Generation Interconnection
Facilities Study Report

For

PJM Transmission Interconnection Request
Queue Position AE1-129

“Zions View – Middletown 115 kV”

May 2021

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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

Tradewind Energy, Inc., (hereinafter referred to as "IC") has proposed a solar generating facility to be located in Conewago and Newberry Townships, York County, Pennsylvania. The installed facilities for AE1-129 will have a total Maximum Facility Output (MFO) of 79.6 MW with 47 MW of this output being recognized by PJM as Capacity. The generation facility will interconnect with Mid-Atlantic Interstate Transmission, LLC (MAIT), a FirstEnergy Company (FE), hereinafter referred to as "Transmission Owner" (TO), by constructing a new 115 kV three (3) breaker ring bus substation and looping the Middletown Junction – Zions View 115 kV line into the new substation. The new substation will be located approximately 6.4 miles from Middletown Junction Substation.

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

There were no notable amendments since the December 2020 revised System Impact Study.

3. Interconnection Customer's Milestone Schedule

The Commercial Operation Date (COD) for the transmission interconnection facility is **December 31, 2023**.

Milestone Schedule:

12/15/2023	Initial Back-feed 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, 115 kV (AE1-129) generator lead line and connection to the tap point at the newly constructed 115 kV three (3) breaker ring bus interconnection substation.

Point of Interconnection (POI): The interconnection of the project will be accomplished by constructing a new 115 kV three (3) breaker ring bus substation and looping the Middletown Junction – Zions View 115 kV line into the new substation. The new substation will be located approximately 6.4 miles from Middletown Junction Substation. The project will require non-direct connection upgrades at Middletown Junction and Smith Street Substations.

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 115 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 115 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 115 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 115 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 115 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.
- A Reactive Power Deficiency has been identified. The estimated required additional capacitive (lagging) reactive power and inductive (leading) reactive power are 40.65 MVAR and 11.67 MVAR, respectively, to fulfill the power factor requirement. The Customer must indicate how they will address the power factor requirement and the potentially required reinforcement.

5. Description of Facilities Included in the Facilities Study

Attachment Facilities

- AE1-129 Generator Lead Termination (Connection to the newly proposed three (3) breaker ring bus interconnection substation)
    - Transmission Owner will design, furnish and construct the new 115 kV line terminal and take off structure. This work will include, but not be limited to, installation of a 115 kV line exit take-off structure, foundations, disconnect switch and associated equipment to accommodate the termination of the 115 kV generator lead line at the newly constructed interconnection substation.

- AE1-129 Customer Substation
    - Review nameplates, drawings, and relay settings.

Direct Connection

- AE1-129 Interconnection Substation
    - Transmission Owner will construct a new three (3) breaker ring bus on the Middletown Junction – Zions View (977) 115 kV line between Middletown Junction and Zions View.

- SCADA/ Fiber Communication
    - Estimated SCADA work at Middletown Junction and Smith Street Substations to support wave trap and relay installations.
    - Estimated two (2) in-sub fiber runs to represent ADSS trail extension from AE1-129 Substation control house to last T-Line structures for OPGW builds.

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

Non-Direct Connection

- Middletown Junction – Zions View (997) 115 kV Line Loop
    - Creation of a line loop in the Middletown Junction – Smith Street (977) 115 kV line to the proposed interconnection substation.
    - Installation of midspan structure on the Middletown Junction – Smith Street (978) 115 kV line to support the routing of the interconnection.

Other Facilities

- AE1-129 Metering
    - Assistance will be provided to the developer on the customer-owned revenue metering design, a remote meter checkout will be performed, and facilitation of the meter's installation in the FE MV-90 system will be completed.
    - It is assumed that the developer's engineering consultant will work on the design with the FE meter engineering at the beginning of 2021 and that 115 kV back-feed to the step-up substation will occur by 09/30/2021.

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:	**$ 683,700**	**$ 120,500**	**$ 804,200**
Total Direct Connection (DC) Costs:	**$ 5,894,200**	**$ 1,037,500**	**$ 6,931,700**
Total Non-Direct Connection (NDC) Costs:	**$ 2,110,800**	**$ 371,700**	**$ 2,482,500**
Total Other Costs	**$ 4,600**	**$ 900**	**$ 5,500**
New System Upgrades	**$ 0**	**$ 0**	**$ 0**
TOTAL Costs (ALL Categories)	**$ 8,693,300**	**$ 1,530,600**	**$ 10,223,900**

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

Attachment Facility	*Duration*
AE1-129: Engineering, Procurement, and Construction	29 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

