Facilities Study Report
For
Physical Interconnection of
PJM Generation Interconnection Request
Project ID AF2-126

"Sand Ridge 69 kV II"

Revision 1: December 2024

Introduction

This Facilities Study has been prepared in accordance with the PJM Open Access Transmission Tariff. The Transmission Owner (TO) is the American Transmission Systems, Inc (ATSI).

A. Transmission Owner Facilities Study Summary

1. PROJECT DESCRIPTION

The Project Developer (PD) has proposed an uprate to a planned/existing solar Generating Facility located in, Wood County, Ohio with a designated PJM Project ID of AF2-126.

This project is an increase to the AF1-064 project, and will share the same Point of Change in Ownership.

The AF2-126 project is a 12 MW uprate (8 MW Capacity uprate) to the previous project. The total installed facilities will have a capability of 62 MW with 41.4 MW of this output being recognized by PJM as Capacity.

2. POINT OF INTERCONNECTION (POI)

The Generating Facility will interconnect with the ATSI transmission system via a direct connection into the Sand Ridge 69 kV substation.

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

3. POINT OF CHANGE IN OWNERSHIP

The Point in Change of Ownership will be located within the Sand Ridge 69 kV substation where PD-owned 69 kV attachment line conductor for AF1-064 will terminate on the insulators on the dead-end takeoff structure.

4. SCOPE OF PROJECT DEVELOPER INTERCONNECTION FACILITIES

None.

B. Transmission Owner Facilities Study Results

The following is a description of the planned Transmission Owner facilities for the physical interconnection of the proposed AF2-126 project to ATSI transmission system. These facilities

shall be designed according to ATSI Applicable Technical Requirements and Standards. Once built, ATSI will own, operate, and maintain these Facilities.

1. TRANSMISSION OWNER INTERCONNECTION FACILITIES:

AF2-126 Project Developer Substation

- Integrate Interconnection Facilities protection and controls to the transmission system

2. STAND ALONE NETWORK UPGRADES

None.

3. NETWORK UPGRADES

Sand Ridge Substation

- Review/revise relay settings

Bowling Green No. 2 Substation

- Review/revise relay settings

Midway Substation

- Review/revise relay settings

Ayersville Substation

- Review/revise relay settings

4. OTHER SCOPE OF WORK

None

5. MILESTONE SCHEDULE FOR COMPLETION OF ATSI WORK

Facilities outlined in this report are estimated to take 10 months to construct, from the time the Generation Interconnection Agreement is fully executed. This schedule is may be impacted by the ability to obtain outages to test the proposed facilities.

Activity	Start Month	End Month
Preliminary Engineering	1	2
Detailed Engineering	3	7
Construction	10	10
Testing & Commissioning	10	10

6. ASSUMPTIONS IN DEVELOPING SCOPE/COST/SCHEDULE

6.1 Cost Estimate Assumptions:

- The cost estimates provided in this report were developed as of July 31, 2024, based upon current market conditions. Hence, they are subject to significant changes in the event that project implementation is delayed. Notwithstanding the cost estimates from this report being used in the Generator Interconnection Agreement for the related project, ATSI reserves the right to re-evaluate and provide a more accurate cost estimate during the implementation phase of the project. In accordance with section 217 of the Open Access Transmission Tariff, the Project Developer will be responsible for 100 percent of the actual costs of the facilities required to accommodate its Interconnection Request.
- ATSI reserves the right to charge the Project Developer operation and maintenance expenses to maintain the Project Developer attachment facilities, including metering facilities, owned by ATSI. These costs will be specified in the Generator Interconnection Agreement.
- No AMPT scope of work has been included in this report (See RTEP Supplemental s2827 for potential additional remote end relay setting review)

6.2 Schedule Assumptions:

- ATSI's ability to support this schedule also depends on the feasibility of taking the required outages to support construction. Outages that are determined to negatively impact system reliability or cause congestion may be delayed or denied, at any time, even if they are submitted on time based on the Outage Submittal Rules in section 4.2.1 of PJM Manual 03. This includes, but is not limited to, outages requested between the months of June and September, as well as January and March, which typically get denied due to summer and winter peak conditions. Therefore, the construction schedule will be adjusted as needed to accommodate any outage restrictions that have been identified by ATSI or the Transmission Provider.

7. REVENUE METERING REQUIREMENTS

All revenue metering needed for this interconnection project must meet the metering requirements stated in Appendix 2, section 8 of the AF1-064/AF2-126 GIA, and in PJM Manuals M01 and M14D. The details of applicable revenue metering requirements are given in the 'FirstEnergy Corporation Requirements for Transmission Connected Facilities' posted on the PJM website.

The revenue metering will be owned and maintained by the Project Developer.

