Generation Interconnection Facilities Study Report

For

PJM Transmission Interconnection Request Queue Position AE1-185

"Hokes – Jackson 69 kV"

May 2021

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

Cottontail Solar 1, LLC, (hereinafter referred to as "IC") has proposed a solar generating facility to be located in North Codorus Township, York County, Pennsylvania. The installed facilities for AE1-185 will have a total Maximum Facility Output (MFO) of 20 MW with 12.6 MW of this output being recognized by PJM as Capacity. The generation facility will interconnect with Mid-Atlantic Interstate Transmission (MAIT) (in Metropolitan Edison Company (ME), a FirstEnergy Company (FE), hereinafter referred to as "Transmission Owner" (TO), by tapping the Hokes – Jackson (79) 69 kV Line and constructing a one-span tap. The transmission line tap will be located approximately 3.5 miles from Jackson substation.

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

There were no notable amendments since the System Impact Study.

3. Milestone Schedule

The Commercial Operation Date (COD) for the transmission interconnection facility is **December 31, 2022**.

Milestone Schedule:

10/31/2022	Initial Back-feed Date
12/31/2022	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 (AE1-185) generator lead line and connection to the tap point on the Hokes – Jackson (79) 69 kV line.

Point of Interconnection (POI): The interconnection of the project will be accomplished by tapping the Hokes – Jackson (79) 69 kV line and constructing a one-span tap. The transmission line tap will be located approximately 3.5 miles from Jackson Substation.

IC is required to own, install, and maintain a fully-rated, fault-interrupting circuit breaker on the high-side of the GSU transformer, as well as the necessary revenue metering equipment. 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

- AE1-185 Generator Lead Termination (Connection via a one-span tap to the Hokes – Jackson (79) 69 kV line)
    - Transmission Owner will design, furnish and construct a one-span to interconnect to the point of change of ownership with the Interconnection Customer.

- AE1-185 Customer Substation
    - Review nameplates, drawings, and relay settings.

Direct Connection

- SCADA/ Fiber Communication
    - Transmission Owner will install a 700 MHz radio system (70% penetration of FE territory) to support the SCADA switch installations.

Non-Direct Connection

- Hokes-Jackson 69 kV Line Tap
  Tap the Hokes-Jackson (79) 69 kV line at structure 79-65 and install SCADA controlled disconnect switches on either side of the tap.

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

- Hokes Substation

- Upgrade of relay settings required.

- Jackson Substation
  - Upgrade of relay settings required.

Other Work

- AE1-185 Metering
  - Transmission Owner support for Customer-owned revenue metering at the new AE1-185 substation.

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:	**$ 249,780**	**$ 44,080**	**$ 293,860**
Total Direct Connection (DC) Costs:	**$ 96,600**	**$ 17,100**	**$ 113,700**
Total Non-Direct Connection (NDC) Costs:	**$ 1,239,920**	**$ 218,520**	**$ 1,458,440**
Other Charges:	**$ 4,600**	**$ 900**	**$ 5,500**
New System Upgrades	**$ 0**	**$ 0**	**$ 0**
TOTAL Costs (ALL Categories)	**$ 1,590,900**	**$ 280,600**	**$ 1,871,500**

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

Attachment Facility	*Duration*
AE1-185: Engineering, Procurement, and Construction	15 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

Hokes – Jackson 69 kV (79) 69 kV Line

- Tap the Hokes – Jackson (79) 69 kV line at structure 79-65. Install disconnect switches with SCADA control and construct one (1) span of 69 kV line towards the developer substation.
- The existing line consists of the following:
  - Single circuit wood monopole structures with distribution underbuild.
  - Existing conductor is 2/0 Cu, 7 Strand and the existing shield wire is unknown.
- The customer tap requires three (3) existing wood poles to be rebuilt, one (1) wood monopole structure be installed, and one (2) spans (approximately 200') of conductor and shield wire installed towards the developer substation per the following:
  - One (1) steel monopole vertical tap structure on a drilled shaft foundation at structure 79-65.
  - Two (2) wood switch structures at structure 79-64 and structure 79-66.
  - The conductor assumed for the line tap is 795kcmil ACSR shielded with one (1) 3#6 Alumoweld.
  - One (1) steel monopole deadend structure on a drilled shaft foundation will be installed on the tap line.
- Siting/Licensing
  - Assume siting will not be required for 69 kV.
  - Assumes ROW can be acquired between residential property and commercial property the tap line will need to span through.
- Assumptions
  - An aerial LiDAR survey of the tap will be required.
  - Switches will be 1200A with SCADA, MOABs, and high-speed whips.
  - Existing conductor and shield wire are sufficient to transfer to new structures.
  - Assume adjacent structures have adequate capacity to handle the new loading. An engineering analysis will be required.
  - Exact location of tap and station is not yet determined. Once this has been completed, a detailed engineering analysis will need to be conducted to confirm.
  - Assume the outage requirements for construction on the line can be met.
  - Assume OPGW is not needed.

