# *Generation Interconnection*
# *Facility Study Report*

# *For*

# *PJM Generation Interconnection Request*
# *Queue Position AD1-074/075/076*

# *Trowbridge 230 kV*
# *484.0 MW Energy / 320.7 MW Capacity*

**January 2023**

# 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 Macadamia Solar LLC, the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is Virginia Electric and Power Company (VEPCO).

## Point of Interconnection

AD1-074/075/076 will interconnect with the ITO transmission system via a direct connection into the Trowbridge 230 kV substation.

## Cost Summary

The AD1-074/075/076 project will be responsible for the following costs:

| Description | Total Cost |
|---|---|
| Attachment Facilities | $788,752 |
| Direct Connection Network Upgrades | $0 |
| Non Direct Connection Network Upgrades | $68,960,061 |
| Allocation for New System Upgrades | $0 |
| Contribution for Previously Identified Upgrades | $0 |
| **Total Costs** | **$69,748,813** |

# A. Transmission Owner Facilities Study Summary

## 1. Description of Project

Queue AD1-074/075/076 is a request to interconnect a 484 MW solar generating facility to be located in Washington County, North Carolina. AD1-074/075/076 will interconnect with the ITO transmission system via a direct connection into the Trowbridge 230kV substation. Attachment Facility and Network Upgrade construction is estimated to be 40-56 months.

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

None

## 3. Interconnection Customer's Milestone Schedule

- Plan to break ground December 31, 2026
- Permits – state level Permit By Rule and county level final site plan approval complete December 31, 2026
- Substantial site work completed September 30, 2027
- Delivery of major electrical equipment June 30, 2027
- Back Feed Power December 1, 2027
- Commercial Operation March 31, 2028

## 4. Scope of Customer's Work

AD1-074 consists of 141 x 2.167 MW SMA Sunny Central MVB 2500-US solar inverters, modelled as two lumped equivalents of 74 x 2.167 MW solar inverters and 67 x 2.167 MW solar inverters. Each solar inverter is connected to a 34.5/0.55 kV generator step up (GSU) transformers, each with a 2.5 MVA rating. Two collector systems will then connect each of the two sets of GSU transformers to an individual 230/34.5/13.8 kV station transformer with a rating of 162/216/270 MVA. A 7-mile generator tie line connects the two station transformers directly to the Trowbridge 230 kV substation.

AD1-075 consists of 36 x 2.119 MW SMA Sunny Central MVB 2500-US solar inverters. Each inverter is connected to a 34.5/0.55 kV GSU transformer, each with a 2.5 MVA rating. A collector system will then connect the GSU transformers to the same station transformer that the 74 x 2.167 MW solar inverters of queue project AD1-074 are connected to.

AD1-076 consists of 52 x 2.133 MW SMA Sunny Central MVB 2500-US solar inverters. Each inverter is connected to a 34.5/0.55 kV GSU transformer, each with a 2.5 MVA rating. A collector system will then connect the GSU transformers to the same station transformer that the 67 x 2.167 MW solar inverters of queue project AD1-074 is connected to.

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

AD1-074/075/076 provides for the initial construction of one new 230kV interconnect into Trowbridge Substation. The project will relocate and expand the existing 115 kV yard with 7 new 115 kV breakers and re-terminate 115 kV lines 1020, 25, 167, and 168. Three new 230 kV

breakers will be added in the 230 kV yard and a new 230 kV backbone installed to terminate the new interconnect as well as re-terminating 230 kV line no. 2126 to Mackey's substation. Transformers TX#1 and TX#2 will be relocated as well.

The single line is shown in Attachment 1. Site plan (Attachment 2) was developed by the ITO during PJM's generation queue process.

Additional network upgrades will be done on line 189 and line 2021 and at Shawboro substation will be replaced as a result of the project.

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

| Work Description | Direct | | Indirect | | Total Cost |
|---|---|---|---|---|---|
| | Labor | Material | Labor | Material | |
| | | | | | |
| Attachment Facilities | $412,610 | $217,083 | $127,951 | $31,108 | $788,752 |
| **Total Attachment Facilities Cost** | $412,610 | $217,083 | $127,951 | $31,108 | $788,752 |
| | | | | | |
| #n6287 - Expand Trowbridge Station | $10,469,170 | $6,462,844 | $3,316,857 | $882,384 | $21,131,255 |
| #n8190 – Route developer transmission line into Trowbridge substation | $1,833,794 | $901,641 | $260,843 | $171,486 | $3,167,764 |
| #N8113 - Partially rebuild Line 25 with 768.2 ACSS | $2,555,664 | $1,729,625 | $371,570 | $80,884 | $4,737,743 |
| Partial Line 218 Rebuild (N6144) | $20,824,697 | $14,695,563 | $3,218,761 | $1,184,278 | $39,923,299 |
| **Total Network Upgrades** | $35,683,325 | $23,789,673 | $7,168,031 | $2,319,032 | $68,960,061 |
| **Total Project Costs** | $36,095,935 | $24,006,756 | $7,295,982 | $2,350,140 | $69,748,813 |

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

Facilities are estimated to take 40-56 months from ISA execution and is based on the ability to obtain outages to construct and test the proposed facilities.

