343
    a. Replace 75B with 80B to provide clearance to Open Switch position (per Drawing 11.830)
    b. Offset from permanent line alignment minimum of 3 feet for Swing violation due to H-frame installation at 130/344
14. Replace Structure 130/345
    a. Replace 60A H-frame DDE Anchor Structure with 80B H-frame DDE Anchor Structure to provide clearance to Open Switch position & increased line angle
    b. Offset from permanent line alignment of ~7.0 feet for FRAWG clearances to Edge of ROW (note this does not address FRAWG clearances in the span going into the station)
15. Replace Structure 130/344
    a. Replace 75A Single pole Davit Arm SUS Structure with 80A H-frame DDE Anchor Structure
    b. Increase line tensions in new ruling span (342-344) to 6500# NESC HVY to provide clearance to Open Switch position
    c. Offset from permanent line alignment of ~7.5 feet for FRAWG clearances to Edge of ROW

ESTIMATE ASSUMPTIONS:

1. The final location and layout of Meherrin Substation was not confirmed at the time of this estimate; final foundation and structure costs and locations may vary from the estimate as a result.
2. The preferred ITO ROW width for this project is 100’.

## 3. New Substation/Switchyard Facilities

See Attachment Facility scope.

## 4. Upgrades to Substation / Switchyard Facilities

**PJM Network Upgrade #n5475 - 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 Carolina, Clubhouse, and Emporia 115kV substations. These costs include the following:

**Carolina 115 kV Substation**

Project Summary
Installation of CT-51C and CS-51C Transfer Trip sets to Line 130 at Carolina Substation.

Purchase and install:

1. Install any foundations, grounding, steel pipe stands, conductor and connectors

Purchase and install relay material:

1. One (1), 1604 – 24" Transmission Transfer Trip and Islanding Panel

**Clubhouse 115 kV Substation**

Project Summary
Installation of a CT-51C and CS-51C Transfer Trip Set on Line 130 at Clubhouse Substation.

Purchase and install:

1. Install any foundations, grounding, steel pipe stands, conductor and connectors

Purchase and install relay material:

1. One (1), 1604 – 24" Transmission Transfer Trip and Islanding Panel

**Emporia 115 kV Substation**

Project Summary
Installation of a Transfer Trip Receive panel on Line 130 at Emporia Substation.

Purchase and install:

1. Install any foundations, grounding, steel pipe stands, conductor and connectors

Purchase and install relay material:

1. One (1), 1604 – 24" Transfer Trip Receive Panel

| Work Description | Direct | | Indirect | | Total Cost |
|---|---|---|---|---|---|
| | Labor | Material | Labor | Material | |
| Carolina | $30,338 | $30,607 | $7,088 | $4,564 | $72,597 |
| Clubhouse | $30,338 | $30,128 | $7,088 | $4,564 | $72,118 |
| Emporia | $29,422 | $27,251 | $6,795 | $4,129 | $67,597 |
| **Total Remote Relay Upgrades** | $90,098 | $87,986 | $20,971 | $13,257 | $212,312 |

## 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.

**Meteorological Data Reporting Requirement**

The solar generation facility shall provide the Transmission Provider with site-specific meteorological data including:

- Temperature (degrees Fahrenheit)
- Atmospheric pressure (hectopascals)
- Irradiance
- Forced outage data

**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

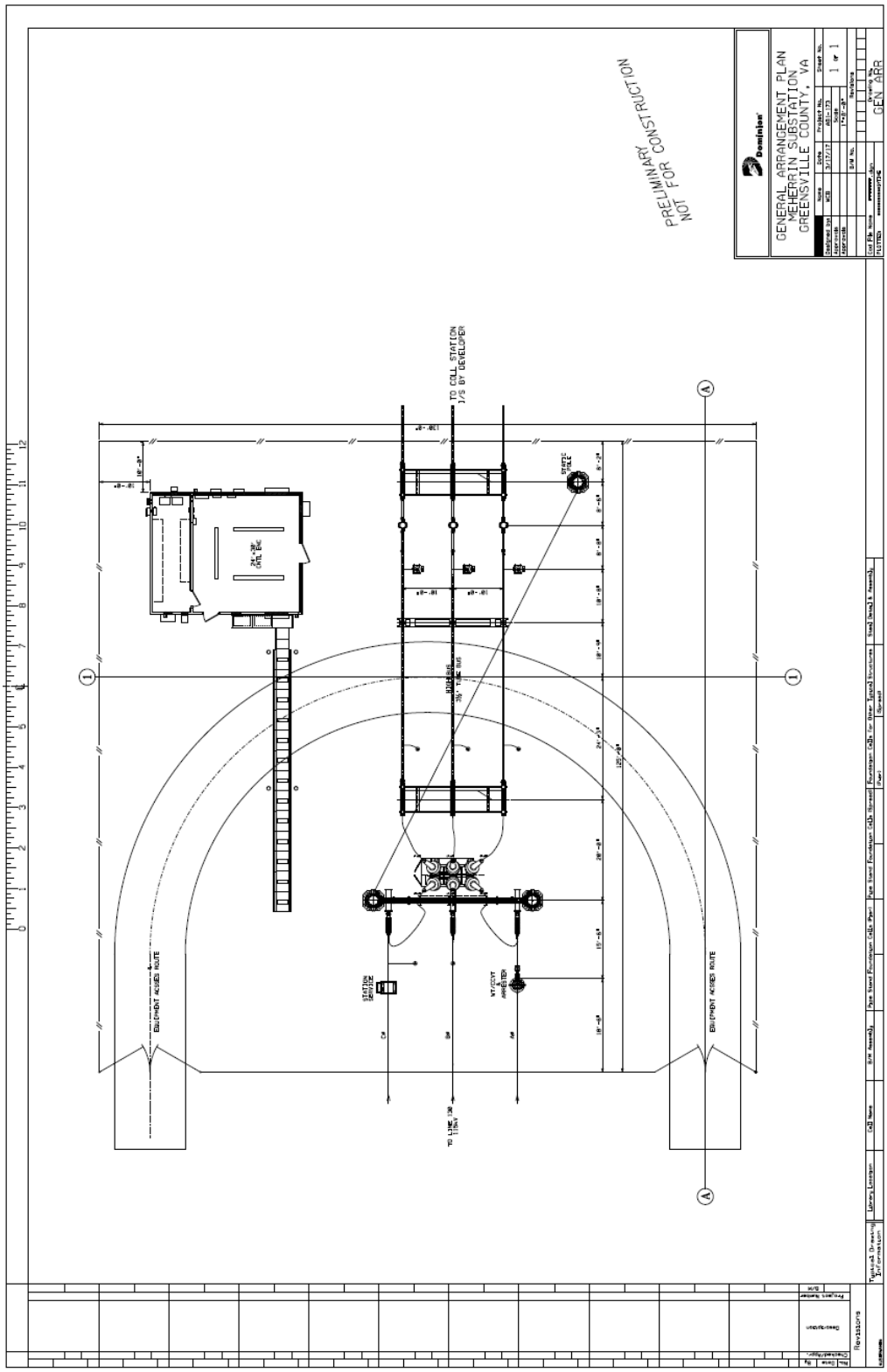
The IC would be responsible for the following expectations in the area of Environmental, Real Estate and Permitting:

