# *Generation Interconnection*
# *Facility Study Report*

# *For*

# *PJM Generation Interconnection Request*
# *Queue Position AB2-158*

# *Louisa - South Anna 230kV*
# *61 MW Capacity / 88.2 MW Energy*

**July 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 Belcher Solar, LLC, (Interconnection Customer (IC)) and PJM Interconnection, LLC (Transmission Provider (TP)). The Interconnected Transmission Owner (ITO) is Virginia Electric and Power Company. IC has proposed a solar generating facility located in Louisa, VA (Louisa County). The installed facilities will have a total capability of 88.2 MW with 61 MW of this output being recognized by PJM as Capacity. The proposed in-service at stated in the AB2-158 Attachment N is 10/1/2018. However, the IC provided a revised in-service date of 10/01/2020. **This study does not imply an ITO commitment to this in-service date.**

## Point of Interconnection

AB2-158 will interconnect with the ITO transmission system via a three breaker ring bus tapping the Louisa – South Anna 230kV line, #255.

## Cost Summary

The AB2-158 project will be responsible for the following costs:

| Description | Total Cost |
|---|---|
| Attachment Facilities | $ 616,159 |
| Direct Connection Network Upgrades | $13,081,424 |
| Non Direct Connection Network Upgrades | $ 2,181,036 |
| Allocation for New System Upgrades | $ 0 |
| Contribution for Previously Identified Upgrades | $ 0 |
| **Total Costs** | **$15,878,619** |

# A. Transmission Owner Facilities Study Summary

## 1. Description of Project

Queue AB2-158 is a request to interconnect 88.2 MW (Capacity 61 MW) of energy from a new solar facility to be located near Louisa, VA in Louisa County. The proposed facility will interconnect with ITO's existing Louisa – South Anna 230 kV line via a new three breaker ring bus tapping the line.

## 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 – July 15, 2019
- Permits – state level Permit By Rule and County level Final Site Plan approval complete by November 15, 2019
- Substantial site work completed by March 31, 2020
- Delivery of major electrical equipment by April 30, 2020
- Back Feed Power target June 30, 2020
- Commercial Operation target October 1, 2020

## 4. Scope of Customer's Work

IC will build a solar generating facility in Louisa County, Virginia. The generating facility (Belcher Solar) will be comprised of solar arrays. AB2-158 facility consists of:

- 35 x 2.7MVA TMEIC PVH-L2700GR inverters
- 35 x 34.5/0.6 kV 2.7 MVA generator step up transformers
- 1 x 230/34.5 kV collector step up transformer

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

The work scope to be performed by the ITO includes:

- Installation of attachment facilities including metering and associated protection equipment at the AB2-158 Switching Station.
- Construction of a three breaker ring bus tapping the existing line #255 from South Anna Pumping Station – North Anna Substation
- Relay modification work at South Anna Pumping Substation
- Relay modification work at the Louisa Pumping Substation
- Relay modification work at the North Anna Substation
- Modification of the existing Louisa – South Anna line #255 to accommodate the proposed AB2-158 interconnection switching station.

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

| Upgrade Type | Work Description | Direct Labor | Direct Material | Indirect Labor | Indirect Material | Total |
|---|---|---|---|---|---|---|
| Attachment Facilities | Desper Substation | $294,910 | $242,334 | $52,752 | $26,163 | $616,159 |
| Direct Connection | Desper Substation | $6,589,556 | $5,032,967 | $1,080,918 | $377,983 | $13,081,424 |
| Non-Direct | South Anna Substation Upgrades | $22,256 | $0 | $5,481 | $0 | $27,737 |
| Non-Direct | North Anna Substation Upgrades | $22,256 | $0 | $5,481 | $0 | $27,737 |
| Non-Direct | Louisa Pumping Station Upgrades | $20,758 | $0 | $4,972 | $0 | $25,730 |
| Non-Direct | Transmission Line Estimate | $709,707 | $1,109,044 | $142,944 | $138,137 | $2,099,832 |
| **Grand Total** | | **$7,659,443** | **$6,384,345** | **$1,292,548** | **$542,283** | **$15,878,619** |

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

The AB2-158 facilities are estimated to take 12 - 14 months to construct and this is based on the ability to obtain transmission permitting, time of year restrictions for work, outages to construct and test the proposed facilities.

