Generation Interconnection

Combined Facilities Study Report

for

Queue Projects AE2-318 and AF1-045

Ford – Cedarville 138 kV

Clermont County, OH

February 2022

1 Facilities Study Summary

1.1 Project Description

The interconnection customer has proposed a combined solar and storage generating facility located in Clermont County, Ohio. The generating facility will have a total generating capability of 152.2 MW (100 MW solar and 52.2 MW storage) with 98.5 MW of this output being recognized by PJM as Capacity (67.2 MW solar and 31.3 MW storage). The generating facility will connect to the Duke Energy Ohio & Kentucky (DEOK) owned Ford to Cedarville 138 kV feeder via a new three-breaker ring bus approximately 2.5 miles from Ford and approximately 8 miles from Cedarville. The proposed in-service date for the project is October 01, 2023. This study does not imply a Duke Energy Ohio & Kentucky (DEOK) commitment to this in-service date.

1.2 Amendments/Changes to the Impact Study Report

No significant amendments/changes are noted. Since the completion of the Impact Study report, the customer has elected to self-build the direct connection and attachment facilities.

The solar generating facility AE2-318 does not meet the reactive power requirement at the high side of main transformer. Reactive power compensation is required for this project. This project needs to have additional reactive power capabilities to fulfill the power factor requirement. The estimated required additional capacitive reactive power is 28.703 MVar.

The reactive power capability of AF1-045 meets the 0.95 leading PF requirement at the high side of the main transformer. It does not meet the lagging PF requirement at the high side of the main transformer and is deficient by 7.56 MVAr. It is recommended that the plant's reactive power compensation be reviewed to address the deficiency in lagging reactive power capability at the POI.

1.3 Interconnection Customer Schedule

Receive back feed power from DEOK: 06/01/2023

Generation Commercial Operation Date: 10/01/2023

1.4 DEOK's Scope of Work to Facilitate Interconnection

The Interconnection Customer (IC) is responsible for all design and construction related activities on their side of the Point of Interconnection (POI). Route selection, line design, and right-of-way acquisition for the IC's facilities are not included in this report and are the responsibility of the IC.

The generating facility will connect to the DEOK owned Ford to Cedarville 138 kV feeder via a new 138 kV three-breaker ring bus approximately 2.5 miles from Ford and approximately 8 miles from Cedarville. The customer has elected to self-build the attachment facilities and the direct connection network facilities, which include but are not limited to the generation lead line from the 138 kV three-breaker ring bus to the POI and the three-breaker ring bus itself. DEOK will purchase, test, install, and commission the revenue meters used in the attachment facilities connecting the generator lead line to the three-breaker ring bus substation. The IC is required and is responsible for verifying that they are using DEOK approved contractors, vendors, materials, standards, etc. Any work submitted by a contractor or vendor not approved by DEOK will not be reviewed, and the IC will be required to re-submit work performed by a DEOK approved contractor or vendor. All work completed by the IC shall be subject to DEOK's review and approval. All drawings and documents shall undergo a 30%, 60%, 90%, and Issued For Construction review by DEOK. Approximate costs for all DEOK oversight work are given below. Additionally, although the document is not an exhaustive list of requirements, the customer will be responsible for following all self-build requirements given in the Duke Energy Midwest Transmission Interconnections Self-Build Requirements document. Upon final inspection, testing, completion, and DEOK approval of the project, all self-built facilities on the DEOK side of the POI, including but not limited to the 138 kV three-breaker ring bus and generation lead line from the 138 kV three-breaker ring bus up to the POI, the substation property, transmission facilities, access road, and necessary rights-of-way, will be ceded to DEOK along with all applicable as-built drawings.

In addition to PJM's criteria, the IC will be responsible for meeting all criteria as specified in the applicable sections of the "Duke Energy Midwest transmission systems Facility Connection Requirements" document given here: http://www.ferc.duke-energy.com/DEW/MidwestConnection.pdf. DEOK reserves the right to review the electrical protection design and relay settings for interconnection customer facilities to ensure that the protective relaying equipment will be compatible with that installed at the new substation. DEOK personnel must be present at the time of commissioning to witness proper function of the protection scheme and related coordination.