*Please note: Preliminary outage sequencing has identified several outages and complex construction phasing will be required to reconfigure the substation. It is unlikely these outages can occur concurrently, and the actual construction duration is dependent on outage availability.*

Attachment Facilities Proposed Schedule

- Detailed design: 6-12 months
- Permitting: 6-12 months (some overlap with design)
- Construction 30-34 months (network upgrades occurring consecutively rather than simultaneously due to expected outage constraints)

N6144 Upgrade Timeline 30–56 Months

- Detailed Design: 8-10 Months
- Real Estate/Permitting: 24-36 Months (some overlap with design)
- Construction: months 6 – 10 Months

N8113 Upgrade timeline 12-16 months

- Detailed design: 6-8 months
- Permitting: 8-12 months (some overlap with design)
- Construction: 4-6 months

ITO requires the site to be fully graded and permitted site so they can start construction by January 1, 2027.

# B. Transmission Owner Facilities Study Results

## 1. Attachment Facilities

The Attachment Facilities include the portion of the interconnecting switching station which is associated solely with the single feed to the generating facilities collector station. The equipment associated with the Attachment Facilities include the metering accuracy CCVT's, metering accuracy CT's, conductors and connectors.

Purchase and install substation material:

1. Three (3), 230kV, metering accuracy CCVT's,
2. Three (3), 230kV, 500:5 metering accuracy CT's
3. Three (3), 180kV, 144kV MCOV surge arresters
4. Conductor, connectors, conduits, control cables, foundations, steel structures and grounding material as per engineering standards

Purchase and install relay material:

1. One (1), 1340 – 28" dual SEL-411L CD/Fiber line panel
2. One (1), 1425 – 28" dual SEL-735 transmission and generator interconnect metering panel
3. One (1), 4524 – revenue metering CT make-up box
4. One (1), 4506 – CCVT potential make-up box
5. One (1), 1323 – 28" SEL-487E/735 PMU and PQ monitoring panel
6. Two (2), 4541 – control cable make-up box

7. Two (2), 4528A – generation fiber make-up box

## 2. Transmission Line – Upgrades

**PJM Network Upgrade #n8190 - Re-arrange lines 167, 168, and 2126 and reroute lines 25 and 1020 at Trowbridge substation and route developer transmission line into Trowbridge substation**

A new 230kV developer transmission line is to be routed into Trowbridge substation. To integrate the line into the sub, the site must be expanded to the north and reconfigured such that the 230kV lines enter on the south side and the 115kV lines enter on the north side. In general, the termination points for lines 167, 168 and 2126 are being shifted within the site while lines 25 and 1020 are being rerouted to the north side of the sub.

The project work summary is described below:

**EXISTING FACILITIES TO BE REMOVED:**

1. Remove (4) SC A-frame backbone structures as follows:
    a. Structures 25/189, 167/1A, 168/1A and 2126/483.
2. Remove (1) SC H-Frame backbone structure on foundations as follows:
    a. Structure 1020/1.
3. Remove (1) guyed static direct embed monopole structure as follows:
    a. Structure 168/1C.
4. Remove (2) static monopole structures on foundations as follows:
    a. Structures 167/1B and 168/1B.
    b. These structures were installed in 2019 per project 946082 and may be in adequate condition to be reused within the site.
5. Remove (1) weathering steel guyed double dead-end structure as follows:
    a. Structure 168/1.
6. Remove approximately 112 feet of 2-545.6 ACAR (15/7) conductor from existing structures 25/188 to 25/189.
7. Remove approximately 412 feet of 3#6 AW shield wire from existing structures 25/188 to 25/189 and 2126/483.
8. Remove approximately 150 feet of 7#7 AW shield wire from existing structures 167/1B and 168/1B.
9. Remove approximately 616 feet of 3#6 AW shield wire from existing static pole 168/1C to structures 167/1 and 168/1.
10. Remove approximately 217 feet of 1351.5 ACSR (45/7) conductor from existing structures 2126/483 to 2126/484.
    a. This includes the removal of (1) set of 3-phase risers tapping into the existing substation equipment.