Fiber (Relaying & Communications)

- None

SCADA Communication
- Install (2) disconnect switches with SCADA control.

Distribution
- Existing structures have distribution underbuild which will need to be transferred to the new poles.
- 120 V AC supply for transmission switches

Real Estate
- Assume all work will be performed within the existing ROW or on substation property with no additional ROW required.
- Assume new ROW will need to be acquired for the new tap line to customer substation.

Environmental
- Assume an environmental survey will be required to identify any construction constraints or additional permitting requirements.
- Assume some minor access improvements at existing structure locations. Terrain is flat.

Forestry
- Some clearing may be required. Priority tree rights may be expanded.

3. New Substation/Switchyard Facilities

AE1-185 Customer Substation
- Below Grade
  - None
- Above Grade
  - Review nameplates, drawings, and add to HV circuit diagram.
- R&C (Relaying & Communications)
  - None
- Additional Equipment to be Removed
  - None
- Assumptions
  - None

Revenue Metering
- Revenue metering to be located at Customer substation

4. Substation/Switchyard Facility Upgrades

Hokes Substation
- Below Grade
  - None
- Above Grade
  - Update Relay Settings.
- R&C (Relaying & Communications)
  - None
- Additional Equipment to be Removed

        - None
    - Assumptions
        - None

Jackson Substation
- Below Grade
    - None
- Above Grade
    - Update Relay Settings.
- R&C (Relaying & Communications)
    - None
- Additional Equipment to be Removed
    - None
- Assumptions
    - None

Fiber (Relaying & Communications)
- None

SCADA Communication
- Add to EMS screen.

Distribution
- None

Real Estate
- None

Environmental
- None

5. Telecommunications Facilities – Upgrades

The AE1-185 generation (collector) substation will be connected directly to an existing line (Hokes – Jackson (79) 69 kV line) within FirstEnergy's transmission system without a dedicated Transmission Owner interconnection substation and will therefore not require MPLS communications.

6. Metering & Communications

IC shall install, own, operate, test and maintain the necessary revenue metering equipment. IC shall provide Transmission Owner with dial-up communication to the revenue meter.

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 October 3, 2016 document located at the following links:

www.firstenergycorp.com/feconnect

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

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) 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			
AE1-185 Generator Lead Termination: Tap the Hokes-Jackson (79) 69 kV line at structure 79-65 and install one (1) span of 69 kV line to the point of change of ownership with the Interconnection Customer.	$ 222,480	$ 39,180	$ 261,660
AE1-185 Customer Substation: Review nameplates, drawings, and relay settings.	$ 27,300	$ 4,900	$ 32,200
Total Attachment Facilities (AF) Costs	$ 249,780	$ 44,080	$ 293,860
Direct Connect Facilities			
AE1-185 SCADA/Fiber	$ 96,600	$ 17,100	$ 113,700