- Suitable Access Road from Substation to a North Carolina 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.

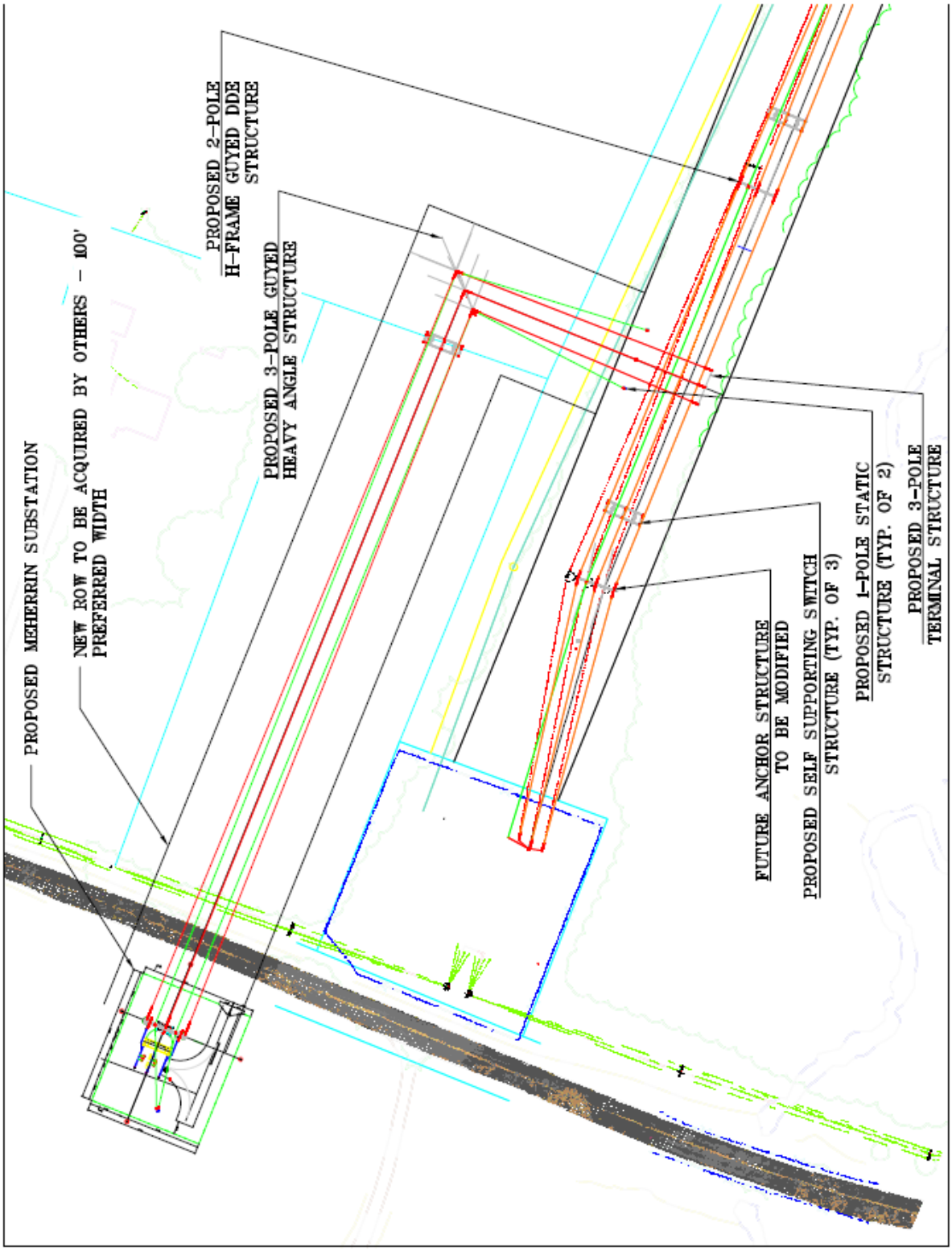
ITO Real Estate Needs:

- The preferred ITO ROW width for this project is 100’
- The substation layout is complete and ITO requires a 125’x 130’ 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 May 2019.
    - 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.*
## *Site Plan*



## *Attachment 2.*
### *Transmission Plan*



## *Attachment 3.*
### *Single Line*