Middletown Junction – Smith Street (977) 115 kV Line Loop

- Cut the existing Middletown Junction – Smith Street (977) 115kV line between existing structure 65 and structure 66 to create a loop to the proposed ring bus.
- The loop will create the following new line names:
  - Middletown Junction - AE1-129 Interconnection 115kV Line
  - AE1-129 Interconnection – Smith Street 115kV line
- The existing line consists of the following:
  - Double circuit lattice structures shared with the Middletown Junction – Smith Street No.2 (978) 115kV line.
  - Existing conductor is 394.5 kcmil 19-Strand AAAC shielded with (1) OPGW ALCOA AC-34/52/646.
- The proposed loop requires the installation of one (1) 3-pole steel loop structure (see attachment, Loop Structure) and two (2) spans of conductor installed to create the loop per the following:
  - One (1) double circuit vertical deadend 3-pole steel loop structure on drilled shaft foundations will be installed on the 977 line between existing structure 65 and structure 66.
  - The middle pole on the 3-pole structure will support the 977 and 978 lines on davit arms. The Middletown Junction – Smith Street No.1 (977) 115kV circuit will jumper to vertical strain bus and then jumper to a horizontal span to the station to the west. See attachment, Loop Structure.
  - The middle pole in the structure will be a davit arm tangent to raise the parallel Middletown Junction – Smith Street No. 2 (978) 115kV circuit (see estimate ME-T-418 below)
  - The conductor assumed for the loop is 336 kcmil 26/7 ACSR.
  - Two (2) spans approximately 100’ each from the existing centerline.
  - Assume the existing conductor and OPGW are in good condition and can be transferred to the new structures.

- Siting/Licensing
  - Assume Letter of Notification (LON) will be required.
- Assumptions
  - Assume existing LiDAR data is sufficient.
  - Switch to the generation facility will be inside the substation.
  - Existing lattice towers structure 65 and structure 66 have adequate capacity for the new configuration, an engineering analysis will be required to confirm.
  - Assume existing conductor is adequate to transfer to the new structure.
  - Assume the outage requirements for construction on the new line can be met.
  - The exact location of the new substation has not been determined. Once decided further analysis shall be conducted.
  - FOWR will be required

Middletown Junction – Smith Street (978) 115 kV Line

- Raise the 978 line using the 3-pole steel loop structure installed on the Middletown Junction-Smith Street (977) 115kV Line between structures 65 and 66 to maintain proper line clearances to the 977 line crossing under the 978 line. See estimate ME-T-343 above.
- It is assumed that tangent hardware assemblies will be installed on the newly installed davit arms of the 3-pole steel loop structure.

Fiber (Relaying & Communications)

- OPGW termination at the 3-pole steel loop structure

SCADA Communication

- None

Distribution

- None

Real Estate

- Assume all work will be performed within the existing line ROW or on the substation property and no additional ROW will be requested.
- A rights and restrictions review will need to be completed to review existing easement rights. Additional rights may need to be acquired.
- Assume some minor access improvements at existing structure locations.

Environmental

- An environmental review will be required to identify any constraints and additional permitting requirements.

Forestry

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

3. New Substation/Switchyard Facilities

AE1-129 Interconnection Substation

- Below Grade
  - Substation drainage, conduit, raceway, grounding, foundations, stoning & fence
- Above Grade
  - Install (3) 115 kV Circuit Breakers.
  - Install (6) 115 kV Disconnect Switches.
  - Install (3) 115 kV MOAB Switches.
  - Install (9) 115 kV CVTs.
  - Install (9) 90 kV, 70 kV MCOV, Surge Arresters.
  - 1 Lot of Rigid Bus, Strain Bus, and Steel Support Structures for the Bus, Switches, and CVTs.
  - Install (3) 115 kV dead ends as indicated on the typical attached layout.
  - Install (2) 115kV line traps, tuners, and coax.
  - Install (2) AMETEK Smart-Gap (Pending FE Substation Approval).
  - Relay house with AC & DC station service, SCADA, fiber termination rack, other communication equipment, and relay & control panels
- R&C (Relaying & Communications)
  - Install (1) standard transmission line relaying panel with Dual SEL411L and SEL501 BFT to be used for AE1-129 generation line relaying.
  - Install two (2) standard transmission line relaying panels with UPLC for DCB and PowerComm PCM-5350 to be used for Middletown Junction and Zions line relaying.
- Additional Equipment to be Removed
  - None
- Assumptions
  - Developer is providing a rough graded substation site with access road.
  - Developer has not yet elected Option to Build.