Communication: Estimated installation of 700 MHz radio system (70% penetration of FE territory) to support the SCADA switch installations. Assumed SCADA work is included in this cost. (PJM Network Upgrade Number n7261.1)			
Total Direct Connect (DC) Costs	$ 96,600	$ 17,100	$ 113,700
Non-Direct Connect Facilities			
Hokes-Jackson 69 kV Line Tap: Tap the Hokes-Jackson (79) 69 kV line at structure 79-65 and install SCADA controlled disconnect switches on either side of the tap. (PJM Network Upgrade Number n7261.3)	$889,920	$156,720	$1,046,640
AE1-185 Project Management: Project Management, Commissioning, Environmental, Forestry, Real Estate, and Right of Way. (PJM Network Upgrade Number n7261.3)	$ 182,800	$ 32,200	$ 215,000
Hokes 69 kV Substation: Update Relay Settings. (PJM Network Upgrade Number n7261.4)	$ 83,600	$ 14,800	$ 98,400
Jackson 69 kV Substation: Update Relay Settings. (PJM Network Upgrade Number n7261.5)	$ 83,600	$ 14,800	$ 98,400
Total Non Direct Connect (NDC) Costs	$ 1,239,920	$ 218,520	$ 1,458,440
Other Charges			
AE1-185 Metering: Customer-owned revenue metering at AE1-185 generating facility.	$ 4,600	$ 900	$ 5,500
Other Charges Costs	$4,600	$900	$5,500
Total Costs (All Categories)	**$ 1,590,900**	**$ 280,600**	**$ 1,871,500**

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 **15 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.

15 month Schedule (assume September 1, 2021 start)

Activity	Start Month	End Month
[redacted]		
Preliminary Engineering	1	3
Siting, Permits & Real Estate	2	10
Detailed Engineering	2	10
Equipment Delivery	8	10
Below Grade Construction – Substation	10	12
Below Grade Construction – T-Lines	10	13
Above Grade Construction – Substation	10	13
Above Grade Construction – T-Lines	14	15
Testing & Commissioning	15	15

10. Information Required for Interconnection Service Agreement

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
AE1-185 Generator Lead Termination: Tap the Hokes-Jackson (79) 69 kV line at structure 79-65 and install one (1) span of 69 kV line to the point of change of ownership with the Interconnection Customer.	$150,040	$38,460	$33,420	$560	$222,480
AE1-185 Customer Substation: Review nameplates, drawings, and relay settings.	$ 22,300	$ 0	$ 5,000	$ 0	$ 27,300
Total Attachment Facilities Cost	**$172,340**	**$ 38,460**	**$38,420**	**$ 560**	**$ 249,780**
SCADA/Fiber Communication: Estimated installation of 700 MHz radio system (70% penetration of FE territory) to support the SCADA switch installations. Assumed SCADA work is included in this cost.	$ 68,200	$ 13,000	$ 15,200	$ 200	$ 96,600
Total Direct Connection Cost	**$ 68,200**	**$ 13,000**	**$ 15,200**	**$ 200**	**$ 96,600**
Hokes-Jackson 69 kV Line Tap: Tap the Hokes-Jackson (79) 69 kV line at structure 79-65 and install disconnect switches on either side of the tap.	$ 600,160	$ 153,840	$ 133,680	$ 2,240	$ 889,920
Project Management: Project Management, Commissioning, Environmental, Forestry, Real Estate, and Right of Way.	$ 149,500	$ 0	$ 33,300	$ 0	$ 182,800
Hokes Substation:	$ 68,400	$ 0	$ 15,200	$ 0	$ 83,600

Update Relay Settings.					
Jackson Substation: Update Relay Settings.	$ 68,400	$ 0	$ 15,200	$ 0	$ 83,600
Total Non-Direct Connection Cost	**$ 886,460**	**$ 153,840**	**$ 197,380**	**$ 2,240**	**$ 1,239,920**
AE1-185 Metering: Review customer-owned revenue metering at Hokes – Jackson 69 kV.	$ 3,800	$ 0	$ 800	$ 0	$ 4,600
Other Costs:	**$ 3,800**	**$ 0**	**$ 800**	**$ 0**	**$ 4,600**
Total Project Costs	**$ 1,130,800**	**$ 205,300**	**$ 251,800**	**$ 3,000**	**$ 1,590,900**

Attachment #1: Protection Study

PROTECTION & COMMUNICATION AND EQUIPMENT SCOPE

Short Circuit Values At 69kV:

Positive Seq. Impedance = 1.3930 + j6.21847 Ohms

Zero Seq. Impedance = 2.60041 + j10.1146 Ohms

Single Line to Ground Fault Current = 5155 Amps Three

Phase Fault Current = 6252 Amps

Fault values are expressed in current system conditions without the proposed generation. Future changes in fault currents are possible and it's the customer's responsibility to upgrade their equipment and/or protection equipment coordination when necessary.

General Connection Requirement

All proposed generation interconnection points and load-serving delivery points must comply with the technical requirements detailed in the FirstEnergy "Requirements for Transmission Connected Facilities" document.