The revenue metering system (particularly the revenue metering current transformers) shall be designed to accurately meter the light loads that will occur when the facility is not generating power and only back-feeding station service from the Transmission Owner. This may require the use of high accuracy extended range current transformers.

The revenue metering CTs and VTs shall be located on the transmission voltage side of the Project Developer's step-up transformer, on the generation side of the fault-interrupting device, and within the local zone of fault protection for the facility.

Transmission Owner will obtain real-time, site-specific, generation data from PJM, via the required communication link from Project Developer to PJM. Transmission Owner will work with PJM and Project Developer to ensure the generation data provided to PJM meets Transmission Owner's requirements.

Communications for transmission line protection between Sand Ridge substation, and Project Developer's generation (collector) substation, will be via fiber optics.

8. LAND REQUIREMENTS FOR INTERCONNECTION SUBSTATION

None

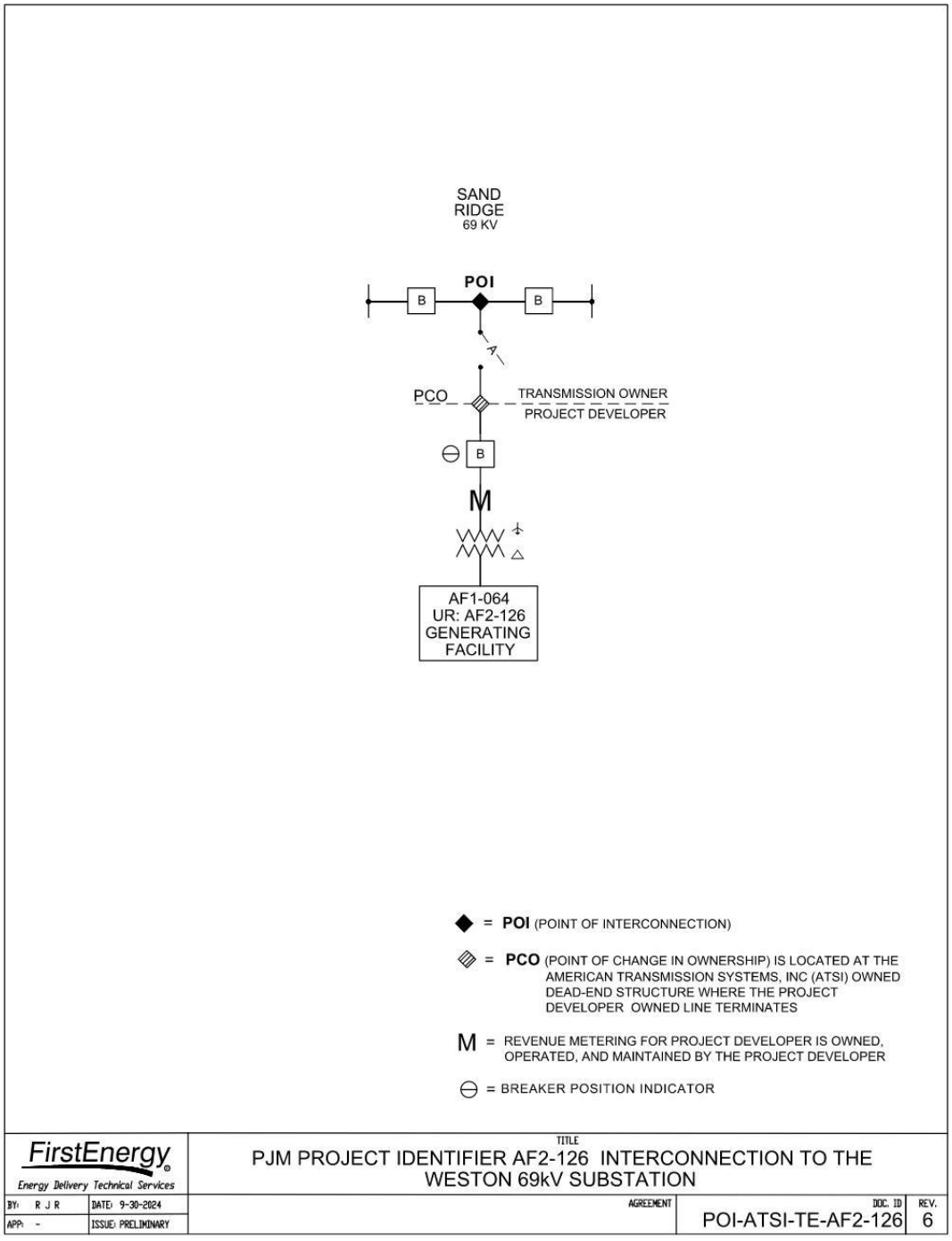
9. ENVIRONMENTAL AND PERMITING

None

C. APPENDICES

Attachment #1: Single line Diagram for the Physical Interconnection
Attachment #2: Substation General Arrangement
Attachment #3: Protection Study