**PERMANENT FACILITIES TO BE INSTALLED:**

1. Install (5) static monopole structures on foundations as follows:
    a. Structures 167/1B, 168/1B, 1020/2B, 2126/483A, and 2126/483B.
2. Install (3) 115kV H-Frame backbone structures on foundations as follows:

    a. a. Structures 167/1A, 168/1A and 25/189, 1020/1.
3. 3. Install (1) 230kV H-Frame backbone structure on foundations as follows:
    a. a. Structure 2126/484.
    b. This structure shall also be used as the line termination for the 230kV developer transmission line, referred to in the conceptual model as D-Tie.
4. Install (1) 230kV Monopole deadend structure with davit arms on a foundation as follows:
    a. a. Structure 2126/483.
    b. This structure would greatly benefit by being designed for full dead-end loading or differentially tensions to accommodate potential future line work.
5. Install (4) 115kV direct embed 3-pole guyed angle structures as follows.
    a. a. Structures 25/189A, 168/1, 1020/1A and 1020/2A.
6. Install (1) 115kV direct embed 3-pole riser structure as follows.
    a. Structure 25/188A.
7. Install (1) set of 768.2 ACSS (20/7) three phase risers connecting structure 25/188A to the existing 230kV line 25 span from structure 187 to 188.
8. Install approximately 314 feet of 768.2 ACSS (20/7) conductor from structure 25/188A to 25/189.
9. Install approximate 236 feet of 2-7#7 AW shield wire from new structures 25/189A to 25/189.
10. Transfer existing 2-545.6 ACAR (15/7) conductor from the existing 167/1A lattice A-Frame structure to the new 167/1A H-Frame backbone structure.
11. Transfer existing fiber wire from the existing 167/1B static pole to the new 167/1A H-Frame backbone structure.
    a. a. This includes the installation of a fiber splice point on structure 167/1A.
12. Install approximately 189 feet of 7#7 AW shield wire from new structure 167/1A to existing structure 167/1.
13. Transfer existing 2-545.6 ACAR (15/7) conductor from existing line 168 to new structure 168/1A and 168/1.
14. Transfer existing fiber wire from the existing line 168 to new structures 168/1A and 168/1.
    a. This includes the installation of a fiber splice point on structure 168/1A.
15. Transfer existing 3#6 AW shield wire from existing structure 168/1 to new structure 168/1.
16. Install approximately 235 feet of 7#7 AW shield wire between new structures 168/1A and 168/1.
17. Transfer existing 768.2 ACSS (20/7) conductor from existing structure 1020/1 to new structure 1020/2A.
18. Transfer existing 3#6 AW shield wire from existing structure 1020/1 to new structure 1020/2A.
19. Transfer existing fiber wire from existing structure 1020/1 to new structures 1020/2A and 1020/2B.
    a. This includes the installation of a fiber splice point on structure 1020/2B.
20. Install approximately 610 feet of 768.2 ACSS (20/7) conductor from new structures 1020/1 to 1020/2A.

21. Install approximately 329 feet of 2-7#7 AW shield wire from new structure 1020/1 to 1020/1A.
22. Transfer existing 1351.5 ACSR (45/7) conductor from existing lattice A-Frame structure 2126/483 to new monopole structure 2126/483.
23. Transfer existing 3#6 AW shield wire from existing lattice A-Frame structure 2126/483 to new monopole structure 2126/483.
24. Install approximately 240 feet of 2-636 ACSR conductor from new structures 2126/483 to 2126/484.
25. Install approximately 240 feet of 2-7#7 AW shield wire from new structure 2126/483 to 2126/484.
26. Install approximately 490 feet of 7#7 AW shield wire between the following structures:
    a. From structure 167/1B to 168/1B.
    b. From structure 2126/483A to 2126/483B.
27. Acquire additional property rights for structure placements in the following locations:
    a. An area approximately 70ft x 70ft around structure 1020/1A.
    b. An area approximately 80ft x 80ft around structure 25/189A.
28. Acquire additional property rights for wire clearances in the following locations:
    a. An approximately 400ft long, 60ft wide section along the centerline from structure 1020/1 to 1020/2A.
    b. An approximately 125ft long, 65ft wide section along the centerline from structure 25/188A to 25/189.
    c. An approximately 150ft long, 60ft wide triangular section from new structure 168/1A to the existing ROW boundary.