All work to accommodate the interconnection of AE2-318/AF1-045 is dependent upon the IC obtaining all necessary permits. In addition, the IC shall be responsible for acquiring all real property rights and acquisitions, including but not limited to rights-of-way and easements. Any deferment in obtaining the necessary real property rights, acquisitions, and permits required for this interconnection may delay the construction schedule.

DEOK's scopes of work to connect the interconnection customer to the system are as follows (please note the scopes given below are estimates and are subject to change):

Scope of Work for Attachment Facilities

The IC has elected to self-build the attachment facilities using DEOK's approved vendors and contractors as well as DEOK's standard equipment and any other applicable standards. DEOK will purchase, test, install, and commission the revenue meters used in the attachment facilities connecting the generator lead line to the three-breaker ring bus substation. DEOK will also provide oversight hours for the self-build. All drawings and documents shall undergo a 30%, 60%, 90%, and

Issued For Construction review by DEOK. The IC will be required to install a customer owned switch approximately 20-30 feet outside the new substation fence at the POI.

Scope of Work for Direct Connection Facilities

The interconnection customer has elected to self-build the direct connection facilities using DEOK's approved contractors and vendors as well as DEOK's standard equipment and any other applicable standards. DEOK will be utilizing oversight hours for the self-build. All drawings and documents shall undergo a 30%, 60%, 90%, and Issued For Construction review by DEOK. Please note the substation used to connect the generating facility to the Duke Energy system is required to be a complete 138 kV three-breaker ring bus.

Scope of Work for Line Loop Through the New Substation

To Cedarville:

- Install one (1) engineered deadend pole with foundation.
- Install three (3) tangent light duty steel poles (assume 85' H4) to transition into engineered pole.
- Install approximately 200 linear feet of 954ACSS/TW (200C), one (1) OPGW, and one (1) 7#8AW.
    - Spliceboxes required on substation take-off structure and transmission pole.
- Retire 2-3 wood structures and transfer wire to new steel poles.

To Ford:

- Install one (1) engineered deadend pole with foundation.
- Install three (3) tangent LD steel poles (assume 75' H4) to transition into engineered pole.
- Install approximately 200 linear feet of 954ACSS/TW (200C), one (1) OPGW, and one (1) 7#8AW.
    - Spliceboxes required on sub take-off structure and transmission pole.
- Retire 3-4 wood structures and transfer existing conductor and static to new steel poles.

Other:

- Route/ground survey needed to identify underground utilities.

Assumptions:

- Line will be bifurcated near the new substation.
- Substation take-off structures will be within 200 ft of the transmission line and the line can enter in directly from the engineered structures.
- Any land or right-of-way needed to accomplish the loop in and out of the existing transmission line will be acquired by the IC and ceded to DEOK.

Scope of Work for Distribution Service to the new Substation

- Extend 34.5kV single-phase to provide the substation with backup station power service.
- Install one (1) 100kVA pad-mount station power transformer located outside of the substation for the backup station power.

- Assumption made that the line will follow the access road through the solar farm and be approximately 6000 ft long with the IC providing the required right-of-way to DEOK.

Scope of Work for Cedarville Substation Work

- Remove the 138 kV transmission line TYS Primary and DPL Backup relays.
- Install one (1) standard dual SEL-421 relay protection package for the 138 kV transmission line.
- Remove the GE Model Carrier and direct trip receiver equipment.
- Install one (1) RFL-9785 Power Line Carrier System, plus one (1) carrier test switch for the 138 kV transmission line.
- Install one (1) SEL-451 relay for breaker failure protection, reclosing and control of the 138 kV transmission line circuit breaker.
  - Install one (1) Electroswitch type lock out relay for breaker failure in which the transmission line circuit breaker will trip its adjacent breakers in the event of a failure.
- Re-tune frequency of the existing transmission line wave trap.

Scope of Work for Ford Substation Work

- Remove the 138 kV transmission line TYS Primary and DPL Backup relays.
- Install one (1) standard dual SEL-421 relay protection package for the 138 kV transmission line.
- Remove the GE Model Carrier and direct trip transmitter equipment.
- Install one (1) RFL-9785 Power Line Carrier System, plus one (1) carrier test switch for the 138 kV transmission line.
- Install two (2) SEL-451 relays for breaker failure protection, reclosing, and control of two 138 kV circuit breakers
  - Install an Electroswitch type lock out relay for each breaker failure which will trip its adjacent breakers in the event of a failure.
- Re-tune frequency of the existing 138 kV transmission line wave trap.

