Generation Interconnection Facilities Study Report

For

PJM Transmission Interconnection Request Queue Position AE1-079

"Maysville-Sharon 69 kV"

January 2022

Table of Contents

Contents

Preface

The intent of the Facility Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

In some instances, an Interconnection Customer may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection or merchant transmission upgrade, may also contribute to the need for the same network reinforcement.

The Facility Study estimates attempt to identify the estimated time required to obtain property rights and permits for construction of the required facilities. The project developer is responsible for the right-of-way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

A. Transmission Owner Facilities Study Summary

1. Description of Project

ReneSola Power Holdings, LLC, (hereinafter referred to as "IC") has proposed a 19.9 MW solar/ storage generating facility to be located in West Salem Township, Mercer County, Pennsylvania. The installed facilities for AE1-079 will have a total Maximum Facility Output (MFO) of 19.9 MW with 13.5 MW of this output being recognized by PJM as Capacity. The generation facility will interconnect with American Transmission Systems, Incorporated (ATSI) distribution system, a FirstEnergy Company (FE), hereinafter referred to as "Transmission Owner" (TO), by interconnecting with the Maysville – Sharon 69 kV line and constructing a one-span tap. The transmission line tap will be located approximately 1.25 miles from Maysville substation.

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

There were no notable amendments since the System Impact Study.

3. Interconnection Customer's Milestone Schedule

IC's expected Commercial Operation Date (COD) for the generation facility is December 31, 2023.

Milestone Schedule:

06/31/2023	Initial Back-feed through Project Substation Date
12/31/2023	Project Commercial Operation Date

4. Customer's Scope of Work

IC is responsible for all design and construction related to activities on their side of the Point of Interconnection (POI). This includes, but is not limited to, the generation step-up (GSU) transformer, 69 kV (AE1-079) generator lead line and connection to the tap point on the Maysville – Sharon 69 kV line.

Point of Interconnection (POI): The interconnection of the project will be accomplished by tapping the Maysville – Sharon 69 kV line and constructing a one-span tap. The transmission line tap will be located approximately 1.25 miles from Maysville substation. The project will also require non-direct connection upgrades at Maysville and Sharon substations.

FirstEnergy shall, at the IC's expense, provide, own, operate, test and maintain the revenue metering equipment at the generation facility's step-up substation. The IC shall, at its own expense, install the FE-owned revenue metering equipment at the step-up substation. IC is required to own, install, and maintain a fully-rated, fault-interrupting circuit breaker on the high-side of the GSU transformer. The revenue metering current and voltage transformers shall be installed on the high voltage side of the GSU, on the generation side of the fault-interrupting device, and within the local zone of fault protection for the facility. The protective relaying and metering design must comply with FirstEnergy's applicable standards as well as with PJM requirements.

The easements and associated rights of way for the TO owned substation along with the 69 kV line taps to the substation will be acquired by the IC and transferred to the TO at no cost. Site preparation for the TO owned substation, including clearing, grading and an access road, as necessary, is assumed to be by the IC. The access road design must be approved by FirstEnergy to ensure it provides adequate access to the substation to support construction and maintenance activities. 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.

Assumptions / Notes:

- IC will coordinate design and alignment of proposed 69 kV generator lead line with the Transmission Owner for review of any clearance, right-of-way or right-of-way encroachment issues with TO owned facilities.
- IC will coordinate design and construction of proposed 69 kV lead line. For these areas, the IC shall provide TO with proposed drawings prior to construction and as-built drawings, confirmed by as-built survey data post-construction.
- Transmission Owner's preference would be to limit interference and avoid transmission line crossings with new 69 kV terminal positions. As a minimum, IC facilities should not encroach within 100 feet of TO centerline at blowout conditions. If IC's line design does not comply with this requirement TO would need to review this area as a special exception.
- Additional costs will be incurred by the IC, if final alignment of the 69 kV generator lead line causes encroachments, changes, or modifications to any existing or relocated TO facilities.
- IC is responsible to make all arrangements for electric distribution service (if required) for its generation station. No costs or schedule are included herein.
- All new generator only and new generator plus load facilities must be isolated from the FE Transmission System by a Power Transformer. The winding configurations of the transformer connecting to a non-effectively grounded portion of the FE Transmission system shall be determined by FE on a case-by-case basis.

5. Description of Facilities Included in the Facilities Study

Attachment Facilities

- AE1-079 Generator Lead Termination (New line tap on Maysville – Sharon (Y-301) 69 kV line)
  - Install one span of the tap line to the point of interconnection for the customer facility.
- Metering
  - First Energy owned 69 kV revenue metering at AE1-079 generation facility.

Direct Connection

- SCADA/Fiber Communication
  - Estimated installation of 700 MHz radio systems (70% penetration of FE territory) to support the SCADA switch replacements.

- Project Management
  - Project Management, Commissioning, Environmental, Forestry, Real Estate, and Right of Way.

Non-Direct Connection

- AE1-079 Generator Lead Termination (New line tap on Maysville – Sharon (Y-301) 69 kV line)
  - Tap the Maysville – Sharon (Y-301) 69 kV line near structure 62
  - Install two (2) 2000 A line switches with SCADA (one on each side of the new tap structure)

- Sharon 69 kV Substation
  - Relay settings changes

- Maysville 69 kV Substation

- Relay settings changes

- Masury 69 kV Substation
  - Relay settings changes

- Cedar Street 69 kV Substation
  - Relay settings changes

- McDowell 69 kV Substation
  - Relay settings changes

- Dilworth 69 kV Substation
  - Relay settings changes

Other work

- AE1-079 Customer Substation
  - Review nameplates, drawings, and add to the HV circuit diagram

New System Upgrades

None.

