

Facilities Study Report

For

Physical Interconnection of

PJM Generation Interconnection Request

Project ID AF1-282

Stuart-Clinton 345 kV

Revision 0: October 2024

Introduction

This Facilities Study has been prepared in accordance with the PJM Open Access Transmission Tariff. The Transmission Owner (TO) is Dayton Power and Light Company d/b/a AES Ohio ("AES Ohio").

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A. Transmission Owner Facilities Study Summary

1. PROJECT DESCRIPTION

The Project Developer has proposed a solar Generating Facility located in Clay Township, Highland County, Ohio. See Attachment 2. The installed facilities for AF1-282 will have a total Maximum Facility Output (MFO) of 100 MW with 60 MW of this output being recognized by PJM as Capacity.

2. POINT OF CHANGE IN OWNERSHIP

The Generating Facility will interconnect with the AES Ohio transmission system via a direct connection into the Clay 345 kV substation bus.

The Point of Change in Ownership will be located at the first dead-end structure outside the Clay Substation fence on the AF1-282 345 kV generator transmission line.

The proposed generation interconnection is shown on the single line diagram in Attachment 1.

3. AMENDMENTS TO THE IMPACT STUDY DATA OR IMPACT STUDY RESULTS

Changes to the data or results of the System Impact Study, dated November 2020 are noted as follows.

This study assumes that queue project AE2-221 (Lynchburg Substation) will be in service prior to AF1-282 therefore the Lynchburg Substation will be considered as the remote end for AES Ohio transmission line 34508 instead of the Clinton Substation.

4. PROJECT DEVELOPER SCHEDULE

The AF1-282 in-service date will be dependent on the TO construction schedule.

5. SCOPE OF PROJECT DEVELOPER FACILITIES

Developer will design, build, own, operate and maintain the project developer Interconnection Facilities on project developer's side of the Point of Change in Ownership (PCO). This includes, but is not limited to:

- 100 MW solar Generating Facility.
- Generation step-up (GSU) transformer
- Circuit breakers and associated equipment located between the high side of the GSU and the Point of Change in Ownership
- Generator lead line from the Generating Facility to the Point of Change in Ownership
- Protective relaying and telecommunication equipment and system(s) necessary to facilitate AES Ohio status monitoring and supervisory control of the circuit breaker(s) at the interconnection line terminal. Note: 48-count fiber will be installed between the AES Ohio interconnection substation and the Project Developer's collector substation for metering, relaying, monitoring, and remote tripping.
- See Attachment 3 for AES Ohio Generation Connection Requirements.
- See Attachment 4 for AES Ohio Protection Requirements.

AES Ohio requires the Project Developer to utilize Schweitzer Engineering Laboratories (SEL) relays and related protective equipment for facilities that will be interconnecting or communicating with AES Ohio relaying. AES Ohio reserves the right to specify relays or other protective equipment utilized in the Project Developer's substation as required. All protection system designs shall be reviewed by AES Ohio during the design phase to ensure proper clearing times, coordination, and compliance with applicable NERC regulations and AES Ohio requirements.

B. Transmission Owner Facilities Study Results

The following is a description of Transmission Owner facilities for physical interconnection of project to the AES Ohio Transmission System. These facilities and upgrades shall meet all applicable PJM requirements including "PJM Transmission and Substation Design Subcommittee Technical Requirements" and "PJM Protection Standards" (PJM Manual 7). They shall also be designed and constructed according to AES Ohio standards. See Attachment 3. After they have been constructed and put into service, AES Ohio will own, control, operate, and maintain these Facilities on the AES Ohio side of the Point of Change in Ownership.

Since the upgrades described in this study will be made to existing AES Ohio owned facilities, they are not eligible for the Option to Build by the project developer.

1. INTERCONNECTION SUBSTATION (EXISTING)

Clay Substation 345 kV Upgrade (AF1-282)

The existing substation, Clay 345 kV, will be upgraded to interconnect the project with the AES Ohio Transmission System. The scope of work for the Network Upgrades is further detailed below. During

detailed design and analysis, other components may be identified for installation or replacement due to this interconnection.

Remove existing rigid bus and install one (1) 345 kV breaker and one (1) 345 kV disconnect switch on existing stand in the fourth (future) position of the ring bus. Install rigid bus from the 345 kV ring to the new take-off structure location. Install three (3) line PT's at the new take-off structure location, and add one (1) new relay panel for line protection and metering of the AF1-282 gen tie line in the existing control enclosure. Also install rigid bus and two (2) additional 345 kV disconnect switches on the north end of the ring to accommodate future expansion of the ring.