1.5 Description of Transmission Owner Facilities Included in the Facilities Study

(please note the scopes given below are estimates and are subject to change)

1.5.1 Direct Connection Work

The interconnection customer has elected to self-build the direct connection facilities using DEOK's approved contractors and vendors as well as DEOK's standard equipment and any other applicable standards. DEOK will be utilizing oversight hours for the self-build. All drawings and documents shall undergo a 30%, 60%, 90%, and Issued For Construction review by DEOK. Please note the substation used to connect the generating facility to the Duke Energy system is required to be a complete 138 kV three-breaker ring bus.

1.5.2 Non-Direct Connection Work

Scope of Work for Line Loop Through the New Substation

To Cedarville:

- Install one (1) engineered deadend pole with foundation.
- Install three (3) tangent light duty steel poles (assume 85' H4) to transition into engineered pole.
- Install approximately 200 linear feet of 954ACSS/TW (200C), one (1) OPGW, and one (1) 7#8AW.
  - Spliceboxes required on substation take-off structure and transmission pole.
- Retire 2-3 wood structures and transfer wire to new steel poles.

To Ford:

- Install one (1) engineered deadend pole with foundation.
- Install three (3) tangent light duty steel poles (assume 75' H4) to transition into engineered pole.
- Install approximately 200 linear feet of 954ACSS/TW (200C), one (1) OPGW, and one (1) 7#8AW.
  - Spliceboxes required on sub take-off structure and transmission pole.
- Retire 3-4 wood structures and transfer existing conductor and static to new steel poles.

Other:

- Route/ground survey needed to identify underground utilities.

Assumptions:

- Line will be bifurcated near the new substation.
- Substation take-off structures will be within 200 ft of the transmission line and the line can enter in directly from the engineered structures.
- Any land or right-of-way needed to accomplish the loop in and out of the existing transmission line will be acquired by the IC and ceded to DEOK.

Scope of Work for Distribution Service to the new Substation

- Extend 34.5kV single-phase to provide the substation with backup station power service.
- Install one (1) 100kVA pad-mount station power transformer located outside of the substation for the backup station power.
- Assumption made that the line will follow the access road through the solar farm and be approximately 6000 ft long with the IC providing the required right-of-way to DEOK.

Scope of Work for Cedarville Substation Work

- Remove the 138 kV transmission line TYS Primary and DPL Backup relays.
- Install one (1) standard dual SEL-421 relay protection package for the 138 kV transmission

line.

- Remove the GE Model Carrier and direct trip receiver equipment.
- Install one (1) RFL-9785 Power Line Carrier System, plus one (1) carrier test switch for the 138 kV transmission line.
- Install one (1) SEL-451 relay for breaker failure protection, reclosing and control of the 138 kV transmission line circuit breaker.
  - Install one (1) Electroswitch type lock out relay for breaker failure in which the 138 kV transmission line circuit breaker will trip its adjacent breakers in the event of a failure.
- Re-tune frequency of the existing 138 kV transmission line wave trap.

Scope of Work for Ford Substation Work

- Remove the 138 kV transmission line TYS Primary and DPL Backup relays.
- Install one (1) standard dual SEL-421 relay protection package for the 138 kV transmission line.
- Remove the GE Model Carrier and direct trip transmitter equipment.
- Install one (1) RFL-9785 Power Line Carrier System, plus one (1) carrier test switch for the 138 kV transmission line.
- Install two (2) SEL-451 relays for breaker failure protection, reclosing and control of two 138 kV circuit breakers
  - Install an Electroswitch type lock out relay for each breaker failure which will trip its adjacent breakers in the event of a failure.
- Re-tune frequency of the existing 138 kV transmission line wave trap.

1.5.3 Attachment Facilities Work

The IC has elected to self-build the attachment facilities using DEOK's approved vendors and contractors as well as DEOK's standard equipment and any other applicable standards. DEOK will purchase, test, install, and commission the revenue meters used in the attachment facilities connecting the generator lead line to the three-breaker ring bus substation. DEOK will also provide oversight hours for the self-build. All drawings and documents shall undergo a 30%, 60%, 90%, and Issued For Construction review by DEOK. The IC will be required to install a customer owned switch approximately 20-30 feet outside the new substation fence at the POI.