6. Total Cost of Transmission Owner Facilities Included in the Facilities Study

Description	Total (w/o Tax)	Tax (if applicable)	Total Cost (w/Tax)
Attachment Facilities:	**$ 300,740**	**$ 39,613**	**$ 340,353**
Total Direct Connection (DC) Costs:	**$ 103,300**	**$ 13,500**	**$ 116,800**
Total Non-Direct Connection (NDC) Costs:	**$ 1,748,560**	**$ 228,287**	**$ 1,976,847**
Other Costs	**$30,200**	**$4,000**	**$34,200**
New System Upgrades	**$ 0**	**$ 0**	**$ 0**
TOTAL Costs (ALL Categories)	**$ 2,182,800**	**$ 285,400**	**$ 2,468,200**

7. Summary of the Schedule for Completion of Work for the Facilities Study

Attachment Facility	*Duration*

AE1-079: Engineering, Procurement, and Construction	14 months

B. Transmission Owner Facilities Study Results

This section describes facilities identified to be installed (attachment facilities), replaced, and/or upgraded (upgrade facilities) by FirstEnergy to accommodate the project. During detailed design and analysis other components may be identified for installation or replacement due to this interconnection.

1. Transmission Lines –New

None.

2. Transmission Lines – Upgrade

Maysville – Sharon (Y-301) 69 kV Line

- Install one span of the tap line on the Maysville-Sharon 69kV (Y-301) line near structure 62 to the point of interconnection for the customer facility and install two 2000A line switches with SCADA, one on each side of new tap structure.
- Existing Maysville-Sharon 69kV structures are double circuit steel towers.
- The existing conductor is 477 kcmil ACSR and shielded with (1) 7#7 Copperweld with a ruling span of 939 feet.
  - Plan and Profile shows 477 kcmil ACSR for an adjacent line section while TAMI shows 266.8 kcmil ACSR. Assume 477 kcmil is the existing conductor for the entire line.
  - Shield wire is shared with the Maysville-Sharon 69kV line (Y-81/Y-299).
- Install steel monopole tap structure and deadend structure between structure 61 and structure 62.
  - Maysville-Sharon 69kV line (Y-301) will be custom single circuit 2000A switch structures with SCADA.
  - Maysville-Sharon 69kV line (Y-81/Y-299) will be a single circuit deadend steel monopole structure.
- Replace existing structure 61 and structure 62 with two-pole structures
  - Existing structure 61 and structure 62 are 50’ steel lattice towers.
  - Maysville-Sharon 69kV line (Y-301) will be custom single circuit 2000A switch structures with SCADA.
    - Assume switch breaking devices are vacuum bottles.
  - Maysville-Sharon 69kV line (Y-81/Y-299) will be single circuit deadend steel monopole structures.
- Assume existing conductor and shieldwire will be re-used in the span from structure 61 to structure 62.
- Install 795 kcmil 26/7 ACSR on tap line to customer point of interconnection, shielded with a single 3#6 Alumoweld.
  - Assume shield wire is 3#6 Alumoweld and OPGW is not required.
  - Assume span length is 400 feet.
  - Tap line route is unknown.
- Siting/ Licensing

        - Letter of Notification will be required to be filed with the PaPUC.
        - Assume there will be no local opposition to the project.
        - Assume there will be minimal social/ecological impacts.
    - Assumptions
        - New LiDAR will be required for the tap line.
        - Assume adjacent structures are in good condition and have adequate capacity for new wire loads. An engineering analysis will be required to confirm.
        - A structure condition assessment will be required to identify any structures requiring repair or replacement due to condition.
    - Fiber (Relaying and Communications)
        - None
    - SCADA/Other
        - SCADA for 2 line switches
    - Distribution
        - Power source will be required for new SCADA control at the switches.
    - Real Estate
        - New ROW will be required for the new tap line.
        - A rights and restrictions review by Real Estate will be required.
            - Georeferenced ROW extents will be required to be provided to Engineering.
    - Environmental
        - An environmental review will be required to identify any construction constraints or additional permitting requirements.
    - Forestry
        - Clearing will be required on the new tap line.
        - Terrain is flat in the area. Access roads will be required for 400-foot tap line.

3. New Substation/Switchyard Facilities

AE1-079 Customer substation

- Below Grade
    - None
- Above Grade
    - Review one-line, nameplates, and add to HV circuit diagram
- R&C
    - None
- Additional Equipment to be Removed
    - None
- Assumptions
    - Customer has 69 kV ground switch protection with BFT of primary fault protection device.

Revenue Metering

- Revenue metering located at customer substation

4. Substation/Switchyard Facility Upgrades

Sharon Substation

- Below Grade
    - None
- Above Grade

        - None
    - Relay & Communications (R&C)
        - Relay settings changes
    - Assumptions
        - None

Maysville Substation
    - Below Grade
        - None
    - Above Grade
        - None
    - Relay & Communications (R&C)
        - Relay settings changes
    - Assumptions
        - None

Cedar Street Substation
    - Below Grade
        - None
    - Above Grade
        - None
    - Relay & Communications (R&C)
        - Relay settings changes
    - Assumptions
        - None

McDowell Substation
    - Below Grade
        - None
    - Above Grade
        - None
    - Relay & Communications (R&C)
        - Relay settings changes
    - Assumptions
        - None

Masury Substation
    - Below Grade
        - None
    - Above Grade
        - None
    - Relay & Communications (R&C)
        - Relay settings changes
    - Assumptions
        - None

Dilworth Substation
    - Below Grade
        - None
    - Above Grade
        - None
    - Relay & Communications (R&C)

- Relay settings changes
- Assumptions
  - None

Fiber (Relaying and Communications)
- None

SCADA/Other
- Add SCADA to EMS

5. Telecommunications Facilities – Upgrades

The AE1-079 generation (collector) substation will be connected directly to an existing line within FirstEnergy's transmission system without a dedicated Transmission Owner interconnection substation and will therefore not require MPLS communications.