**CONCEPTUAL DESIGN NOTES:**

1. Transmission Line survey should be acquired from existing structures 2034/278 to 2034/280 as well as 167/1A, 168/1A to 167/5, 168/5.
    a. Sufficient survey exists for lines 1020 and 2126 but as-built survey is needed for the recent line 167 and 168 work. Survey for the 2034 and 25 segment will be used to determine existing tensions with Method 4 structure models to analyze the changes in load on existing tower structure 2034/280.
2. Land acquisition and switch installations within the substation expansion will be required but have been included within the substation scope of work.
3. According to boring logs taken in 2017 for project 946082, soil conditions are not favorable for foundations. Direct embed DOM pole structures are likely to require pipe pile foundations.
4. Static poles and wires were spotted based on a 30° shielding angle. It is recommended that a lightning study is completed to determine if the quantity of static poles can be reduced.
5. While the developer line design is not included within this scope, it is assumed that the line will enter the substation on the west side of the substation on monopoles and will cross over the top of the 115kV line 25.
    a. Clearances between the first developer structure outside of the station (D-TIE 2 in model) and the existing tower 2034/280 are very close and are currently balanced

with tight clearances to avoid spanning over the transformer. If additional clearance is necessary:

i. Floating deadends could be installed on line 25 after the tap into new structure 25/188A to isolate the line at the structure.
ii. A dead-end monopole structure could be installed midspan for line 25 to transition the line into horizontal phasing before it reaches the tower.

6. 115kV lines 167 and 168 are the only transmission lines feeding Weyerhaeuser substation. Line work must be sequenced such that both lines do not experience outages simultaneously. This would require the substation expansion to be installed in sequences that alternate which line is experiencing an outage.
7. Existing tower structure 25/188, 2034/281 is having the ahead span of conductor and shield wire on the 25 line removed. According to the tensions from the line 25 and 2034 NERC models, the standard tower model can handle the change in loading. This structure should be analyzed in detail when new survey is acquired to confirm.

**PJM Network Upgrade #N8113 – Partially rebuild line 25 with 768.2 ACSS.**

N8113 serves to partially rebuild one (1) 115kV line 25 between structure 25/180 to Trowbridge Substation (25/189) in Plymouth, North Carolina. Additionally, one (1) 230kV line 2034 will remain on existing adjacent towers between structure 2034/273 and Trowbridge Substation (2034/280). Included in the scope are new engineered steel single circuit monopoles. The new 115kV circuit will be constructed with single 768.2 ACSS/TW/HS "Maumee", while the 230kV circuit will keep the existing bundled 545.6 ACAR. The new 115kV circuit will be shielded with DNO-11410, while the existing 230kV circuit will be shielded with the existing 3 #6 Alumoweld. This scope assumes that the Trowbridge Substation reconfiguration completed in the scope for AD1-074/075/076 takes place prior to this work.

**EXISTING FACILITIES TO BE REMOVED:**

1. Remove approximately 0.01 miles of Line 25 115 kV 3-phase 545.6 ACAR conductor from existing structure 25/180 to existing structure 25/181 (2034/273).
2. Remove one (1) 3-pole wood double deadend structure as follows:
    a. Structure 25/180

**MODIFICATIONS TO EXISTING FACILITIES:**

1. Transfer existing Line 25 3-phase 545.6 ACAR conductor from existing structure 25/180 to proposed 3-pole structure 25/180.

**PERMANENT FACILITIES TO BE INSTALLED:**

1. Install two (2) engineered steel double deadend 3-pole structures on foundations as follows [12.156]:
    a. Structures 25/180 and 25/188
        i. Structure 25/188 is also included in the scope of AD1-074/075/076 as a DOM 3-pole structure; however, project N8113 is changing the use of this

significantly enough to where an engineered 3-pole is needed for this estimate.
        ii. Structure 25/188 will be used to phase roll line 25, hence it does not relate specifically to a DEV standard framing drawing.
2. Install five (5) engineered steel single circuit suspension monopole structures on foundations as follows [11.441]:
    a. structures 25/182 to 25/185, and 25/187.
3. Install two (2) engineered steel single circuit deadend monopole structures on foundations as follows [11.437]:
    a. Structures 25/181 and 25/186
4. Install approximately 1.34 miles of 3-phase single 768.2 ACSS/TW/HS "Maumee" conductor from structure 25/180 to 25/188.
5. Install approximately 1.34 miles of DNO-11410 OPGW from structure 25/180 to 25/188.
    a. Install an OPGW splice on structures 25/180 and 25/188.