1.5.4 Network Upgrade Work

No network upgrades were identified in this study.

1.6 Total Cost of Transmission Owner Facilities Included in the Facilities Study:

Attachment Facilities	$185,625
Direct Connection Facilities	$214,028
Non-Direct Connection Facilities	$2,162,424
Network Upgrade Facilities	$0
Total Cost	$2,562,077

Estimate range is (+30%/-20%). Customer will be required to pay actual costs incurred throughout the project lifecycle. The estimates do not include the impact that delays in obtaining ROW, permits, or other approvals may have. The estimates do not include CIAC Tax Gross-up.

1.7 Summary of Schedule Milestones for Completion of Transmission Owner Work Included in Facilities Study:

Approximate Schedule Milestones are given from months after a DEOK kickoff meeting is held. The DEOK kickoff meeting will be held within approximately 2-3 months of receiving a signed ISA and ICSA. Please note if the commercial operation date is extended, the schedule below will no longer be valid.

Task	Months from Kickoff Meeting
Engineering Start	1
Order Long Lead Items	6
Engineering Finish	12
Bid Project Start	12
Bid Project Finish	15
Construction Start	18
Construction Finish	24

Overall, the project should take approximately 24 months from a DEOK kickoff meeting to complete.

Assumptions

- **There will be no issues obtaining right-of-way, no issues getting a PJM Outage, and no major interruptions for weather.**
- **System conditions must allow scheduled outages to occur.**
- **The customer will perform site development and road construction in accordance with DEOK specifications.**
- **The customer will provide a site that is acceptable to DEOK and any additional easements for the 138 kV station and line work to include access to all facilities and structures.**
- **The customer will have their construction and required checkout completed prior to the start of the cut-in and testing outage. DEOK personnel will need to be present at any testing and at cut-in.**

Transmission Outage Plan

No transmission outage plan has been specified at this time

2 Transmission Owner Facilities Study Results

2.1 Transmission Lines – New

2.2 Transmission Lines – Upgrades

2.3 Substation Facilities – New

2.4 Substation Facilities – Upgrades

2.5 Metering & Communications

The Interconnection Customer will be required to comply with all Duke Energy Midwest metering and communication requirements for generation interconnection customers found in the "Duke Energy Midwest transmission systems Facility Connection Requirements" document, along with any other DEOK self-build metering and communication requirements. The metering and communication requirements may be found at the following link: http://www.ferc.duke-energy.com/DEW/MidwestConnection.pdf

2.6 Environmental, Real Estate, and Permitting issues

The IC is responsible for obtaining all necessary land control, right-of-way, and permitting for this project. Any land used by DEOK to construct facilities shall be environmentally permitted, graded and ready for construction. Final size and location are to be approved by DEOK.

2.6.1 System Modeling & Operating Requirements

In addition to the IPP modeling requirements imposed by PJM as part of the Generation Interconnection process, the following system modeling parameters will need to be supplied by the Interconnection Customer to DEOK:

- None

2.7 Summary of Results of Study

Cost Estimates for DEOK

Task	Network Upgrade Number	Engineering	Material	Construction	TOTAL
Attachment Facilities (Oversight of Self Build and Installing Revenue Meters)	N7842	$28,985	$13,587	$143,053	$185,625
Direct Connection Facilities (Oversight of Self Build)	N7843	$107,865	-	$106,163	$214,028
Transmission Line Loop In/Out	N7844	$124,119	$292,938	$835,443	$1,252,500
Remote Ends Work	N7845	$103,953	$209,985	$404,717	$718,655
Distribution Line Extension for Station Power	N7846	$13,445	$43,984	$133,840	$191,269

Estimate range is (+30%/-20%). Customer will be required to pay actual costs incurred throughout the project lifecycle. The estimates do not include the impact that delays in obtaining ROW, permits, or other approvals may have. The estimates do not include CIAC Tax Gross-up.