Protection Requirements for PV installation on 69kV Line

There should be two levels of anti-island protection. If the inverters meet the testing requirements of IEEE-1547.1 or are UL1741 certified, Anti-islanding Direct Transfer Trip will not be required and the inverters themselves have one level of anti-island protection.

The second level of anti-island protection, the intertie relay, could be a SEL-351-7 or similar and provide just the intertie functionality (ANSI 27,59,32,50,51,67,81) but this functionality can be placed inside the SEL-351-7s that are used for the fault protection at the POI breaker. This relay is to be located on high side of 69/34.5kV transformer. Install 3 Phase PTs [Potential Transformers] (WYE Gnd -WYE Gnd-Broken Delta) on 69kV side of existing transformer.

Intertie relaying located on High side of 69/34.5kV transformer will need to trip Solar Generation offline during a fault event on 69kV Line and Solar Gen is feeding the fault. This can be achieved by either tripping a device on high side of Step Up transformer or by tripping individual PV strings offline. This tripping can be done via Fiber or microwave communication, if preferred.

All relays, relay schemes, and relay settings that include 69kV voltages or currents or trip any 69kV circuit breakers shall require the review and approval of FirstEnergy.

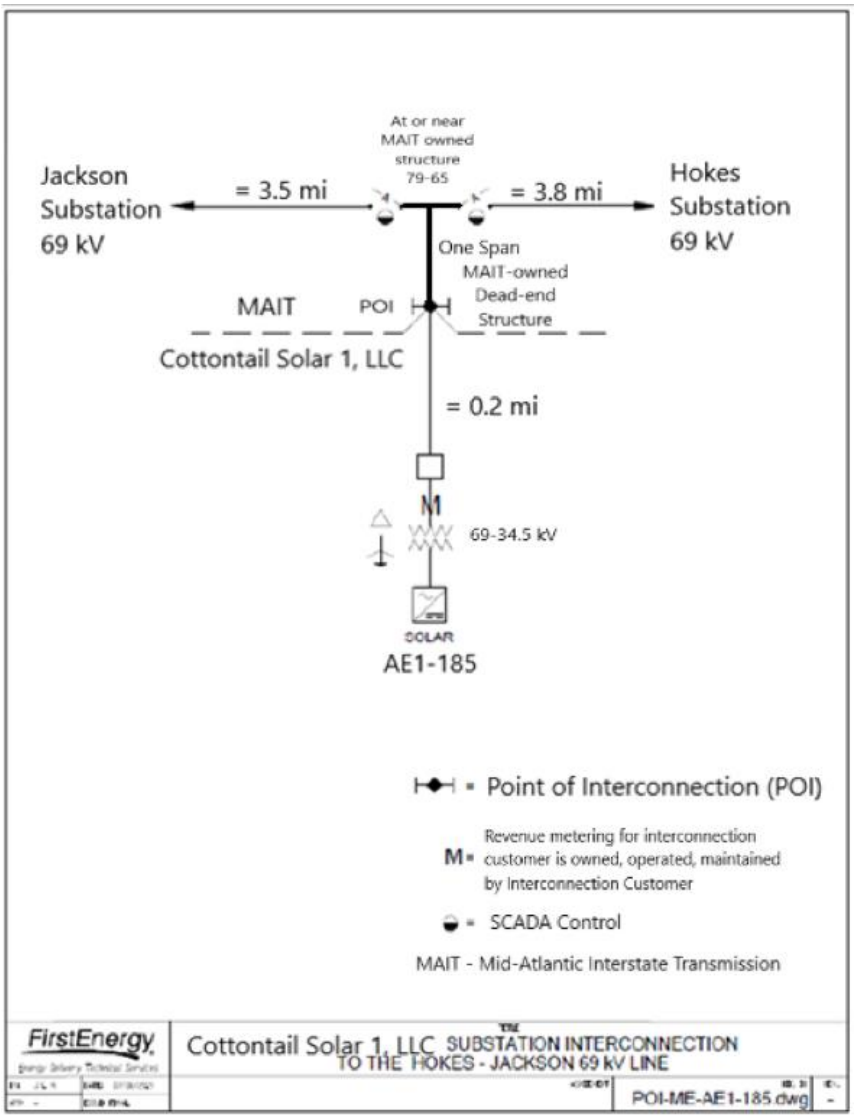
Customer shall install a Delta High (utility) side or Ungrounded Wye High side transformer. The transformer shall be protected by independent protection schemes, namely, Primary Differential and Backup Differential or Backup Overcurrent, with current inputs from independent CT (Current Transformer). Customer shall install a 69kV breaker at the POI with Primary and Backup (SEL-351-7 or similar) relays on independent CTs with Overcurrent Functions.