**CONCEPTUAL DESIGN NOTES:**

1. All proposed structures are engineered structures. No light duty embedded steel poles will be used for this project.
2. This scope assumes that an outage can be acquired on line 25 and 2034 during construction.
3. The existing line 25 should be left in place on the tower structures and idled by disconnecting their corresponding jumpers.
    a. Existing double circuit towers (with the exception of existing structure 25/181 (2034/273) were not analyzed as part of this project since existing wires were primarily left in place. **Please note that many of the existing towers experiencing existing conditions appeared to have overstressed members. This is outside the scope of this project to mitigate. Should this change, additional costs for possible tower reinforcements may need to be accounted for.**
    b. Existing structure 25/181 (2034/273) will have its loading altered slightly with the removal of the slack span of Line 25 connecting to existing structure 25/180. No overstressed tower members were observed.
    c. Existing structure 25/188 (2034/280) was analyzed as par of Project AD1-074-075-076 and was found to have no overstressed tower members.
4. Per existing Plan and Profiles, the ROW between Trowbridge Substation and structure 2034/275 is 120 feet, and existing ROW between structures 2034/275 and 2034/273 is 185 feet. As these additional ROW assumptions are predicated on the anticipated ROW lengths, the existing ROW widths will need to be verified using a digital ROW file in detailed design. The subsequent additional ROW will be necessary:
    a. Twenty (20) feet of additional ROW width on the north side of Line 25 for approximately 1.34 miles between structure 25/180 to structure 25/188. Existing vegetation within the proposed ROW limits will need to be cleared.
        i. The proposed ROW may run into private property owned by Weyerhaeuser Plymouth Wood Plant.

        ii. This amount of additional ROW could possibly be decreased in detailed design.
5. New LiDAR data will be required for detailed design.
6. Structures 25/183 to 25/185 are in a possible wetlands area. Additional foundation considerations may be required.
7. The DNO-11410 OPGW will not connect substation to substation as part of this project. The fiber installation is to allow future rebuilds of Line 25 to connect to it if necessary.

**PJM Network Upgrade #n6144 – Rebuild 230kV line 218 from structure 218/13 to Everetts Substation**

This project serves to rebuild 230kV line 218 from structure 218/13, demarcation point between Dominion and Duke Energy, to Everetts Substation. The existing structures shall be replaced one for one within the existing ROW, using primarily DOM direct buried structures with custom engineered deadend structures utilized as required. The line will be rebuilt with 3-phase 2-636 ACSR (24/7) conductor and two (2) DNO-11410 shield wire. The backbone at Everetts is to be replaced in this project

**Existing Facilities to be Removed:**

1. Remove four (4) existing TL218 wood 3-pole double deadend structures as follows:
    a. Structures 37, 42, 168, 195
2. Remove one (1) existing TL218 wood H-frame double deadend structure as follows:
    a. Structure 13
3. Remove two (2) existing TL218 wood static pole structures as follows:
    a. Structures 197A & 197B
4. Remove one (1) existing TL218 galvanized steel A-frame backbone structure as follows:
    a. Structure 198
        i. This includes the removal of the switch mounted on this backbone.
5. Remove one hundred and forty-five (145) existing TL218 wood H-frame tangent structures as follows:
    a. Structures 14-18, 21-30, 33-36, 39-41, 43-61, 63-64, 66-73, 75-77, 79-95, 97, 99-100, 102-106, 108-109, 112-114, 116, 121-122, 124, 127-129, 131, 133-134, 136, 139-141, 143-145, 147-160, 162-167, 169-170, 172-191, 193-194
6. Remove two (2) existing TL218 weathering steel H-frame tangent structures as follows:
    a. Structures 110 & 126
7. Remove five (5) existing TL218 wood 3-pole running angle structures as follows:
    a. Structures 19, 78, 98, 161, 192
8. Remove two (2) existing TL218 wood H-frame running angle structures as follows:
    a. Structures 120 & 196
9. Remove two (2) existing TL218 DOM weathering steel 3-pole double deadend structures as follows:
    a. Structures 142 & 197
10. Remove one (1) existing TL218 DOM wood H-frame tangent structure as follows:
    a. Structure 74
11. Remove twenty-three (23) existing TL218 DOM steel H-frame tangent structures as follows:

    a. Structures 20, 31-32, 38, 62, 65, 96, 101, 107, 111, 115, 117-119, 123, 126, 130, 132, 135, 137-138, 146, 171
12. Remove approximately 20.32 miles of 3-phase 1109 ACAR (24-EC/ 13-6201) conductor from structure 218/13 to 218/198
13. Remove approximately 20.32 miles of two (2) 3#6 Alumoweld shield wire from existing structure 218/13 to 218/198