2.8 Information Required for Interconnection Service Agreement

Description	Attachment Facility	DCF Facility	NDCF Facility	TOTAL
Direct Material	$11,770	-	$479,642	$491,412
Direct Labor	$94,699	-	$811,294	$905,993
Indirect Material	$1,295	-	$47,922	$49,217
Indirect Labor	$71,637	$205,796	$747,752	$1,025,185
Carrying Charges (AFUDC at 4%)	$6,224	$8,232	$75,814	$90,270
TOTAL	$185,625	$214,028	$2,162,424	$2,562,077

Estimate range is (+30%/-20%). Customer will be required to pay actual costs incurred throughout the project lifecycle. The estimates do not include the impact that delays in obtaining ROW, permits, or other approvals may have. The estimates do not include CIAC Tax Gross-up.

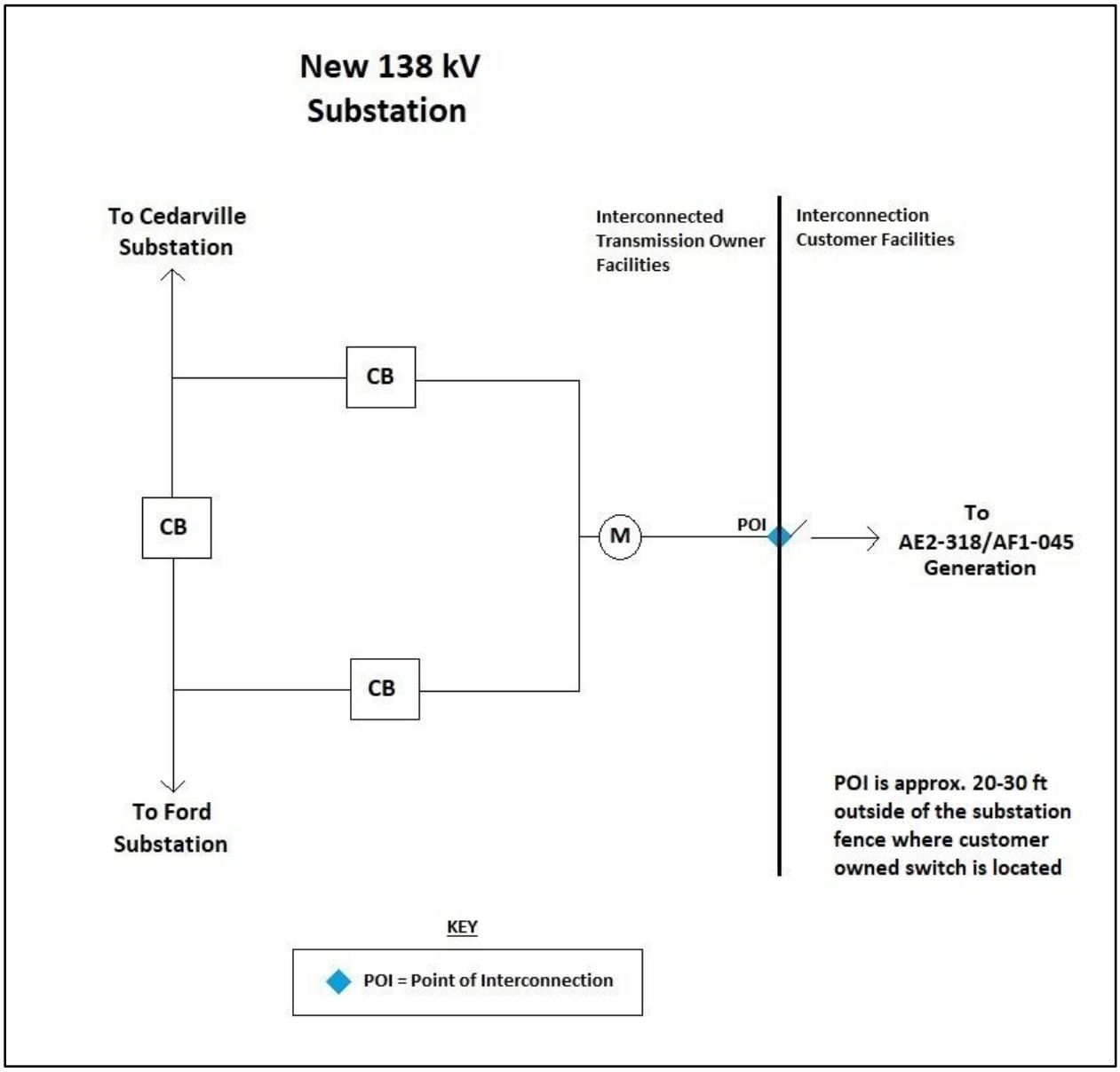

Figure 1a: Point of Interconnection and Revenue Metering Ford to Cedarville 138 kV One-Line Diagram