AE1-129 Customer Substation

- Below Grade
  - None
- Above Grade
  - Review drawings, nameplates, and relay settings.
  - 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

Middletown Junction

- Below Grade
  - Grounding and conduit for new equipment.
- Above Grade
  - Replace (1) 115 kV Line Trap, Line Tuner, and Coax.
  - Replace (1) 115 kV CVT.
- R&C (Relaying & Communications)
  - Replace existing line relaying to Smith Street with one (1) new standard transmission line relaying panel with UPLC for DCB and PowerComm PCM-5350 to be used on the AE1-139 Interconnection line terminal.
- Additional Equipment to be Removed
  - None
- Assumptions
  - Existing steel can be reused.
  - 115 kV Breaker (B 97742) is a New Siemens Breaker with a Second CT to Separate the Primary/Backup Relaying not shown on the One line (DWG. ME-133-10-01).

Smith Street Substation

- Below Grade
  - Grounding and conduit for new equipment.
- Above Grade
  - Replace (1) 115kV Line Trap, Line Tuner, and Coax.
  - Replace (1) 115kV CVT.
  - Replace (1) 115 kV OCB (97702) due to Single CT Condition.
- R&C (Relaying & Communications)
  - Replace existing line relaying to Middletown Junction with one (1) new standard transmission line relaying panel with UPLC for DCB and PowerComm PCM-5350 to be used on the AE1-139 Interconnection line terminal.
  - Separate Primary and Backup Relaying onto Separate CTs on New Breaker.
- Additional Equipment to be Removed
  - None
- Assumptions
  - Existing steel can be reused.

Zions View Substation

- Below Grade
  - None
- Above Grade

        - Revise drawings & nameplates,
        - Add to HV circuit diagram
    - R&C (Relaying & Communications)
        - None
    - Additional Equipment to be Removed
        - None
    - Assumptions
        - None

Fiber (Relaying & Communications)
- None

SCADA Communication
- New SCADA RTU and other standard communication equipment

Distribution
- None

Real Estate
- Real estate required for new ring bus sub site from developer.

Environmental
- Required for new ring bus sub site from developer

5. Telecommunications Facilities – Upgrades

IC will design, provide, install, own and maintain a fiber-optic communications cable between the new **interconnection** substation, and IC's **generation** (collector) substation. Two (2) fiber-optic channels are required for each generator protection scheme to obtain high- speed tripping capability for any fault within the zone of protection. Should subsequent/additional PJM studies indicate that stability issues exist, the primary and backup relay fiber-optic communication channels must be in separately-routed cable paths and additional fiber-optic connection costs would apply (not included herein).

The IC will make the fiber-optic cable termination connections for its cable(s) at the Hamilton substation control house.

IC is responsible for obtaining and maintaining all associated Rights-of-Way (ROW), Easements, and Permits for its fiber cable.

6. Metering & Communications

IC shall install, own, operate, test and maintain the necessary revenue metering equipment. Revenue billing

data from the meter is accessed by FirstEnergy over a cellular connection provided by FirstEnergy. If local cellular service is not applicable, the applicant will be required to provide appropriate communication circuits.

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.

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 provide the telecommunication circuits for the SCADA RTU and the telephone in the Transmission Owner interconnection substation.

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.

Communications for transmission line protection between the new **interconnection** substation, and IC's **generation** (collector) substation, will be via fiber optics (see "Telecommunication Facilities" section above).

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			
AE1-129 Generator Lead Termination (New Interconnection Substation): Installation of a 115 kV line exit take-off structure, foundations, disconnect switch and associated equipment to accommodate the termination of the 115 kV generator lead line.	$ 544,100	$ 95,800	$ 639,900
AE1-129 Customer Substation: Review nameplates, drawings, and relay settings.	$ 87,800	$ 15,500	$ 103,300
Zionsview: Revise drawings and nameplates	$ 51,800	$ 9,200	$ 61,000
Total Attachment Facilities (AF) Costs	**$ 683,700**	**$ 120,500**	**$ 804,200**
Direct Connect Facilities			
AE1-129 Interconnection Substation: Construct a new 3-breaker Ring Bus on the 115kV (977) line between Middletown Junction and Zions View.	$ 4,897,400	$ 862,000	$ 5,759,400
SCADA/Fiber Communication: Estimated SCADA work at Middletown Junction & Smith Street substations to support wave trap & relay installations. Estimated (2) in-sub fiber runs to represent ADSS tail extension from AE1-129 substation control house to last T-Line structures for OPGW builds.	$ 128,200	$ 22,600	$ 150,800