6. Metering & Communications

FirstEnergy shall, at the IC's expense, provide, own, operate, test and maintain the revenue metering equipment at the generation facility's step-up substation. The IC shall, at its own expense, install the FE-owned revenue metering equipment at the step-up substation.

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 will require the use of high accuracy extended range current transformers.

Transmission Owner's Revenue Metering Requirements may be found FirstEnergy Corporation Requirements for Transmission Connected Facilities dated August 6, 2021 document located at the following links:

www.firstenergycorp.com/feconnect

https://www.pjm.com/-/media/planning/plan-standards/private-fe/fcr-facilities-connection-requirements.ashx

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

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

7. Environmental, Real Estate and Permitting

The following are possible environmental, real estate and permitting issues:

- Environmental permitting, Real Estate acquisition, and Pennsylvania Public Utility Commission (PaPUC) notifications vary, some up to twelve (12) months after preliminary engineering is completed to secure the required approvals.
- Prior to agreement by Developer to purchase the property, a Phase 1 Environmental Assessment should be conducted for the entire site to avoid assumption of environmental liabilities by Developer or Transmission Owner.
- The Transmission Owner interconnection substation may involve environmental surveys, permits, approvals and plans with federal, state, and/or local agencies.
- Assumed Developer is to provide all access rights, easements, ROW and permits necessary to complete the Project to the satisfaction of Transmission Owner. Environmental permitting shall encompass all federal, state and local requirements, consultations and agency coordination. Confirmation of meeting all permitting requirements shall be provided to Transmission Owner, prior to start of construction. Following construction and energization, confirmation of permit closeout shall be provided to the satisfaction of Transmission Owner, prior to transfer of ownership. If any of these elements are not included in the final agreement between Transmission Owner and Developer, twelve (12)-to-eighteen (18) months should be added to the Project Schedule to secure necessary permits, and additional costs would apply.
- Developer will provide copies of all of the relative environmental permits and other necessary approvals to Transmission Owner before Transmission Owner accepts the interconnection facilities.
- Developer is required to install an access road from the new interconnection substation to the nearest public road (must be approved by Transmission Owner) and obtain access rights for Transmission Owner. Developer is responsible to maintain access road and ensure unimpeded access for Transmission Owner at all times.
- Developer is responsible for all property acquisition (including easements/rights-of-way (ROW)) for transmission, distribution and communication facilities needed for the generator interconnection.
- If Developer owns the project property, in fee title, Transmission Owner will require a fee property transfer for the interconnection substation site which may require subdivision approval, together with permanent access rights to and from the substation, as well as a perpetual easement for any transmission lines to the substation. Developer is responsible for all costs, including but not limited to subdivision, associated with the property transfer.
- If Developer leases the project property, the Developer will be required to obtain fee property from the underlying fee property owner, on behalf of Transmission Owner, for the interconnection substation site, together with permanent access rights to and from the substation, as well as a perpetual easement for any transmission lines to the substation.
- All property rights must be surveyed and metes and bounds descriptions prepared for incorporation into Transmission Owner's document forms, for transfer of title.
- The Transmission Owner interconnection substation and transmission line loop will involve Pennsylvania Public Utility Commission (PaPUC) notifications notification/approval.
- All work occurs within an existing transmission line right-of-way or on Developer's property with access to all existing structures possible via that property and the right-of- way following established access routes that do not cross wetlands or streams.
- Developer will develop, and secure regulatory approval for, all necessary Erosion and Sediment Control (E&SC) plans and National Pollutant Discharge Elimination System (NPDES) permits.
- Developer will obtain all necessary permits.
- Developer will conduct all necessary wetlands and waterways studies and permits.
- Developer will conduct all necessary historical and archaeological studies.
- If the Developer plans to cross the transmission line right of way with facilities or access roads, please refer to the Transmission Rights-of-Way Restrictions information located at:

https://www.firstenergycorp.com/help/safety/real-estate-power-lines/transmission-right-of-

way.html#ROWform

8. Summary of Results of Study

Description	Total Cost (w/o Tax)	Tax (if applicable)	Total Cost (w/ Tax)
Attachment Facilities			
AE1-079 Generator Lead Termination: Install one span of the tap line on the Maysville – Sharon 69 kV (Y-301) line near structure 62 to the point of interconnection for the customer facility	$ 298,240	$ 39,213	$ 337,453
AE1-079 Metering: 69 kV revenue metering at AE1-079 facility.	$ 2,500	$ 400	$ 2,900
Total Attachment Facilities (AF) Costs	$ 300,740	$ 39,613	$ 340,353
Direct Connect Facilities			
SCADA/ Fiber Communication: Estimated installation of 700 MHz radio system (70% penetration of FE territory) to support the SCADA switch replacements. Assumed SCADA work is included in this cost.	$ 103,300	$ 13,500	$ 116,800
Total Direct Connect (DC) Costs	$ 103,300	$ 13,500	$ 116,800
Non-Direct Connect Facilities			
Maysville-Sharon 69 kV Tap : Tap the Maysville-Sharon 69 kV (Y-301) line near structure 62 and install disconnect switches on either side of the tap. Includes project management, environmental, forestry, real estate and right of way.	$ 1,192,960	$ 155,687	$ 1,348,647
Sharon Substation: Relay setting changes	$ 92,600	$ 12,100	$ 104,700