**Permanent Facilities to be Installed:**

1. Install two (2) 230 kV DOM steel H-frame crossing tangents structure as follows:
    a. Structure 218/15 and 218/16
2. Install one (1) DOM HD steel backbone structure as follows:
    a. Structure 218/198
3. Install seven (7) 230 kV custom engineered steel H-frame deadend structures on foundations as follows:
    a. Structures 218/13, 218/37, 218/42, 218/60, 218/120, 218/142, 218/168
4. Install seven (7) 230 kV custom engineered steel 3-pole double deadend structures on foundations as follows:
    a. Structures 218/19, 218/78, 218/98, 218/161, 218/192, 218/195, 218/197
5. Install one hundred and sixty-nine (169) 230 kV DOM steel H-frame tangent structures as follows:
    a. 218/14, 218/16-218/18, 218/20-218/36, 218/38-218/41, 218/43-218/59, 218/61-218/77, 218/79-218/97, 218/99-218/119, 218/121-218/141, 218/143-218/160, 218/162-218/167, 218/169-218/191, 218/193-218/194, 218/196
6. Install approximately 20.32 miles of 3-phase 2-636 ACSR (24/7) conductor from structure 218/13 to structure 218/198.
7. Install approximately 20.32 miles of two (2) DNO-11410 shield wire from structure 218/13 to 218/198.
8. Transfer existing shield wire and conductor to new structure 218/13.
    a. The existing shield wire and conductor is owned by Duke
    b. Additional wire may need to be spliced in

**Conceptual Design Notes:**

1. The line is being designed as “reconductor ready” such that 768 ACSS with an MOT of 250°C could be installed without structure replacements.
2. All engineered steel structures will be designed for full-deadend loading for construction conditions.
3. This project will utilize the new flange plate DOM light duty steel poles. The scope and estimate assume that the flange plate poles will have equivalent or greater strength properties to the slip joint poles.
4. For detailed engineering, a LiDAR survey is required. The conceptual design is based on 2011 LiDAR survey acquired for NERC.
5. Newer existing structures 218/38, 218/130, 218/137, 218/138, 218/146 and 218/171 are assumed to be replaced for this conceptual design.

6. Structure 218/13 is our demarcation point with Duke Energy. Coordination will need to occur such that there are no issues on their line.

## 3. New Substation/Switchyard Facilities

N/A

## 4. Upgrades to Substation / Switchyard Facilities

**PJM Network Upgrade #n6287 – Rebuild Trowbridge station and install one new interconnect**

Project AD1-074/075/076 provides for the initial construction of one new 230kV interconnect into Trowbridge substation.

The objective of this project is to relocate and expand the existing 115kV yard with 7 new 115kV breakers and re-terminate 115kV Lines 1020, 25,167, and 168. Three new 230kV breakers will be added in the 230kV yard and a new 230kV backbone installed to terminate the new interconnect as well as re-terminating 230kV Line No. 2126 to Mackey's Substation. Transformers #1 & #2 will be relocated as well.

Existing control enclosure CE1 will be removed and a new 24' x 60' control enclosure installed.

Transmission line engineering to number the new line between Trowbridge and the 230kV interconnect.

Security and Fence Type – Design Level 3.

Note: Currently, the scope and estimate assume DVP standard spread footer foundations. Once the soil information is received and if it is decided to change that to "pile foundations" then DVP team should be informed at the earliest to adjust the project estimate.

The work required is as follows:

**Purchase and install substation material – Non-Direct Network Upgrade:**

1. Approximately 432' x 200' site preparation and grading as required for the expansion of the existing station.
2. Approximately 1,700 linear ft of chain link, 15 ft tall, perimeter fence around the station along with the security cameras and integrators as per level 3 design standards
3. Approximately 506 ft of cable trough, with a 20 ft road crossing section
4. Three (3), 230kV, 3000A, 50kAIC, SF-6 circuit breaker
5. Ten (10), 230kV, 3000A, 3-phase center break gang operated switch
6. Two (2), motor operator for transformer high side switch
7. Nine (9), 230kV, relaying accuracy CCVT
8. One (1), 230kV, 3000A wave trap (frequency TBD during detail design)
9. One (1), 230kV, line tuner
10. Three (3), 180kV, 144kV MCOV surge arrester
11. One (1), 230kV, heavy duty steel backbone (by Transmission)