Project Management: Project Management, Commissioning, Environmental, Forestry, Real Estate, and Right of Way.	$ 868,600	$ 152,900	$ 1,021,500
Total Direct Connect (DC) Costs	**$ 5,894,200**	**$ 1,037,500**	**$ 6,931,700**
Non-Direct Connect Facilities			
Middletown Junction – Zions View (997) 115 kV Line Loop: Create loop in the Middletown Junction - Smith Street (977) 115kV line to the proposed ring bus.	$ 956,800	$ 168,400	$ 1,125,200
Middletown Junction – Zions View (997) 115 kV Line Loop: Install tangent hardware assemblies as well as transfer conductor onto the newly installed davit arms of the 3-pole steel loop structure captures in the ME-T-343B estimate.	$ 97,000	$ 17,100	$ 114,100
Middletown Junction: Replace limiting equipment at line terminal: Trap, Tuner, CVT, Relaying	$ 405,800	$ 71,500	$ 477,300
Smith Street: Replace limiting equipment at line terminal: Trap, Tuner, CVT, Relaying	$ 651,200	$ 114,700	$ 765,900
Total Non Direct Connect (NDC) Costs	**$ 2,110,800**	**$ 371,700**	**$ 2,482,500**
Other Work			
AE1-129 Metering: Provide assistance to the developer on the customer-owned revenue metering design, perform a remote meter checkout, and facilitate the meter's installation in the FE MV-90 system. The entries below assume that the developer's engineering consultant will work on the design with the FE meter engineer at the beginning of 2021 and that 115 kV back-feed to the step-up substation will occur by 9/30/2021.	$ 4,600	$ 900	$ 5,500

Total Other Costs	**$ 4,600**	**$ 900**	**$ 5,500**
Total AF + DC + NDC + Other Costs	**$ 8,693,300**	**$ 1,530,600**	**$ 10,223,900**

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 **29 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.

29 month Schedule (assume June 30, 2021 start)

Activity	Start Month	End Month
[redacted]		
Preliminary Engineering	1	3
Siting, Permits & Real Estate	2	12
Detailed Engineering	2	12
Equipment Delivery	10	12
Below Grade Construction – Substation	15	22
Below Grade Construction – T-Lines	24	26
Above Grade Construction – Substation	18	28
Above Grade Construction – T-Lines	27	28
Testing & Commissioning	29	29

10. Information Required for Interconnection Service Agreement

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
AE1-129 Generator Lead Termination (New Interconnection Substation): Installation of a 115 kV line exit take- off structure, foundations, disconnect switch and associated equipment to accommodate the termination of the 115 kV generator lead line.	$278,600	$200,500	$62,100	$2,900	$544,100
AE1-129 Customer Substation: Review nameplates, drawings, and relay settings.	$71,800	$0	$16,000	$0	$87,800
Zionsview: Revise drawings and nameplates	$42,400	$0	$9,400	$0	$51,800
Total Attachment Facilities Cost	**$392,800**	**$200,500**	**$87,500**	**$2,900**	**$683,700**
AE1-129 Interconnection Substation: Construct a new 3-breaker Ring Bus on the 115kV (977) line between Middletown Junction and Zions View.	$2,507,900	$1,804,100	$558,700	$26,700	$4,897,400
SCADA/Fiber Communication: Estimated SCADA work at Middletown Junction & Smith Street substations to support wave trap & relay installations. Estimated (2) in-sub fiber runs to represent ADSS tail	$94,500	$12,400	$21,100	$200	$128,200

extension from AE1-129 substation control house to last T-Line structures for OPGW builds.					
Project Management: Project Management, Commissioning, Environmental, Forestry, Real Estate, and Right of Way.	$710,300	$0	$158,300	$0	$868,600
Total Direct Connection Cost	**$3,312,700**	**$1,816,500**	**$738,100**	**$26,900**	**$5,894,200**
Middletown Junction – Zions View (997) 115 kV Line Loop: Create loop in the Middletown Junction - Smith Street (977) 115kV line to the proposed ring bus.	$659,100	$148,600	$146,900	$2,200	$956,800
Middletown Junction – Zions View (997) 115 kV Line Loop: Install tangent hardware assemblies as well as transfer conductor onto the newly installed davit arms of the 3-pole steel loop structure captures in the ME-T-343B estimate.	$70,200	$11,000	$15,600	$200	$97,000
Middletown Junction: Replace limiting equipment at line terminal: Trap, Tuner, CVT, Relaying	$255,100	$92,500	$56,800	$1,400	$405,800
Smith Street: Replace limiting equipment at line terminal: Trap, Tuner, CVT, Relaying	$387,700	$174,700	$86,300	$2,500	$651,200
Total Non-Direct Connection Cost	**$1,372,100**	**$426,800**	**$305,600**	**$6,300**	**$2,110,800**
AE1-129 Metering:	$3,800	$0	$800	$0	$4,600