Proposed Schedule:

- Detailed design: 8 – 12 months
- Engineering 8 – 14 months
- Construction 12 – 14 months

# B. Transmission Owner Facilities Study Results

## 1. Attachment Facilities ($616,159)

The ITO will install a disconnect switch, metering and associated protection equipment at the AB2-158 Switching Station "Desper substation". The ITO scope of work includes the following:

Purchase and install substation material

1. One (1), 230kV, 3000A Center Break Switch
2. Three (3), 230kV, Metering Accuracy CCVT's
3. Three (3), 230kV, 1000:5 Metering Accuracy CT's
4. Tubular bus as required
5. Steel Structures as required
6. Conductor, connectors, conduit, control cable, foundations and grounding material

Purchase and install relay material:

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), 1421 – Generation/NUG/PJM/IPP 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" Dual SEL-487E/735 PMU & PQ Monitoring Panel

7. One (1), Customer Interface Box

## 2. Transmission Line – Upgrades ($2,099,832)

(PJM Network Upgrade Number, n5410)

The following estimate is for the construction of a new substation connection on Transmission Line 255 between North Anna Substation and South Anna Substation. The transmission line estimate includes cost for the following:

**REMOVAL:**

1. Remove one (1) single circuit wood h-frame type suspension structure 255/159.
2. Remove *approximately* 1.2 miles of 3#6 ALW shield wire.

**INSTALLATION:**

1. One (1) 230kV SC Heavy Duty Steel double dead ended backbone structure with foundations.
2. Two (2) Steel Static Poles with foundation.
3. Modify (1) existing static structure 255/152C for new fiber optic splices point.
4. Modify (1) existing H-frame Suspension structures 255/163 for new fiber optic splice point.
5. Modify (7) existing H-frame suspension structures to accommodate proposed OPGW.
6. Modify (2) existing 3-pole dead end structures to accommodate proposed OPGW, modifications included in this estimate are for the installation of dead end shield wire assemblies, replacement and relocation of existing guys, and the replacement of one (outside) pole per structure due to the increased vertical loads produced by the guy relocations .
7. Cut and transfer existing shield wire to modified structure 255/163, plum static insulator on adjacent structure.
8. Install *approximately 1.2 miles* of 1- non-standard fiber optic static wire from proposed splice point structure 255/152C to the proposed Backbone in Desper Substation, then from Desper Substation to proposed splice point structure 255/163.
9. Install *two spans* of 1-7#7 ALW Shield wire from proposed backbone to proposed shield wire structures in Desper Substation.
10. Transfer *two spans* of existing fiber optic shield wire and (2) spans of 2-477 ACSR conductor to proposed Backbone in Desper Substation.
11. Install new underground conduit from Structure existing Distribution pole HH26 to modified structure 255/152C.
12. Renumber approximately 162 structures with new line number 2XXX between Desper Substation and North Anna Substation.

**ESTIMATE ASSUMPTIONS:**

- The final location and grading of Desper Substation was not finalized at the time of this estimate; the proposed elevation to validate security fence clearance was averaged across the substation and assumed to be at elevation 441, this provide roughly 25’ of clearance

between MOT and a 15' security fence. Final foundation and structure costs and locations may vary from the estimate as a result.

- Estimate assumes that dead-end criteria on structure 163 can be dismissed as this is a modification to an existing structure which was not originally designed and constructed for this load case.
- LD1 poles were used for the structure models. These models were expected to have less capacity than the current ITO standard pole. After careful review of the loads with the assumption of the LD1 poles, it was recommended that one pole from each 3-pole structure be replaced. Verification of the pole birthmark to determine actual type whether LD1 or DOM, of the poles is recommended prior to project execution.
- There are time limitations to the outage for the existing FOSW replacement. This will limit the outage window required for replacement and connection into Desper Substation.
- The new Fiber must be 16 LEAF and 32 single mode, to match properties of the existing DNO-1298 being replaced. Proposed designs shall be approved by the tele communications department prior to final order.
- Fiber sequence assumes underground rights exist or can be obtained at structure 152C to complete the scope as it is estimated.
- Fiber cut over sequence recommended for this project by the telecommunications team included:
    - A. Terminating all fibers in Desper Substation Control Enclosure
    - B. Completing both OPGW to underground splices at Desper Substation backbone structure.
    - C. Make all necessary fiber patches at Desper Substation.
        - i. Rework splice at structure 163.
        - ii. Remove ADSS fiber from 152D splice enclosure and reroute to new splice on 152C or cut existing ADSS from existing 152C splice enclosure, remove existing ADSS dead end from Distribution pole previously installed to 152.
        - iii. Splice ADSS to the new OPGW to Desper Structure 152C