Maysville Substation: Relay setting changes	$ 92,600	$ 12,100	$ 104,700
Masury Substation: Relay setting changes	$ 92,600	$ 12,100	$ 104,700
Cedar Street Substation: Relay setting changes	$ 92,600	$ 12,100	$ 104,700
McDowell Street Substation: Relay setting changes	$ 92,600	$ 12,100	$ 104,700
Dilworth Substation: Relay setting changes	$ 92,600	$ 12,100	$ 104,700
Total Non-Direct Connect (NDC) Costs	$ 1,748,560	$ 228,287	$ 1,976,847
Other Work			
AE1-079 Customer Substation: Review nameplates, drawings, and add to HV circuit diagram.	$ 30,200	$4,000	$ 34,200
Other Work	$ 30,200	$4,000	$34,200
Total AF + DC + NDC+ Other Costs	$ 2,182,800	$ 285,400	$ 2,468,200

Generation projects meeting IRS "Safe Harbor" provisions generally do not incur "CIAC" (Contribution in Aid to Construction), a tax collected by the utility for the state or federal government. First Energy does not expect to collect CIAC for this project. If for any reason, "CIAC" would be required for this project, it would be the responsibility of the party owning the generator to pay this cost.

First Energy reserves the right to charge the Interconnection Customer operation and maintenance expenses to maintain the Interconnection Customer attachment facilities, including metering facilities, owned by First Energy.

9. Schedules and Assumptions

A proposed **14 month Direct Connection** schedule is estimated to complete the engineering, construction and the associated activities, from the date of a fully executed Interconnection Construction Service Agreement and Construction Kick-Off Meeting. This schedule assumes that all issues covered by the "Environmental, Real Estate and Permitting Issues" section of this document are resolved, and outages (typically not granted from June through September) will occur as planned. Construction cannot begin until after all applicable permits and/or easements have been obtained.

14 month Schedule

Activity	Start Month	End Month
[redacted]		

Preliminary Engineering	1	3
Siting, Permits & Real Estate	3	7
Detailed Engineering	4	7
Equipment Delivery	8	8
Below Grade Construction – Substation	9	9
Below Grade Construction – T-Lines	9	11
Above Grade Construction – Substation	11	11
Above Grade Construction – T-Lines	10	12
Testing & Commissioning	13	14

10. Information Required for Interconnection Service Agreement

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
AE1-079 Generator Lead Termination (Maysville – Sharon (Y301) 69 kV Line Tap): Install one span of the tap line on the Maysville – Sharon 69 kV (Y-301) line near structure 62 to the point of interconnection for the customer facility.	$ 211,700	$ 19,040	$ 66,280	$ 1,220	$ 298,240
AE1-079 Metering: 69 kV revenue metering at AE1-079 facility.	$ 1,900	$ 0	$ 600	$ 0	$ 2,500
Total Attachment Facilities Cost	**$ 213,600**	**$ 19,040**	**$ 66,880**	**$ 1,220**	**$ 300,740**
SCADA/ Fiber Communication: Estimated installation of 700 MHz radio system (70% penetration of FE territory) to support the SCADA switch replacements. Assumed SCADA work is included in this cost.	$ 68,200	$ 13,000	$ 21,300	$ 800	$ 103,300
Total Direct Connection Cost	**$ 68,200**	**$ 13,000**	**$ 21,300**	**$ 800**	**$ 103,300**
Maysville-Sharon 69 kV Tap Tap the Maysville-Sharon 69	$846,800	$76,160	$265,120	$4,880	$1,192,960

kV (Y-301) line near structure 62 and install disconnect switches on either side of the tap. Includes project management, environmental, forestry, real estate and right of way.					
Sharon Substation: Relay setting changes	$ 70,500	$ 0	$ 22,100	$ 0	$ 92,600
Maysville Substation: Relay setting changes	$ 70,500	$ 0	$ 22,100	$ 0	$ 92,600
Masury Substation: Relay setting changes	$ 70,500	$ 0	$ 22,100	$ 0	$ 92,600
Cedar Street Substation: Relay setting changes	$ 70,500	$ 0	$ 22,100	$ 0	$ 92,600
McDowell Street Substation: Relay setting changes	$ 70,500	$ 0	$ 22,100	$ 0	$ 92,600
Dilworth Substation: Relay setting changes	$ 70,500	$ 0	$ 22,100	$ 0	$ 92,600
Total Non-Direct Connection Cost	**$ 1,269,800**	**$ 76,160**	**$ 397,720**	**$ 4,880**	**$ 1,748,560**
AE1-079 Customer Substation: Review nameplates, drawings, and add to HV circuit diagram.	$ 23,000	$ 0	$ 7,200	$ 0	$ 30,200
Total Other Costs	**$ 23,000**	**$ 0**	**$ 7,200**	**$ 0**	**$ 30,200**
Total Project Costs	**$ 1,574,600**	**$ 108,200**	**$ 493,100**	**$ 6,900**	**$ 2,182,800**

Attachment #1: Protection Study

PROTECTION/ RELAYING AND COMMUNICATION EQUIPMENT SCOPE

Short Circuit Analysis

Short Circuit Values

The preliminary 69kV fault values at the AE1-079 interconnection location are:

Three phase = 9.5kA
Single line to ground = 8.2kA
Z1= (1.9 + j 8.4)%
Z0= (3.0 + j 12.3)%

These values are provided for bolted, symmetrical faults under anticipated normal system conditions and are provided on a 71.07kV, 100MVA base. Future increases in fault currents are possible and it is the customer's responsibility to upgrade their equipment and/or protective equipment coordination when necessary.