12. Seven (7), 115kV, 3000A, 40kAIC, SF-6 circuit breaker
13. Sixteen (16), 115kV, 2000A, 3-phase center break gang operated switch
14. Two (2), motor operator for transformer low side switch
15. Nineteen (19), 115kV, relay accuracy CCVT
16. Twelve (12), 90kV, 74kV MCOV surge arrester
17. Two (2), 115kV, 2000A wave traps (frequency TBD during detail design).
18. Two (2), 115kV, line tuner
19. Three (3), 115kV, heavy duty steel backbones (by Transmission)
20. One (1), 125 VDC, 500 Ah station battery and 75 amp charger (size to be verified during detail engineering)
21. Oil containment for transformer
22. Station stone as required
23. Station lighting as required
24. Steel structures as required including switch stands, bus supports, CCVT and wave trap supports
25. Foundations as required including control enclosure, equipment, and bus support stands
26. Conductors, connectorsconnectors, conduits, control cables, and grounding materials as per engineering standards

**Relocated substation material – Non-Direct Network Upgrade:**

1. Two (2), 230/115kV transformers
2. Four (4), 167kA station service transformers
3. Four (4), SMD-20 200A fused disconnects with 25A K fuses
4. Four (4), 8.3kV, 40A-K fuses
5. Four (4), 18kV, 15.3kV MCOV surge arresters
6. Six (6), 180 kV, 144 kV MCOV surge arresters.
7. Six (6), 90 kV, 74 kV MCOV surge arresters.
8. Steel structures for station service, and bus supports.

**Remove substation material – Non-Direct Network Upgrade:**

1. Four (4), 115kV, 3000A, SF-6 circuit breaker
2. One (1), 230kV, 3000A, SF-6 circuit breaker
3. One (1), 230kV, 3000A, 3-phase center break gang operated switch
4. Seven (7), 115kV, 2000A, 3-phase center break gang operated switch
5. Twelve (12), 115kV, relaying CCVT
6. Eighteen (18), 90kV, 74kV MCOV surge arrester
7. Two (2), 115kV, 2000A wave trap
8. Two (2), 115kV, line tuner
9. Three (3), 115kV heavy duty backbone structure
10. Three (3), 230kV, relaying accuracy CCVT
11. One (1), 230kV, 3000A wave trap
12. One (1), 230kV, line tuner

13. Nine (9), 180kV, 144kV MCOV surge arrester
14. One (1), 230kV, heavy duty steel backbone
15. Control house
16. Steel structures as required including switch stands, bus supports, CCVT and wave trap supports
17. Foundations as required including control enclosure, equipment, and bus support stands.
18. Conductors, connectors, conduits, control cables, and grounding materials as per engineering standards

**Purchase and install relay material – Non-Direct Network Upgrade:**

1. Ten (10), 1510 – 28" dual SEL-351-7 transmission breaker with reclosing panel
2. Twelve (12), 4510 – SEL-2411 equipment annunciator
3. Three (3), 1340 – 28" dual SEL-411L DCB/PLC line panel
4. Two (2), 1340 – 28" dual SEL-411L CD/fiber line panel
5. Nine (9), 4506 – 3-phase CCVT potential make-up box
6. One (1), 4507 – 1-phase CCVT potential make-up box
7. Two (2), 4018 – 500A station service AC distribution panel
8. Two (2), 4007 – 225A outdoor transmission yard AC NQOD
9. Two (2), 4019 – 225A 3-phase throw over switch
10. Two (2), 4016 – 600A PVT disconnect switch
11. One (1), 4153c – wall mount station battery monitor
12. One (1), 5618 – SEL-3555 communications 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. Twelve (12), 4526_A – circuit breaker and transformer fiber optic make-up box
17. One (1), 5202 – 26" APP 601 digital fault recorder
18. One (1), 5603 – station network panel no. 1
19. One (1), 5603 – station network panel no. 2
20. One (1), 4051 – power block
21. One (1), 4042_D1B – security utility – utility ATS
22. One (1), 5616 – station security panel
23. One (1), 5616 – security fence panel
24. Two (2), 4018 – 225A station service AC distribution panel branch breaker
25. Two (2), 1514 – Transmission transformer motor operated air break panel
26. Two (2), 1217 – Dual SEL-487E transmission transformer differential panel
27. Two (2), 4542_A – transformer make-up box
28. Two (2), 7614_A – transformer critical low oil trip assembly
29. One (1), sudden pressure relay auxiliary trip package
30. One (1), electronic temperature monitor
31. Three (3), 1110 – transmission bus panel
32. Three (3), 4200 – bus differential CT make-up box