Per AES Ohio standards, the new equipment and bus will be designed for operation at a nominal system voltage of 345 kV, 3000 amps continuous current, and insulated for a minimum of 1300 kV BIL. Drilled pier foundations and AES Ohio standard structures and will be used to support equipment such as disconnect switches, take-off structures, bus, and instrument transformers. A slab type foundation will be installed for the circuit breaker.

Protective relaying for the Project Developer's generation will consist of SEL-411L (PRI) and SEL-411L (BU) relays. These relays will be connected to the AF1-282 generation facility via direct fiber (OPGW) on the transmission line.

Breaker control, failure and reclosing will be accomplished using one (1) SEL-451 relay for the new breaker. Breaker failure transfer trips will be sent to the remote end terminal via fiber channels in the PRI and BU line relays.

Metering of the POI will be included in the line protection panel for the AF1-282 interconnection via one (1) SEL-735 meter. This meter will be in addition to the Project Developer's required revenue meter installed at the collector substation on the high side of the main power transformer.

No upgrades are required for the existing RTU/communication equipment in the Clay Substation.

The scope of work for the installation of the Project Developer's interconnection and generation facilities are the responsibility of the Project Developer and are not included in this study.

Major switchyard material and equipment items:

<i>Material / Equipment</i>	<i>Quantity</i>
345 kV Circuit Breaker 3000 A, 63 kA	1
345 kV Disconnect Switch, 3000 A	3
345 kV PT	3
345 kV Surge Arresters	3
345 kV Disconnect Switch Stand	2
345 kV PT Stand, Single Phase	3
345 kV Bus Support Stand, 1-Phase, High	9
345 kV Surge Arrester Stand	3
345 kV Breaker Foundation (slab)	1
345 kV Disconnect Switch Stand Foundation (group of piers)	2
345 kV PT Stand Foundation	3
345 kV Bus Support Stand Foundation	9
345 kV Surge Arrester Stand Foundation	3
345 kV Station Post Insulators, High Strength	9
5" SPS AL Bus (Sch 40) with 1351 ACSR Damper	540 FT

<i>Material / Equipment</i>	<i>Quantity</i>
1351 AAC Bare Conductor	600 FT
4/0 AAC Bare Conductor	400 FT
Ground Conductor, 4/0 Bare Copper (Soft Drawn)	350 FT
Ground Rods	4
Conduit	LOT
Power and Control Cable	LOT
Line Relay Panel with (2) SEL-411L, (1) SEL-451& (1) SEL-735 Meter	1
ADSS Fiber Optic Cable, 48 Strand	400 FT
Fiber Splice Case	1
Fiber Splice Tray	2
Cable Storage, For OPGW Cable, 5ft Loop Diameter	1
Outdoor Junction Box	2
Lighting	1
Connectors, Fittings, Grounding & Misc.	LOT

A geotechnical investigation and ground resistivity testing may be required for the design of foundations and the station grounding grid upgrades. Additional studies such as short circuit, lighting, direct stroke shielding, AC and DC station service studies may also be required.

2. TRANSMISSION LINE TIE-IN

None.

3. TRANSMISSION OWNER INTERCONNECTION FACILITIES:

The TO Interconnection Facilities include, but are not limited to, the following. One 345 kV transmission line span, approximately 200-foot total, will be installed from the new AF1-282 interconnection substation bus position (POI) to the Point of Change in Ownership structure (PCO) outside the substation fence. Any future revisions to the location of the PCO may trigger the need for a scope and cost re-evaluation of these Interconnection Facilities.

This study estimates one (1) 345 kV take-off structure inside the substation fence and one (1) 345 kV three-pole steel dead-end structure outside the fence will be installed. The steel dead-end structure will be the PCO structure. The structures will be supported on concrete drilled pier foundations. The new line section will consist of 1024.5 KCMIL 30/7 ACAR conductors and 7 NO. 8 Alumoweld overhead shield wire. Polymer insulators will be used for all structures. One (1) new OPGW-ADSS splice enclosure will also be included on the PCO structure.