Protection Requirements

The AE1-079 facility, consisting of inverter-based PV and battery storage connecting as a tap off the Maysville-Sharon Y-301 69kV line, shall not supply fault current to the FE system. The developer will need to provide information on the inverters and show that they meet the requirements of UL 1741 certification for anti-islanding protection. Under no circumstances would the customer be permitted to energize the FirstEnergy line without a FirstEnergy source.

Generation facilities that comply with IEEE-1547 and are UL1741 certified or that provide documentation by a third-party testing organization of successful testing of the proposed inverter equipment in accordance with IEEE-1547.1 that are connected to the FE Transmission below 100 kV are required to have intertie relaying installed.

Scope and cost estimates supplied assume that that the AE1-079 facility will meet the requirements as stated above, but documentation must be supplied to FirstEnergy to verify inverters meet these standards. Additional upgrades to the transmission system, including but not limited to the addition of fiber cable and direct transfer trip equipment, would otherwise be required at the expense of the generator.

AE1-079 69kV Station

Main 69/34.5kV Transformer

- As inverter-based generation tapped to the FE Transmission System at <100kV, the interconnecting transformer shall have a delta or ungrounded wye winding on the transmission (69kV) side of the

transformer.

- One 69kV, three-phase circuit breaker will be required on the FE side of the customer's main 69/34.5kV delta/wye grounded transformer.
    - The circuit breaker shall be fully rated to interrupt available fault current when calculated according the latest ANSI standard.
    - Bypass switches shall NOT be installed across the breaker. If the customer desired the added reliability benefit of being able to keep the substation energized while performing breaker maintenance, a ring bus or dedicated sparing circuit breaker is required.
    - If the circuit breaker uses gas as an interrupting medium, the device shall be equipped with a low gas pressure alarming/tripping/lockout scheme (as appropriate for the particular device) in order to minimize the possibility of a transmission fault resulting from a loss of insulating gas.
- The circuit breaker should have a high-side motor operator air-break switch and spring-operated ground switch.
- The interconnecting transformer and all 69kV facilities at the customer substation shall have redundant, high-speed protection inclusive of the 69kV breaker and high-side metering and shall trip, at minimum, this breaker. Separate CTs and tripping paths are required between the primary and backup relaying. Dual, high-speed, overlapping differential relaying is required on both the interconnecting transformer and low-side 34.5kV bus.
    - Primary Transformer Differential Protection Relay – minimum functions: 87TP. (FE standard device is SEL-587 or SEL-487E)
        - The 69kV source for primary transformer differential protection shall be CTs on the utility source side of the transformer breaker. The low side source for primary differential protection shall be either CTs on the bus side of the low side transformer breaker or 34.5kV bus breakers.
        - Separate Tripping paths are required for Primary and Back up differential relay.
    - Backup Transformer Differential Protective Relay - minimum functions: 87TB. (FE standard device is SEL-587 or SEL-487E)
        - The 69kV source for backup transformer differential protection shall be CTs on the utility source side of the transformer breaker separate from the primary differential relay. The low side source for backup differential protection shall be CTs on the bus side of the low side transformer breaker or 34.5kV bus breakers separate from the primary differential relay.
        - Separate Tripping paths are required for Primary and Back up differential relay.
    - Breaker Failure (BF) Relay - BF with associated hand-reset lock out relay (LOR). Also required are an automatic motor-operated disconnect switch and a ground switch which operate for a breaker failure condition in order to trip the breakers at the remote terminals and isolate the failed breaker from the transmission system. (FE standard device is SEL-501 or SEL-451-5)
- CTs used for the zones of protection covering the high voltage portion of their system shall use C800 or C400 relay accuracy CTs. These CTs should not saturate for the maximum through-fault current that can be experienced by the relay for the tap ratio in use.
- The relaying system shall have a reliable source of power independent from or immune to disturbances/loss of the AC system (e.g. DC battery and charger) to ensure proper operation of the protection schemes and tripping of the circuit breakers.

- The customer will be required to coordinate with upstream protection. It is solely the customer's responsibility to install and design their relaying to ensure adequate protection of their equipment.
- Detail one-line diagrams with proposed protection should be provided well in advance of design and engineering to allow for approval of the protection scheme and preliminarily validate coordination with FE system.

69kV Intertie Relaying

- Dual, SEL-351-7 intertie relays to trip the 69kV breaker. These relays are independent of the step-up transformer protection. These relays provide the following functions: overfrequency, underfrequency, phase and ground overvoltage, phase undervoltage, directional overcurrent, and directional power.
- The CTs for the intertie relays shall be sourced from the transformer-side of the 69kV breaker independent from each other
- The potential source for the intertie relays shall be located between the 69kV breaker and transformer and shall be independent secondary windings.
- Separate tripping paths are required between the intertie relays.

Generator Owner's System Protection

- The generator owner (GO) is to design their protective system to clear any fault within their zones of protection with one or more of their local breakers.

The Connecting Party shall provide utility-grade relays for protection of the FE Transmission System. FE shall approve all relays specified for the protection of the FE 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 FE 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 FE Transmission System.
Phase Fault Detector	To detect phase to phase faults on the FE Transmission System.
Transfer Trip Receiver	To provide tripping logic to the generation owner for isolation of the generation upon opening of the FE supply circuits.
Directional Power	To detect, under all system conditions, a loss of FE primary source. The relay shall be sensitive enough to detect transformer magnetizing current supplied by the generation.