## 3. New Substation/Switchyard Facilities ($13,081,424):

(PJM Network Upgrade Number, n5409)

The ITO will construct a new 230kV three breaker ring bus switching station (Desper Substation) to support the AB2-158 project.

The AB2-158 site is located along ITO's existing 230kV Line #255 from South Anna NUG Substation to North Anna Substation. The cut line will consume two of the positions in the ring bus. The third position will be for the 230kV feed from AB2-158 Collector Station for the new 88.2MW Solar Farm.

The AB2-158 Interconnection Switching Station (Desper Substation) will share a common foot print and fence line with AB2-158 generator collector station. The demarcation point between the two stations will be the 230kV Breaker disconnect switch 4-hole pad in AB2-158 generator collector Station by the common fence.

The ITO will construct its bus to the demarcation point. The grounding systems for each station will be tied together. Due to the connection along the ITO's designated Black Start Path on Line 255, the ITO Transmission Operations division has stated that this proposed substation will require a Design Level 2, 15'-0" Security Fence. This will consist of two main components - physical security perimeter fence and the required security integrators.

One (1) 14' x 25' security control enclosure will be installed which includes AC Panels, Security, and Communication Panels.

Purchase and install substation material

1. Three (3), 230kV, 3000A, 50 kA SF-6 Circuit Breakers (purchased by ITO)
2. Six (6), 230kV, 3000A Center Break Switches (purchased by ITO)
3. Two (2), 230kV, 3000A, 2-Pole Center Break Switches (for PVT's) (purchased by ITO)
4. Six (6), 230kV, CCVT's relay accuracy (purchased by ITO)
5. Two (2), 3000A, Vertically Mounted, 90-200Hz Wave Traps
6. Two (2), Line Tuners
7. Six (6), 180kV, 144kV MCOV Surge Arresters
8. Four (4) 230kV, 167KVA Power PT's for Station Service (purchased by ITO)
9. One (1), 24' x 40' Control Enclosure, prewired by Trachte (purchased by ITO)
10. One (1), 135VDC, 577 Ah Batteries with Charger (24'x40' Control Enclosure)
11. Oil Containment as required for 230kV PVT's.
12. One Thousand Seventy (1,070) Linear Feet of 15 FT Tall Security Fence
13. One Hundred (100) Linear Feet of 12' Tall Security Fence
14. Two (2) 15' Foot Tall Double Swing Gates, Guardian 7000, 20 Foot Wide
15. Four (4) Man Gate with Vestibule, Guardian 7000, 3'X7'
16. Eight (8) Super Posts, 20 Foot Tall
17. Dig in barrier footing between the perimeter fence foundations
18. One (1) 14' x 25' Security Control Enclosure, AC Panel, Security and Communications Panels
19. Two (2) Standby Generators, Two (2) 1000 Gallon Propane Tanks, One (1) Generator Monitor System
20. One (1) Auto Transfer Switch, Safety Switch, and AC Panels
21. One (1), 230kV Backbone (by TLE; 38'-0" Leg Spacing, No Switches necessary)
22. Two (2), Static Pole (by TLE)
23. Cable Trough as required
24. Tubular bus as required
25. Ground Grid as required
26. Steel Structures as required
27. Install two (2) sets of 3-phase connections for connection of Risers to substation tubular bus
28. Conductor, connectors, conduit, control cable, foundations and grounding material

Purchase and Install Security Integration Material at Desper Substation:

1. Access control at the gates (Card In & Out readers at the gates, security kiosk stations)

2. Access control for the security equipment building and existing control enclosures (AMAG keycard access control equipment).
3. Video surveillance (Control & security building cameras, perimeter fence thermal assessment cameras, pedestrian gates breezeway cameras, perimeter fence LED lighting)
4. Perimeter fence detection system (Perimeter fence line cut/climb detection, Boomerang hardware for shot detection).
5. Video recording equipment (DVTEL NVR server, Intellishot relay Card, UPS)
6. Perimeter fence video analytics system (DVTEL encoders, Comnet transmitters/ receivers, FLIR thermal fixed cameras)
7. Propane integration.
8. PLC Systems (CPU, I/O modules, firewall hardware, power supply)
9. System health monitoring for AMAG access control system, DVTEL archiver and camera functionality, Boomerang sensors and PLC systems.
10. Eight (8) security junction boxes, eight (8) fiber-optic junction boxes, conduits, connectors and cabling.
11. Power pole cabinet & communication hardware.
12. Weather station system installation & configuration.

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. Two (2), 1320 – 28" Dual SEL-421-5 DCB Line Panel
4. Two (2), 4506 – 3 Phase CCVT Potential M.U. Box
5. One (1), 1603 – 28" SEL-451 Islanding Control Scheme Panel
6. Two (2), 4000 – Station Service Potential M.U. Box
7. Two (2), 4018 – 800A Station Service AC Distribution Panel
8. Two (2), 4007 – 225A Outdoor Transmission Yard AC NQOD
9. Two (2), 4019 – 225A Three Phase Throwover Switch
10. Two (2), 4016 – 800A 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 M.U. Box
17. One (1), 5202 – 26" APP 601 Digital Fault Recorder
18. One (1), 5603 – Station Network Panel
19. One (1), 4523 – Security Camera Interface Box
20. One (1), 5603 – Station Network Panel
21. One (1), 5611 – Transmission Fiber Patch Panel

## 4. Upgrades to Substation / Switchyard Facilities ($81,204)

(PJM Network Upgrade Number, n5623)

The ITO will install System Protection at the North Anna, South Anna, and Louisa Pumping Stations to accommodate the AB2-158 interconnection.

A. North Anna Substation Modification

Queue project AB2-158 ITO scope of work includes the drawing work, relay resets, Islanding and BF/Line Transfer Trip reconfiguration, and field support necessary to change the Line 255 number and destination from North Anna to the new Desper Substation. Line number TBD.

B. South Anna Substation Modifications

Queue project AB2-158 ITO scope of work includes the drawing work, relay resets, Islanding and BF/Line Transfer Trip reconfiguration, and field support necessary to change the Line 255 number & destination from South Anna to the new Desper Substation. Line number TBD.

C. Louisa Pumping Substation Modifications

Queue project AB2-158 ITO scope of work includes the drawing work, relay resets, and field support necessary to change the Line 255 number and destination from Louisa pumping Substation to the new Desper Substation. Line number TBD.

## 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 Virginia 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 195'x 340' piece of property (title in fee) to build the substation.
    - ITO requires ownership transfer of the substation site before they start construction. Target for the deed by September 1, 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.