FirstEnergy 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. These relay replacements will be done at the cost of the developer.

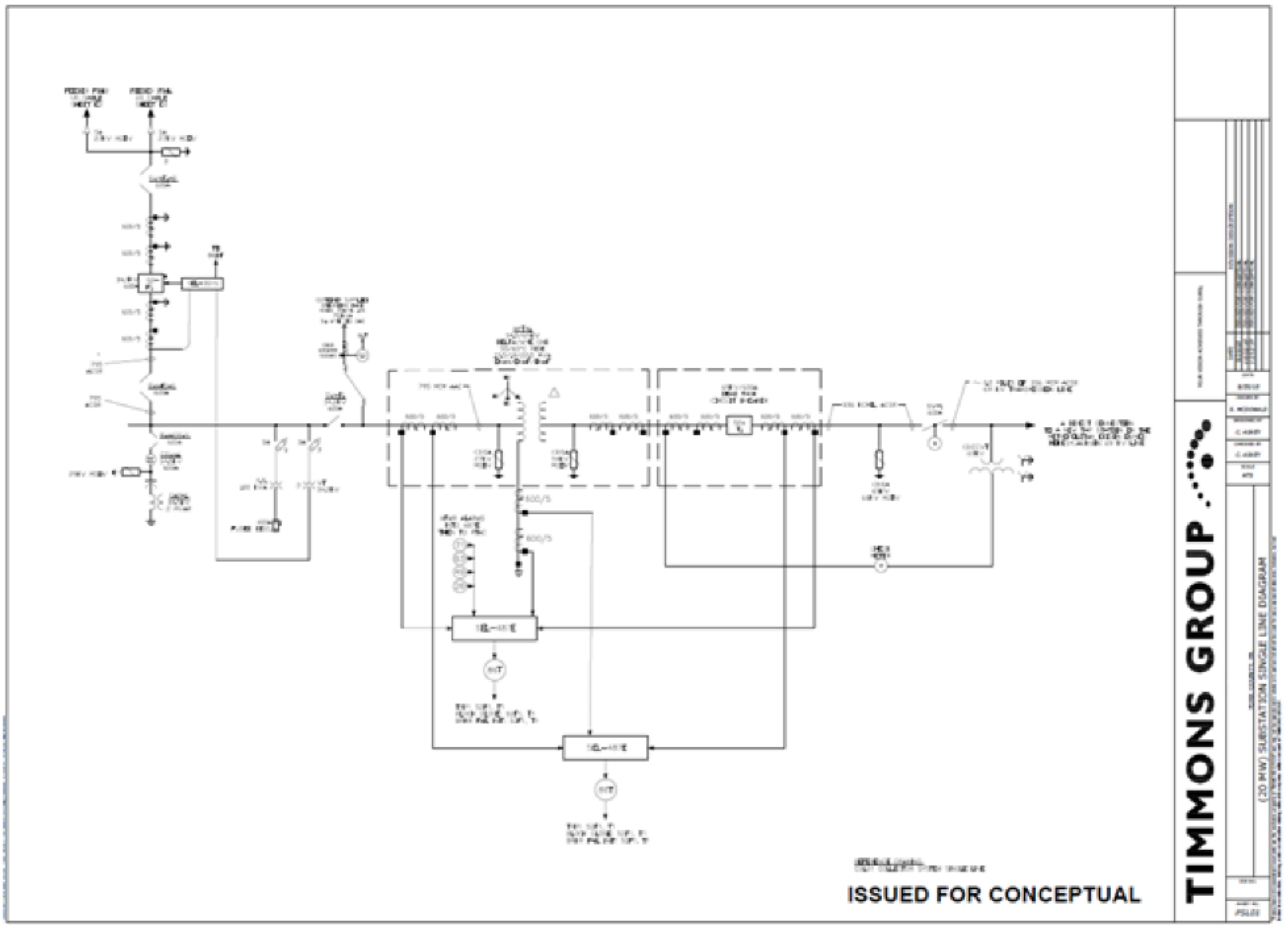
The customer is solely responsible for protecting its own equipment in such a manner that electrical faults or other disturbances on the FE system do not damage its equipment.