The Interconnection Customer will be required to comply with all FE Generation Protection Requirements for Generation Interconnection Customers. The Generation Protection Requirements may be found within 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

FE System Modifications

System modifications may be required to make settings changes and/or replace existing relays at FirstEnergy remote substation. Customer relaying will be required to coordinate with upstream transmission system protection.

Circuit Breaker Adequacy

- PJM does not identify any new breakers as overdutied by this project

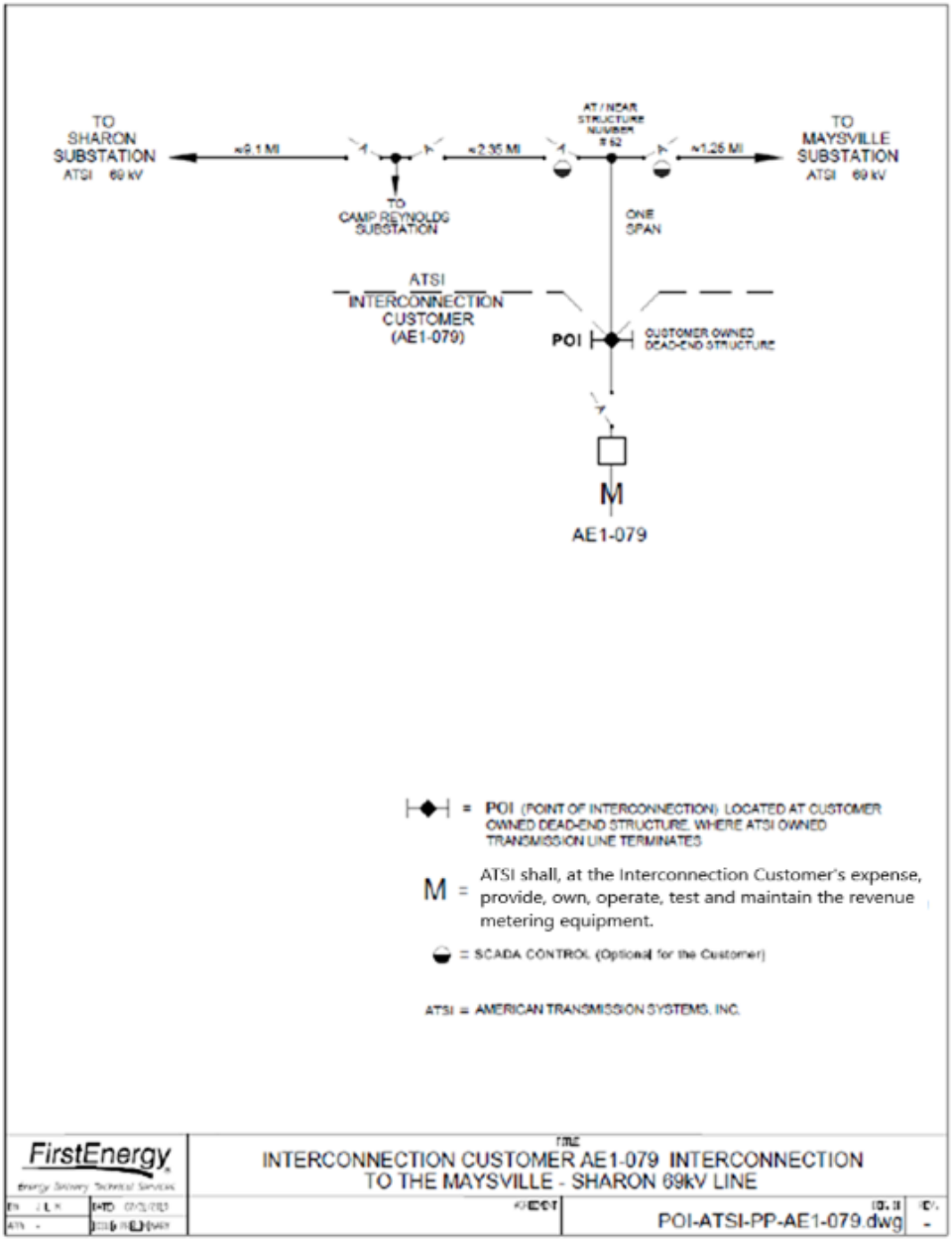
Settings Changes

Settings changes are possible at, but not limited to, the following stations:

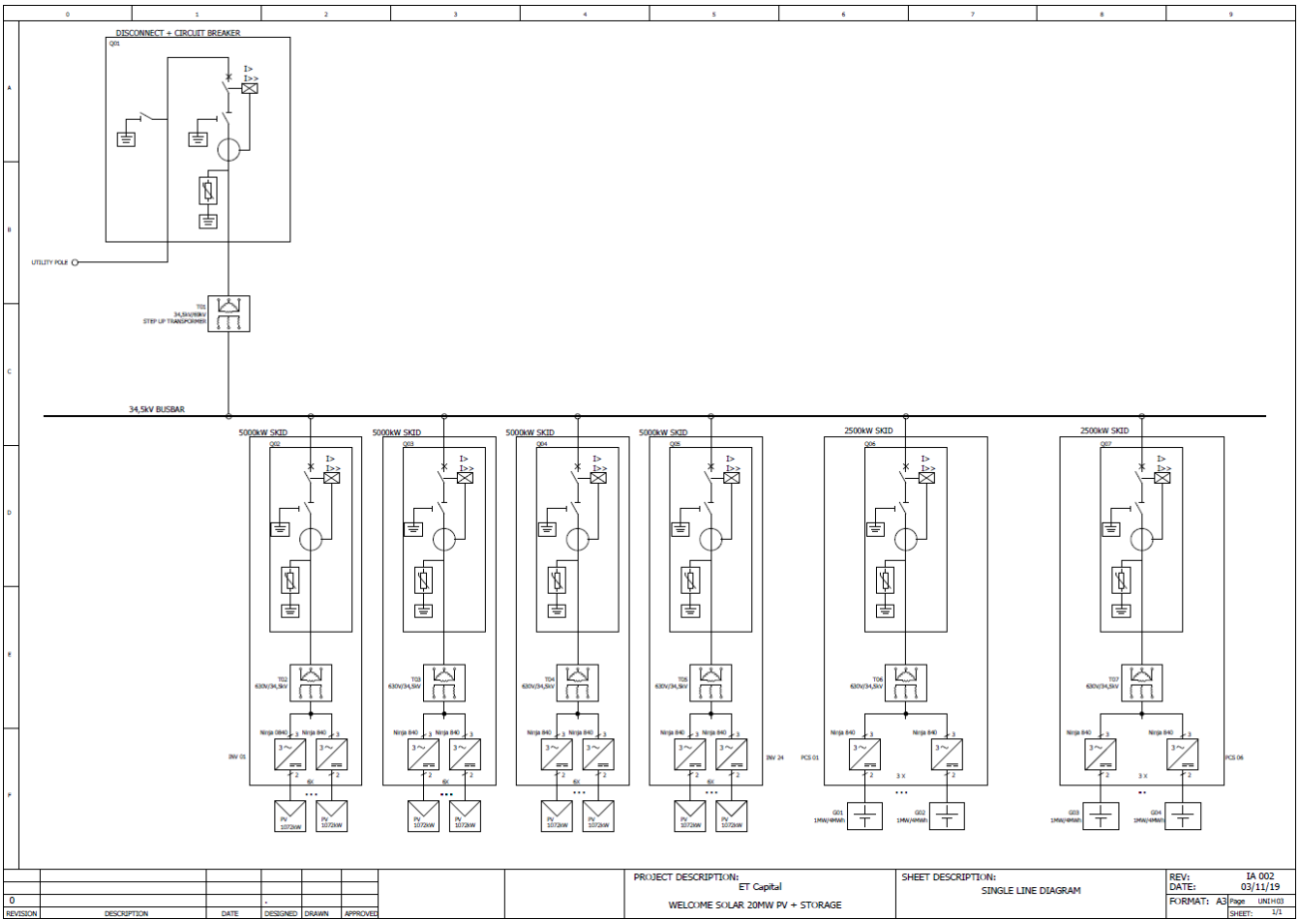
- Cedar Street
- Dilworth
- Masury
- McDowell
- Maysville
- Sharon