Attachment #1: Single line Diagram for the Physical Interconnection



Attachment #2: Substation General Arrangement

Not Applicable

Attachment #3: Protection Study

Preliminary Transmission Protection Scope

AF2-126 Sand Ridge 69 kV II

Breaker Duty Analysis

A circuit breaker duty analysis was completed by PJM and verified by TO for the AF2-126 System Impact Study. The study was completed using the PJM supplied AF2-126 short circuit database. It was determined that no in-service TO owned breakers are overdutied and directly attributable to AF2-126.

Fiber Optic Communication Channels

Project Developer will design, install, own and maintain fiber optic communications between the AF2-126 generating substation and the existing 69 kV ring bus (Sand Ridge) substation to be used for line protection, direct transfer trip (DTT) and other communication.

Note that existing fiber from AF1-064 may be adequate to meet the requirements in this section, as AF2-126 will share the same point of interconnection as AF1-064.

AF2-126 Project Developer Generator Owner fiber requirements:

Existing 69 kV Ring Bus (TO) – AF2-126 Generating Station 69 kV – fiber provided by Project Developer generator owner
Eight (8) fibers (4 pairs) total [minimum number required for protection purposes only]

Project Developer will design, provide, install, own and maintain fiber optic communication channels between the 69 KV interconnection substation and the AF2-126 generation substation (to the point of interconnection with TO). Project Developer is responsible for obtaining and maintaining all associated Rights-of-Way (ROW), Easements, and Permits for its fiber cable.

Detailed Protection Requirements

Short Circuit Analysis

Short Circuit Values

Fault values for the 69 kV AF2-126 generator substation location with the new generation in service are:
Three-phase = 5.2 kA
Single line to ground = 3.5 kA

Z1 = (6.870 + j 13.880) %
Z0 = (6.557+ j 37.910) %

Impedances are on a 100MVA base.

Fault values are estimated from the latest received PJM Short Circuit base case. The faults provided are bolted, symmetrical values for normal system conditions. Future increases in fault currents are possible and it is Project Developer's responsibility to upgrade its equipment and/or protective equipment coordination when necessary.

General Connection Requirements

All proposed generation interconnection points and load-serving delivery points must comply with the technical requirements detailed in Transmission Owner's "Requirements for Transmission Connected Facilities" document. Procedures for gaining access to these standards can be found at the link below.

http://www.pjm.com/planning/trans-standard.html

Project Developer AF2-126 Generator & Substation Protection Requirements

Note that existing GSU relaying from AF1-064 may be adequate to meet the requirements in this section (based on the assumption that the AF2-126 GSU is being upgraded at the same point of interconnection as AF1-064).

The attached "Relay Sketch" (Figure 1A below) provides details of the relay requirements for the generation substation and is to be considered part of this Facilities Study Report. The requirements listed below are the minimum requirements to protect Transmission Owner's transmission system.

The proposed generating interconnection substation will have one (1) 69 kV line side breaker, one interconnection GSU. Also required for the GSU is a dedicated low-side breaker.

The transformer windings of the GSU shall be wye ground–delta (HV-LV) {existing or new if applicable}.

For the GSU, the minimum protective relaying requirements for this installation include primary and backup transformer differential (87T) relays, a transformer neutral time overcurrent relay (51G), and a breaker failure relay for the dedicated high side breaker. Acceptable relay models for each of the schemes are identified below, the use of any other relays will require prior approval from Transmission Owner.

SEL-587, SEL-387 and/or SEL-487E relays are acceptable for both applications of the required 87T functions. The 87T schemes shall trip the high side GSU transformer breaker and the transformer low side breaker to remove the transformer from service. A separate tripping path energizing separate breaker trip coils is required for primary and backup relaying.

The AC current source for the 87T relays shall be CTs on the bus side of the high side GSU circuit breaker and CTs from the low side GSU breaker. The low side CTs can be from either the GSU transformer or transformer breaker(s), depending on Project Developer's protection philosophy (see bus protection requirements below).

An SEL351 or SEL451 relay is acceptable for the 51G function(s). The 51G scheme shall trip the transformer breaker and the transformer low side breakers to remove the transformer from service with a dedicated tripping path.

A breaker failure relay (SEL-451 or SEL-501) shall be utilized on all the high side 69 circuit breaker(s). Any protective trip of the circuit breakers shall initiate the failure to trip scheme. The re-trip feature for the BFT scheme shall be utilized and trip the high side circuit breaker it protects. The high side 69 kV breaker failure scheme shall initiate trip & block close of all adjacent breakers via hand reset lockout relay (86). The line side interconnection circuit breaker at the station will also initiate direct transfer trip via line relaying to the corresponding remote ring bus substation (Sand Ridge). Local tripping shall be accomplished via hand-reset lockout relays.