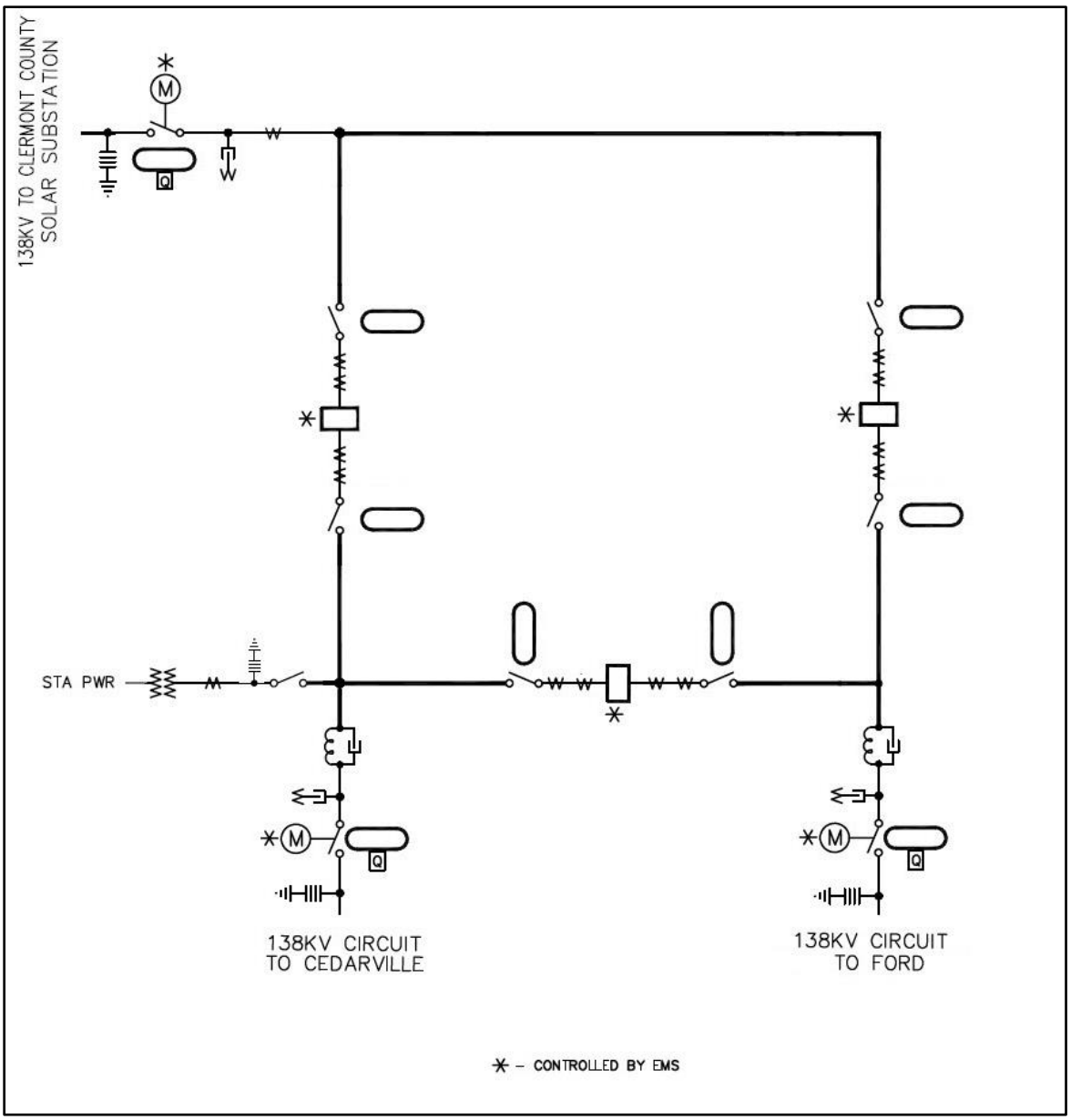

Figure 1b: AE2-318 and AF1-045 Substation Preliminary One-Line Diagram

Figure 2: Point of Interconnection Map