Major transmission line material and equipment items:

<i>Material / Equipment</i>	<i>Quantity</i>
345 kV Transmission Line Conductor, 1024.5 KCMIL 30/7 ACAR	800 FT
7 NO. 8 Alumoweld Shield Wire	300 FT
345 kV Deadend Steel Take-Off Structure, 1 Bay	1

<i>Material / Equipment</i>	<i>Quantity</i>
345 kV Dead-end Steel Three-pole Structure	1
345 kV Deadend Take-Off Structure Foundation	4
345 kV Drilled Pier Foundation, Dead-end Structure	3
Fiber Splice Case	1
Fiber Splice Tray	2
Cable Storage, For OPGW Cable, 5ft Loop Diameter	1
Insulators, Connectors, Fittings, Grounding & Misc.	LOT

A geotechnical investigation will be required for the design of the structure foundations. Additional studies may also be required.

4. UPGRADE TO NEIGHBORING SUBSTATIONS

4.1 LYNCHBURG SUBSTATION

Review and update relay protection settings as required.

4.2 STUART SUBSTATION

Review and update relay protection settings as required.

5. INSTALLATION OF FIBER CABLE CIRCUITS

A fiber optic pathway shall be installed for protective relay communications between the Clay Substation and the Project Developer's collector substation. The Project Developer is responsible for installing 48 strand OPGW, DNO-12161, on the approximately 2.93 mile generator lead line up to the PCO structure. AES Ohio will install ADSS fiber optic cable to extend the fiber optic pathway from the splice point on the PCO structure into the Clay Substation control building.

6. COST ESTIMATE OF AES OHIO FACILITIES FOR PHYSICAL INTERCONNECTION

The following table summarizes the total estimated costs according to FERC criteria. The estimated costs are in 2029 dollars. **This cost excludes a Federal Income Tax Gross Up charges on Contributions in Aid of Construction (CIAC).** This tax may or may not be charged based on whether this project meets the eligibility requirements of IRS Notice 88-129. If at a future date it is determined that the Federal Income Tax Gross charge is required, the Transmission Owner shall be reimbursed by the Project Developer for such taxes.

6.1 COST ESTIMATE FOR TRANSMISSION OWNER-BUILD OPTION

Work Description	Type of Upgrade	Direct		Indirect		Total Cost	Tax
		Labor	Material	Labor	Material		
Transmission Owner Interconnection Facilities	TOIF	\$1,028,704	\$620,573	\$331,349	\$0	\$1,980,626	N/A
Expansion of existing substation	Network Upgrade	\$1,018,315	\$1,302,258	\$616,905	\$0	\$2,937,478	\$0
Remote End Upgrades at Lynchburg Substation	Network Upgrade	\$50,000	\$0	\$25,000	\$0	\$75,000	\$0
Remote End Upgrades at Stuart Substation	Network Upgrade	\$50,000	\$0	\$25,000	\$0	\$75,000	\$0
Total Project Costs		\$2,147,019	\$1,922,831	\$998,254	\$0	\$5,068,104	\$0

Project Developer and Transmission Owner hereby acknowledge and agree that the costs listed in this report are only estimates. Project Developer is responsible for all actual costs, including any applicable direct or indirect taxes and/or gross-up, associated with Transmission Owner's installation of Transmission Owner's Facilities.

6.2 COST ESTIMATE FOR DEVELOPER-BUILD OPTION

None

7. MILESTONE SCHEDULE FOR COMPLETION OF AES OHIO WORK

Facilities outlined in this report are estimated to take 59 months to construct, from the time the Generation Interconnection Agreement is fully executed. This schedule is based on the ability to obtain outages to construct and test the proposed facilities and is subject to change.

Description	Start month	Finish month
Project Kickoff	1	1
Preliminary Engineering	1	4
Detailed Engineering	4	9
Procure Materials and Equipment	1	58
Permitting	49	54
Construction, non-Outage	55	58
Construction, Outage 1	58	59

Description	Start month	Finish month
Testing & Commissioning, Outage 1	59	59

8. ASSUMPTIONS IN DEVELOPING SCOPE/COST/SCHEDULE

Interconnection Construction Service Agreement or Generation Interconnection Agreement will be executed by the end of 2024, and the project start will be early in 2025.

Project developer will be responsible for all expenses to meet the AES Ohio Protection Requirements required for developer to connect to the AES Ohio system.

Project developer will be responsible for acquiring all new rights-of-way, easements and properties required for the project. The Project developer will also be responsible for the costs incurred to obtain the necessary state siting approvals, environmental and other permits required to construct the facilities.