Attachment #2: One-Line Diagrams

FirstEnergy Facilities One-Line

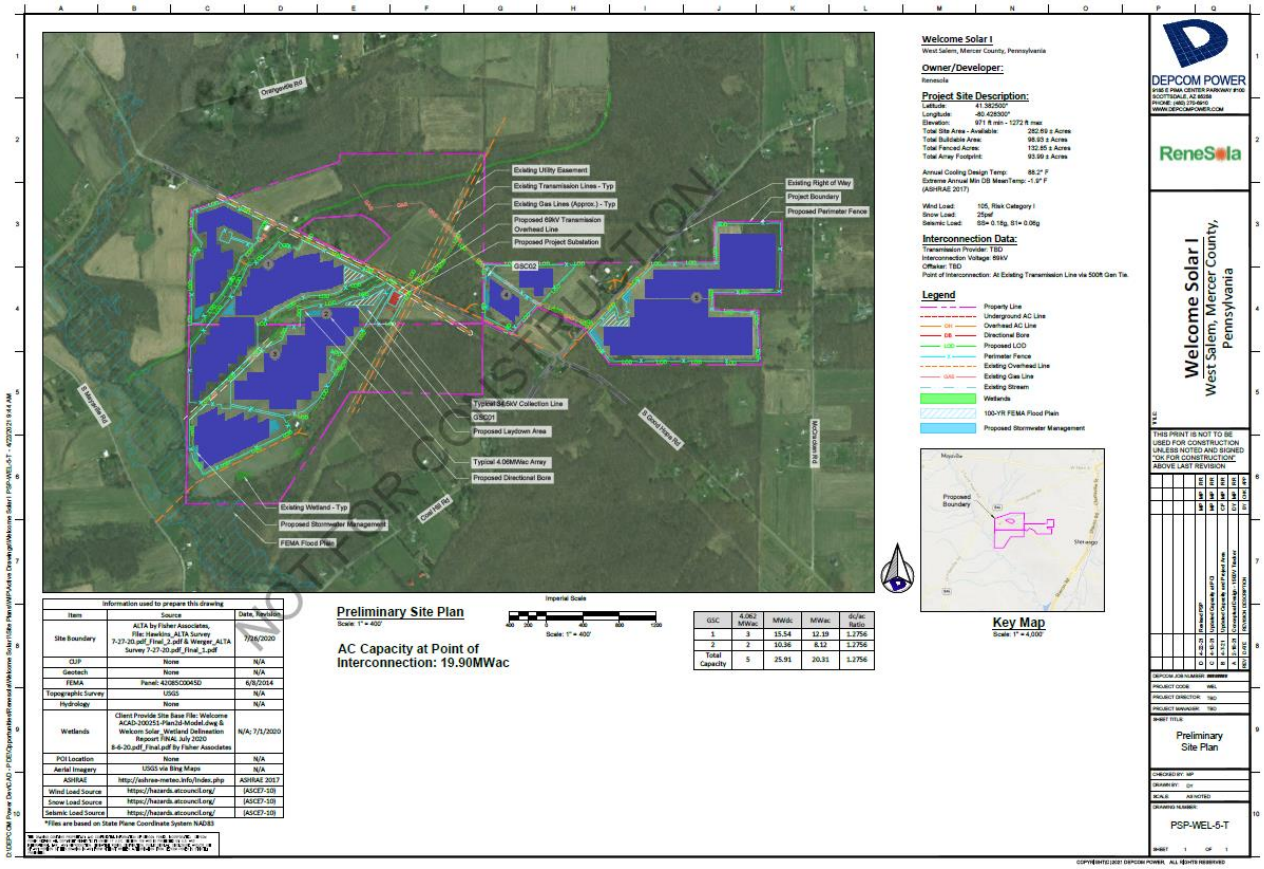


IC Facilities One-Line



Attachment #3: Project Site Plan

IC Site Plan, IC Substation Location and Point of Interconnection to FE



Attachment #4: Generation Connection Requirements

Generation Connection Requirements

The proposed interconnection facilities must be designed in accordance with the Transmission Owner's *Requirements for Transmission Connected Facilities* documents located at either of the following links:

www.firstenergycorp.com/feconnect

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

The following is an excerpt taken from Transmission Owner's *Requirements for Transmission Connected Facilities* document:

For all generation facilities, other than wind-powered and other non-synchronous generating facilities, the minimum requirement shall be the provision of a reactive power capability sufficient to maintain a composite power delivery at continuous rated power output at a power factor as defined in the table below. This requirement will be measured at either the POI or generator terminals as specified in the table below. These reactive requirements apply to both the initial installation as well as to any incremental change in unit MW capability. FE will coordinate with the Connecting Party to identify the optimal generator step-up transformer tap to make such a capability available when demanded.

For all wind-powered or other non-synchronous generating facilities the minimum requirement shall be the provision of a reactive power capability sufficient to maintain a composite power delivery at a power factor as defined in the table. This requirement will be measured at either the POI or generator's terminals as specified in the table below. These reactive requirements apply to both the initial installation as well as to any incremental change in unit MW capability. FE will coordinate with the Connecting Party to identify the optimal generator step-up transformer tap to make such a capability available when needed.

Generation Type	New / Increase	Size	Power Factor Requirement	Measurement Location
Synchronous	New	> 20 MW	0.95 leading to 0.90 lagging	Generator's Terminals
Synchronous	New	<= 20 MW	0.95 leading to 0.90 lagging	Point of Interconnection
Wind or Non-Synchronous	New	All	0.95 leading to 0.95 lagging	Point of Interconnection
Synchronous	Increase	> 20 MW	1.0 (unity) to 0.90 lagging	Generator's Terminals
Synchronous	Increase	<= 20 MW	1.0 (unity) to 0.90 lagging	Point of Interconnection
Wind or Non-Synchronous	Increase	All	0.95 leading to 0.95 lagging	Generator's Terminals

Any different reactive power requirements that FE and/or PJM determines to be appropriate for wind-powered or other non-synchronous generation facilities will be stated in the applicable interconnection agreement(s).
Induction generators and other generators with no inherent VAR (reactive power) control capability, or those that have a restricted VAR capability less than the defined requirements, must provide dynamic supplementary reactive support located at the generation facility with electrical characteristics equivalent to that provided by a similar-sized synchronous generator.

Design Requirements

Developer is responsible for specifying appropriate equipment and facilities such that the parallel generation is compatible with Transmission Owner's Transmission System. Developer is also responsible for meeting any applicable federal, state, and local codes.

Design Criteria

Facilities owned and operated by Transmission Owner shall comply with the applicable Transmission Owner technical requirements and standards posted on the PJM website per the PJM Tariff, and the following criteria. Where there are different requirements for the same criterion, the more restrictive shall apply. Developer must abide by any PJM, RFC or NERC criteria imposed that is more restrictive than those of Transmission Owner.

General Design Requirements

• System phasing (counter clockwise)	1-2-3
• System frequency:	60 hertz
• Elevation, AMSL:	Less than 1000 meters
• Isokeraunic level:	40
• Maximum ambient temperature:	40 degrees C
• Minimum ambient temperature:	-40 degrees C
• Maximum conductor operating temperature:	Contact Transmission Owner
• Wind Loading (round shapes):	Per ASCE 10, per Fig. 250-2B depending on location Per ASCE 7-98, per Fig. 6-1 depending on location
• Ice loading – Substations (no wind):	25 mm
• Seismic zone:	Per ASCE Manual 113 Substation Structure Design Manual. Equipment qualification per IEEE 693-2005 and IEE 1527-2006 Per ASCE 7-98, per Fig. 9.4.1.1(a) and (b). Equipment qualification per IEEE 693-97

Voltage and Current Ratings

• Nominal phase-to-phase:	69 kV
• Maximum phase-to-phase:	72.5 kV
• Basic impulse level (BIL):	350 kV
• Maximum continuous current carrying capacity:	2000 A
• Design fault current:	40 kA

Clearances and Spacing

• Recommended rigid bus center-to-center phase spacing:	60"
• Minimum phase-to-phase, metal-to-metal distance:	31"
• Recommended phase-to-ground:	29"
• Minimum phase-to-ground:	25"
• Minimum vertical clearance from live parts to grade:	10'-5"
• Minimum horizontal clearance from live parts:	4'-11"
• Minimum bottom of insulator to top of foundation:	8'-6"