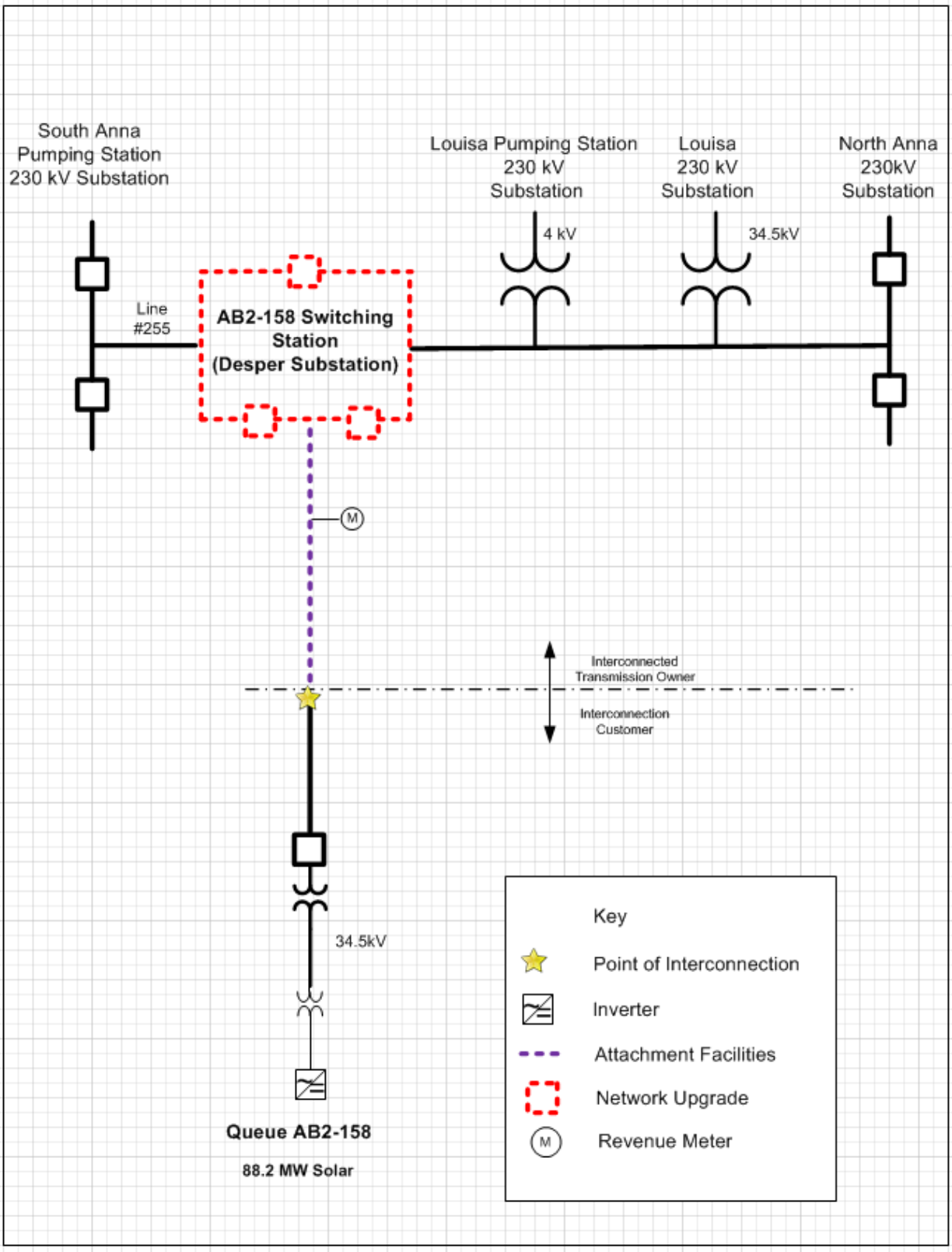
## 7. Information Required for Interconnection Service Agreement

| Upgrade | NUN | Estimated Cost |
|---|---|---|
| **Attachment Facilities** | | |
| • *Install disconnect switch, metering and associated protection equipment at the AB2-158 Switching Station (Desper Substation).* | Not applicable | $ 616,159 |
| **Direct Connection Facilities** | | |
| • *Construct a new 230kV 3 breaker ring bus interconnection switching station (Desper Substation) to support the AB2-158 project.* | N5409 | $ 13,081,424 |
| **Non-Direct Connection Facilities** | | |
| • *Install transmission structure in-line with transmission line to allow the proposed interconnection switching station to be interconnected with the transmission system* | N5410 | $2,099,832 |
| • *Install System Protection at the North Anna, South Anna, and Louisa Pumping Stations to accommodate the AB2-158 Interconnection.* | N5623 | $ 81,204 |
| **Total Attachment Facilities** | | $ 616,159 |
| **Total Direct Connection Facilities** | | $13,081,424 |

| Upgrade | NUN | Estimated Cost |
|---|---|---|
| Total Non-Direct Connection Facilities | | $ 2,181,036 |
| | | |
| Grand Total Estimated Costs | | $15,878,619 |

| Description | Estimated Costs |
|---|---|
| Direct Labor | $ 7,659,443 |
| Direct Material | $ 6,384,345 |
| Indirect Labor | $ 1,292,548 |
| Indirect Material | $ 542,283 |

## *Attachment 1.*
### *Single Line*



## *Attachment 2.*
## Site Plan