AES Ohio will grant overhead easement rights to the project developer along a route associated with the alignment of the generator lead line from the PCO structure to AES Ohio's property line.

Outages can be scheduled as planned. Outage starts are based on long lead material availability and are subject to change. Outage durations are based on 5x10s. Note: no outages have been planned or scheduled as of this study date.

Transmission outages are typically not granted from June to September and are discouraged during extreme winter conditions. PJM and AES Ohio require 6 to 12-month notice for greater than 5-day and 30-day outages, respectively.

Project developer will provide location and orientation of their attachment facilities.

No delays due to funding, equipment or material delivery, environmental, regulatory, permitting, real estate, extreme weather, or similar events. Lead times for long lead equipment and material are subject to change. Schedule assumes 240-week lead time for breakers.

No significant sub-surface rock encountered during construction, and soil conditions are suitable for standard foundation installations.

Neither foundation nor structural analyses have been performed. Study assumes that no significant foundation or structural issues are present.

Existing AC and DC power systems are adequate for proposed remote end upgrades under normal and emergency conditions. Formal power studies will be conducted during detailed engineering to confirm.

Taxes are not required and have not been included.

9. METERING REQUIREMENTS

All metering needed for this interconnection project must meet the metering requirements stated in Appendix 2, section 8 of the AF1-282 GIA, and in PJM Manuals M01 and M14D. The details of

applicable metering requirements are given in the 'AES Ohio Interconnection Standards' posted on the PJM website.

The revenue metering shall be located at the Generating Facility's collector substation on the high side of the main power transformer. The metering data shall be electrically compensated to the Point of Interconnection (the take-off structure inside the new Lexington Substation fence). The revenue meter will be owned and maintained by the Project Developer. Revenue metering is to include KWH, KVARH and real time data (KW, KVAR) for the Project Developer's generating facility.

Check metering will be installed at the Point of Interconnection and will be owned and maintained by AES Ohio.

10. LAND REQUIREMENTS FOR INTERCONNECTION SUBSTATION

None.

11. ENVIRONMENTAL AND PERMITTING

The facility study included an environmental desktop review of the AF1-282 interconnection substation location:

39° 4'18.45"N 83°47'41.71"W

The environmental desktop review included the following resource agency databases for potential environmental conflicts: U.S. Fish and Wildlife Service (USFWS), U.S. Geological Survey (USGS) National Hydrological Dataset (NHD) and topo maps, Federal Aviation Administration, Federal Emergency Management Agency, Ohio Environmental Protection Agency (Ohio EPA), Ohio Department of Natural Resources (ODNR), Ohio Power Siting Board (OPSB), and Highland County.

The desktop review indicated no wetlands and no streams, no potential habitat for threatened/endangered species, and no floodplains within the project's limits of disturbance. A field visit and agency consultation is required to confirm no potential Waters of the US, sensitive species habitat, and to complete informal consultation with the USFWS related to the Migratory Bird Treaty Act (MBTA) and Bald And Golden Eagle Protection Act (BGEPA). This documentation will be required for Ohio Power Siting Board (OPSB) submission.

The Information for Planning and Consultation (IPaC) database indicated that "There are bald and/or golden eagles in your project area." An on-site habitat evaluation is recommended to complete informal consultation with the USFWS related to the MBTA and BGEPA. Due to the lack of potential habitat apparent from a desktop review, it is anticipated there will be no effect to bald and/or golden eagles. Costs have been included for informal consultation with USFWS to confirm no impacts to threatened or endangered species, and no effects to bald and/or golden eagles.

There also appear to be no trees on site, however if trees are to be cleared, a survey should be conducted to identify the presence of potentially suitable habitat for listed threatened and endangered bat species. It is recommended that any necessary tree clearing be conducted between October 1st and March 31st to avoid impacts to listed bat species.