Attachment #2: One-Line Diagrams

FirstEnergy Facilities One-Line

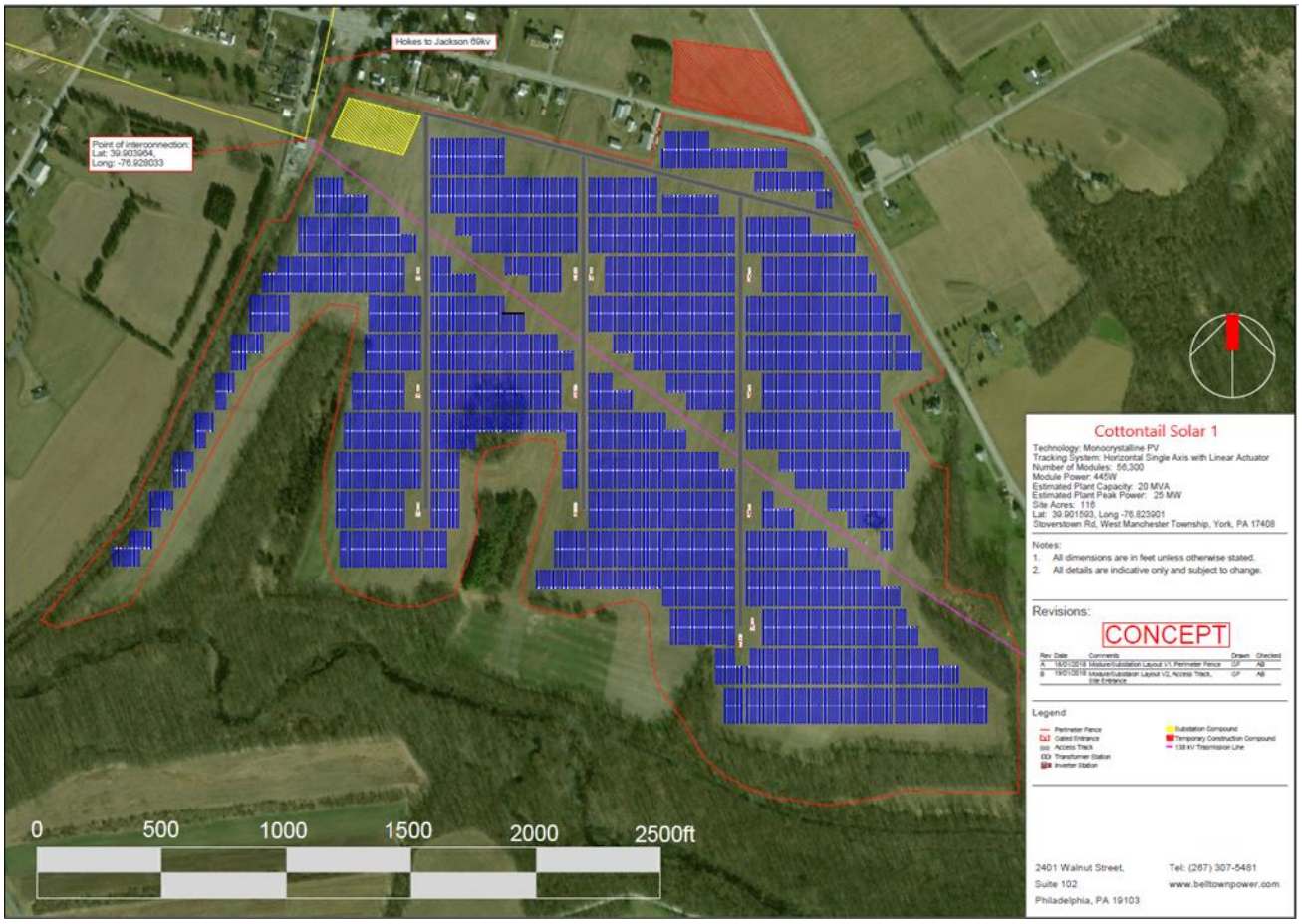


IC Facilities One-Line



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"