For the 69 kV line exit to Sand Ridge ring bus, primary and backup line protection relays are required (note that the existing relays installed as part of AF1-064 project may be utilized for this purpose, provided they meet the requirements below). The primary and backup relays shall be a SEL-411Ls (two (2) relays) (usage of this particular model is required). Specific style numbers shall be provided by Transmission Owner at a later date (must match Transmission owner part # to ensure proper operation). AC sources for these schemes shall be CTs on the 69 kV breaker, located on the bus (GSU) side of the breaker, and CCVTs or PTs on the line side of the 69 kV line breaker. A separate tripping path energizing separate breaker trip coils is required for primary and backup relaying. The line relays shall communicate via dedicated multi-fiber, fiber optic communication channel(s) with the new Sand Ridge ring bus terminal line relays. Transmission Owner shall provide relay settings for these line relays at the cost of Developer.

The relaying systems shall have a reliable source of DC power independent from the AC system or immune to AC system disturbance or loss (for example - DC battery and charger) to assure proper operation of the protection scheme.

The Project Developer shall provide utility-grade relays for protection of the Transmission System, including time delay and auxiliary relays. Relay operation for any of the listed functions that are required shall initiate immediate separation of the parallel generation from the Transmission System:

Relay	Function
Frequency	To detect underfrequency and overfrequency operation.
Overvoltage	To detect overvoltage operation.
Undervoltage	To detect undervoltage operation.
Ground Fault Detector	To detect a circuit ground on the Transmission System.
Phase Fault Detector	To detect phase to phase faults on the Transmission System.
Transfer Trip Receiver	To provide tripping logic to the generation owner for isolation of the generation upon opening of the TO supply circuits.
Directional Power	To detect, under all system conditions, a loss of TO primary source. The relay shall be sensitive enough to detect transformer magnetizing current supplied by the generation
Breaker Failure	To detect a stuck breaker condition at the generation substation and 1-send a trip signal to the remote ends of the connected line via transfer trip or 2-to trip a high-speed ground switch.

The Project Developer will be required to comply with all TO Generation Protection Requirements for Generation Interconnection. The Generation Protection Requirements may be found with the "FirstEnergy Requirements for Transmission Connected Facilities" document located at the following links:

www.firstenergycorp.com/feconnect

www.pjm.com/planning/design-engineering/to-tech-standards.aspx

All relays, relay schemes and relay settings that include bulk electric system 69 kV voltages or currents or trip any 69 kV circuit breakers shall require the review and approval of Transmission Owner. It is required that Transmission Owner review and approve all one-line diagrams and AC and DC schematics showing these relays and their respective inputs, outputs and tripping paths.

It is required that these documents be sent electronically to Transmission Owner at least ninety (90) days prior to the planned in-service date.

Transmission Owner will complete detailed relay coordination studies to identify off-site relay setting changes required due to this generation interconnection. This may result in additional individual relay replacements being required (most likely an electromechanical ground relay due to a range issue). These relay replacements will be done at the cost of Project Developer.

Project Developer is solely responsible for protecting its own equipment in such a manner that electrical faults or other disturbances on the Transmission Owner system do not damage its equipment.

Should the developer elect to utilize the same GSU relays already applied for AF1-064, a refresh of the developer GSU settings will likely be necessary and will still be subject to final review by the Transmission owner.

Transmission Owner System Modifications

Sand Ridge ring bus substation

Evaluate line relay settings for all exits out of Sand Ridge ring bus (determine if any impact from project due to any change in short circuit characteristics.

Midway Substation

Evaluate line relay settings for exit to Sand Ridge ring bus (determine if any impact from project due to any change in short circuit characteristics.

Bowling Green #2 Substation

Evaluate line relay settings for exit to Sand Ridge ring bus (determine if any impact from project due to any change in short circuit characteristics.

Ayersville Substation

Evaluate line relay settings for exit to Sand Ridge ring bus (determine if any impact from project due to any change in short circuit characteristics

Metering and SCADA Requirements

A revenue metering installation is required for this installation. Requirements are outlined in Transmission Owner's "Requirements for Transmission Connected Facilities" document.

Operational metering is also required for generation connections. These requirements are also outlined in Transmission Owner's "Requirements for Transmission Connected Facilities" document.

These requirements are in addition to any metering required by PJM.

Refer to following links:

www.firstenergycorp.com/feconnect

www.pjm.com/planning/design-engineering/to-tech-standards.aspx

Relay Sketch