The proposed project area is less than 1 acre of disturbance and will not require a National Pollutant Discharge Elimination System (NPDES) permit. Additionally, the project meets the OPSB criteria for a "Major utility facility" due to design capacity being greater than the 100kV threshold (Section 4906.01 of the Ohio Revised Code). Due to the need for OPSB filing, Cultural and Historic Resource

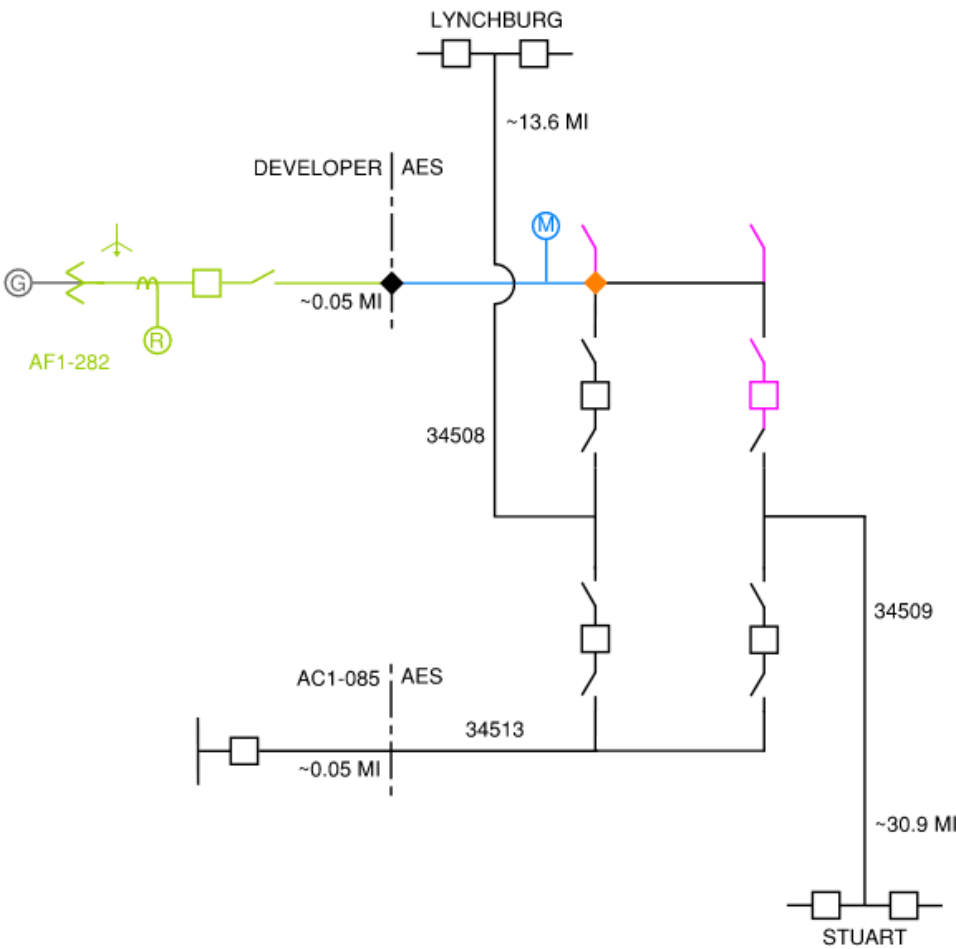
Consultation with State Historic Preservation Office (SHPO) will be required, and consultation with the USFWS and ODNR for threatened and endangered species will be required. Due to the location of this project within the footprint of an existing asset, the proposed project is not expected to require any additional Right-Of-Way or driveway access from any local roadways, so ROW access and work from roadway permits are not anticipated. However, a heavy haul permit may be required for travel to the site via ODOT roadways.

C. APPENDICES

Attachment #1:	Single line Diagram for the Physical Interconnection
Attachment #2:	Substation Location Plan
Attachment #3:	Generator Connection Requirements
Attachment #4:	Protection Requirements