## 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 Section 8 of Attachment O Appendix 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 publicly 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:

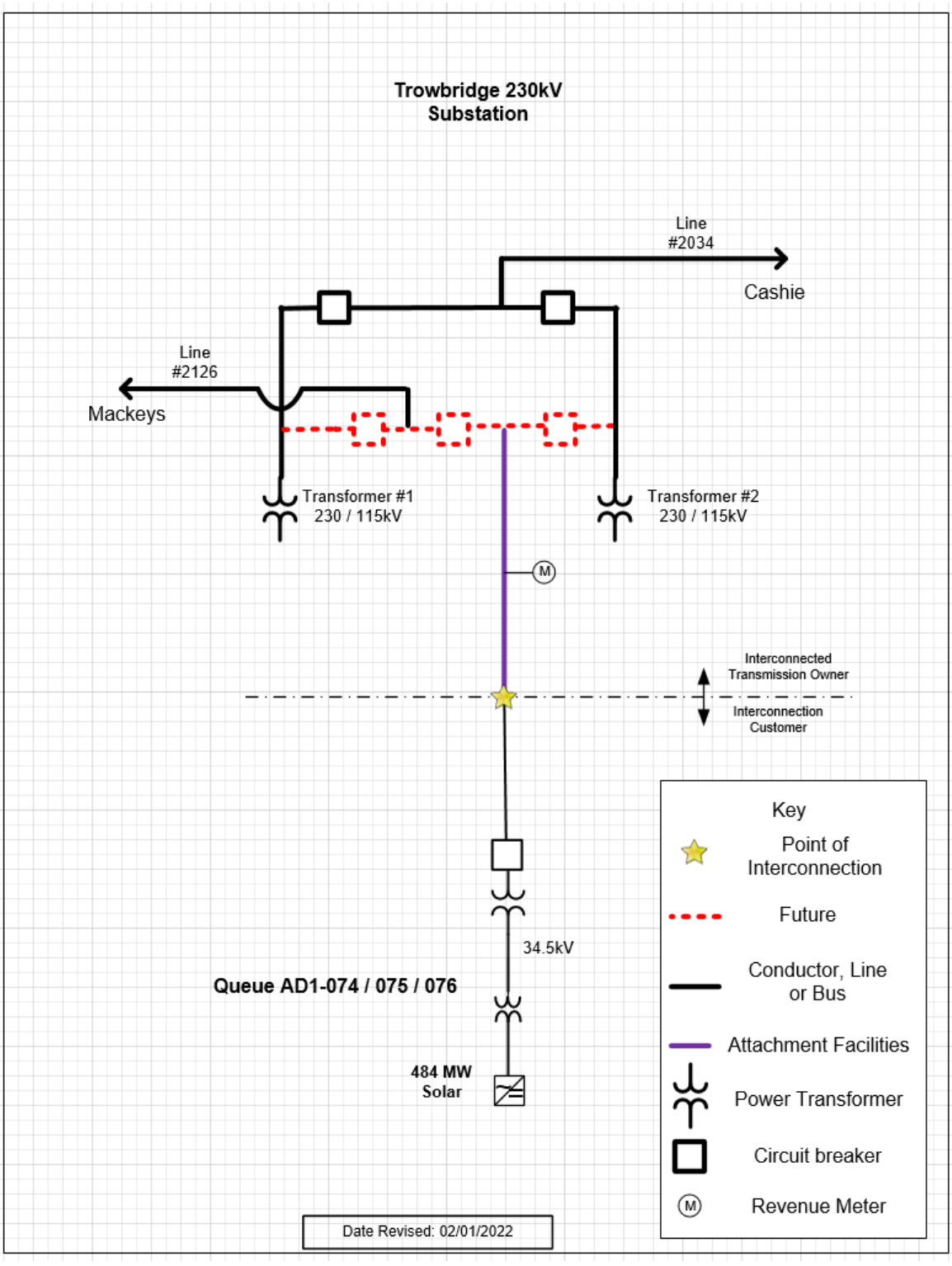
- Suitable Access Road from Substation to a North Carolina State Maintained Roadway.
- Any additional land needed for Storm Water Management, Landscaping, and Wetlands/Wetlands Mitigation.
- Conditional Use Permit for Substation.
- Any other Land/Permitting requirements required by the Substation.

ITO Real Estate Needs:

- The substation layout is complete and ITO requires a 432' x 200' 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 January 2027.

    - 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.*
### *Single Line*




## *Attachment 2.*

## *AD1-074/075/076 Trowbridge Substation General Arrangement*