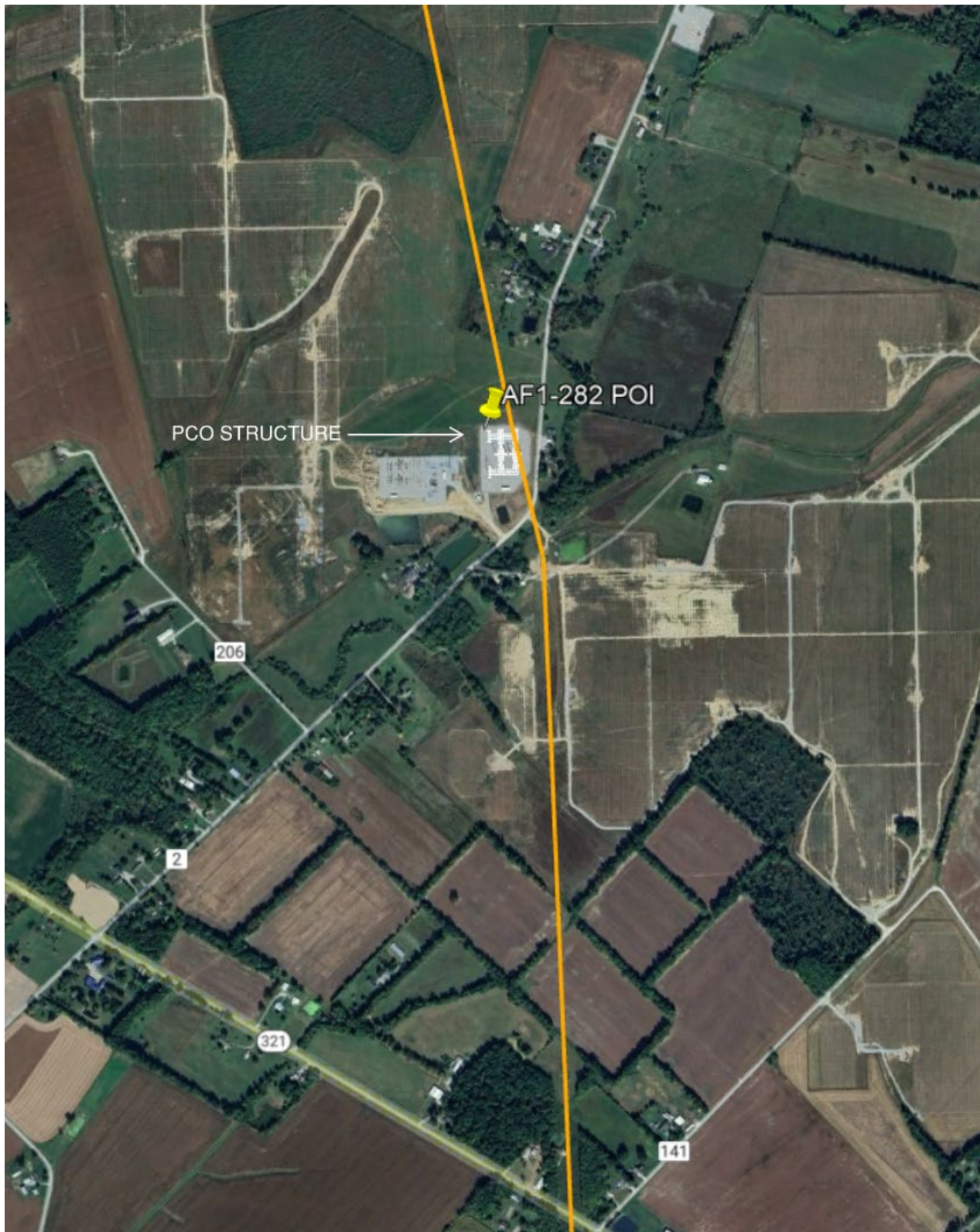
Single Line Diagram for the Physical Interconnection

AF1-282 CLAY SUBSTATION 345 KV



LEGEND	
PROJECT DEVELOPER INTERCONNECTION FACILITY	
TRANSMISSION OWNER INTERCONNECTION FACILITY	
NETWORK UPGRADE	
POINT OF INTERCONNECTION (POI)	
POINT OF CHANGE IN OWNERSHIP (PCO)	
REVENUE METER	
AES METER	

Substation Location Plan



Generator Connection Requirements

AES Ohio has prepared this “AES Ohio Interconnection Standards” document to ensure compliance with North American Electric Reliability Council (NERC) Reliability Standards and applicable Regional Reliability Organization, sub regional, Power Pool, individual Transmission Owner planning criteria and Facility Interconnection requirements in compliance to NERC Standard FAC-001-3. These connection requirements apply to all generation facilities, transmission facilities, and end-users connecting to the AES Ohio transmission system. The “AES Ohio Interconnection Standards” document can be reviewed utilizing the following link:

<https://www.pjm.com/planning/design-engineering/to-tech-standards/private-dayton.aspx>

Protection Requirements

The Project Developer will be required to comply with all AES Ohio System Relay and Protection Requirements. The System Relay and Protection Requirements may be found within the “AES Ohio Interconnection Standards” which can be reviewed at the following link:

<https://www.pjm.com/planning/design-engineering/to-tech-standards/private-dayton.aspx>

System Protection and Coordination

Generation facilities, transmission facilities, and end-user facilities connecting to the AES Ohio transmission system are responsible for determining that the proper protective equipment meet all applicable standards, it is properly installed, and it coordinates with AES Ohio relaying. Protective relaying systems and associated communications systems for all facility interconnections shall be planned, designed, constructed, and maintained in accordance with applicable NERC, RF, and PJM standards. Utility grade protective relays and fault clearing systems are to be utilized on the interconnected power system. Utility grade relays are defined as follows:

- Meet ANSI/IEEE Standard C37.90, Relays and Relay Systems Associated with Electric Power Apparatus.
- Have relay test facilities to allow testing without unwiring or disassembling the relay.
- Have appropriate test plugs/switches for testing the operation of the relay.
- Have targets to indicate relay operation.

The Developer must take responsibility for providing adequate system protection to its facilities and to AES Ohio's facilities under any transmission operating condition, whether or not their facilities are in operation. Conditions may include but are not limited to:

1. Single phasing of supply
2. System faults.
3. Equipment failures.
4. Abnormal voltage or frequency.
5. Lightning and switching surges.
6. Excessive harmonic voltages and/or currents.
7. Excessive negative sequence voltages
8. Separation from AES Ohio.
9. Synchronizing of generation to the AES Ohio system

AES Ohio reserves the right to specify functional specifications and relay settings deemed necessary to avoid safety hazards or to prevent any disturbance, impairment or interference with AES Ohio's ability to serve other customers. The criteria for these functional specifications and settings will be based on existing AES Ohio protection practices. AES Ohio reserves the right to specify the type and manufacturer for these protective relays to ensure compatibility with existing relays. AES Ohio will

make specific recommendations and requirements for protection based on the individual substation location, voltage and configuration.

For generation facilities, the relay protection system may be part of a self-contained generation control package. Additional relay protection may be required if testing or operational problems are encountered with this self-contained generation control package. AES Ohio shall review the interface protection and/or the self-contained protection schemes included with the generation before the unit will be permitted to connect to the AES Ohio system. The following relay functions are required from the Project Developer for protection of the AES Ohio system. Use of the transfer trip receiver is conditional as set forth below.

<u>Relay</u>	<u>Purpose</u>
Frequency	To detect under and over frequency operation and separate the customer's parallel generation.
Under/Over voltage	To detect under and over voltage operation and cause separation of the customer's parallel generation.
Transfer Trip Receiver	To receive a trip signal from a AES Ohio transfer trip transmitter and separate the customer's parallel generation.
Ground Detector	To detect a ground fault on the AES Ohio or customer system and separate the customer's parallel generation.
Directional Power	To detect a reverse power flow condition and separate the customer's parallel generation.

The purpose of these relays is to detect the generation owner's energizing of a AES Ohio circuit that has been isolated from the AES Ohio system, by circuit breaker or other disconnect device operations or detect the generation operating at an abnormal voltage or frequency, or to detect a fault or abnormal condition on the AES Ohio system thereby requiring the generation owner to separate their generation from the AES Ohio system. Output contacts of these relays shall directly energize the trip coil(s) of the generation breaker or an intermediate auxiliary tripping relay that directly energizes the breaker trip coil(s). The relaying system shall have a power source independent from the ac system or immune to ac system loss or disturbances (e.g., dc battery and charger) to assure proper operation of the protection scheme. Loss of this source shall cause removal of the generation from the AES Ohio system.

AES Ohio will specify settings for the generation's AES Ohio -required relays to ensure coordination between the generation protective equipment and the AES Ohio system relays. It is the generation owner's responsibility to determine that their internal protective equipment coordinates with the required AES Ohio protective equipment and is adequate to meet all applicable standards. AES Ohio reserves the right to modify relay settings when deemed necessary.

A transfer trip relaying system (or other not specified above) must be installed at the generation owner's expense if AES Ohio determines it is necessary to protect the transmission system. The transfer trip relaying system shall consist of all transfer trip transmitters located at AES Ohio facilities, transfer trip receivers at the generation facility and the communication channels between the AES Ohio location(s) and the generation facility.

Project Developer should also be familiar with the PJM Protection System Standards which can be found at the link below.

<http://www.pjm.com/-/media/documents/manuals/m07.ashx>