Provide assistance to the developer on the customer-owned revenue metering design, perform a remote meter checkout, and facilitate the meter's installation in the FE MV-90 system. The entries below assume that the developer's engineering consultant will work on the design with the FE meter engineer at the beginning of 2021 and that 115 kV back-feed to the step-up substation will occur by 9/30/2021.					
Total Other Costs	**$3,800**	**$0**	**$800**	**$0**	**$4,600**
Total Project Costs	**$5,081,400**	**$2,443,800**	**$1,132,000**	**$36,100**	**$8,693,300**

Attachment #1: Protection Study

PROTECTION & COMMUNICATION AND EQUIPMENT SCOPE

Short Circuit Values

115kV
Positive Seq. Impedance = 1.50845 + j6.31304 ohms
Zero Seq. Impedance = 2.53458 + j10.3008 ohms
Single Line to Ground Fault Current = 8445 Amps
Three Phase Fault Current = 10229 Amps.

Impedances are given on a 100MVA and 115kV bases. Fault values are from the current system condition on the 977 Line (2.3 miles from Zion View and 6.4 miles from Middletown Junction) tapped to the proposed MAIT (Mid-Atlantic Interstate Transmission) three (3) breaker ring bus for generation project to the POI. The faults provided are bolted, symmetrical values for normal system conditions. Future changes in fault currents are possible and it is the customer's responsibility to upgrade their equipment and/or protective 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 (FE) "Transmission Connection Requirements" document.

Relay and Communication Equipment Scope

- **Middletown Junction Remote Terminal – 115kV 977 Line to MAIT Ring Bus**
    - SEL-421 and SEL-411L with Standard Relaying Panel
    - SEL-501 Breaker Failure
    - One (1) new Ametek UPLC for DCB
    - One (1) new PCM 5350 DCB Power Communication Monitoring
    - Two (2) new Ametek UPLC for DTT Channel 1 and 2
    - One (1) new PCM 5350 DTT Power Communication Monitoring
    - New Line Trap, Line Tuner and Coax.
    - New 1 set of three phase 115kV CCVT installed on the 977 Line exit.
- **Smith Street Remote Terminal – 115kV 977 Line to MAIT Ring Bus:**
    - SEL-421 and SEL-411L with Standard Relaying Panel
    - SEL-501 Breaker Failure
    - One (1) new Ametek UPLC for DCB
    - One (1) new PCM 5350 DCB Power Communication Monitoring

- Two (2) new Ametek UPLC for DTT Channel 1 and 2
- One (1) new PCM 5350 DTT Power Communication Monitoring
- New Line Trap, Line Tuner and Coax.
- New 1 set of three phase 115kV CCVT installed on the 977 Line exit.

- **MAIT Three Breakers Ring Bus:**
  - 115kV Line to Middletown Junction:
    - SEL-421 and SEL-411L with Standard Relaying Panel
    - One (1) new Ametek UPLC for DCB
    - One (1) new PCM 5350 DCB Power Communication Monitoring
    - Two (2) new Ametek UPLC for DTT Channel 1 and 2
    - One (1) new PCM 5350 DTT Power Communication Monitoring
    - New Line Trap, Line Tuner and Coax.
    - New one (1) set of three phase 115kV CCVT installed on the 977 Line exit.
    - One (1) SATEC Power Metering
  - 115kV Line to Smith Street:
    - SEL-421 and SEL-411L with Standard Relaying Panel
    - One (1) new Ametek UPLC for DCB
    - One (1) new PCM 5350 DCB Power Communication Monitoring
    - Two (2) new Ametek UPLC for DTT Channel 1 and 2
    - One (1) new PCM 5350 DTT Power Communication Monitoring
    - New Line Trap, Line Tuner and Coax.
    - New one (1) set of three phase 115kV CCVT installed on the 977 Line exit.
    - One (1) SATEC Power Metering
  - 115kV Line to AE1-129 Solar Generation:
    - Dual SEL-411L Fiber for Dual Line Differential with Standard Relaying Panel
    - New 1 set of three phase 115kV CCVT installed on the AE1-129 Line exit.
    - One (1) SATEC Power Metering
  - Two (2) new SEL-501 for Breaker Ring Bus Breaker Failure Protection and One (1) SEL-451 for the third breaker for breaker failure and Sync Check.
  - Additional items:
    - GPS Clock and its appurtenances as required
    - SCADA and annunciator, details to be determined by Real Time Operations

- SEL RTAC for remote access to SEL protective relays
- Test switches, fuses, and terminal blocks as deemed necessary

Relay Communication Channels

Two independent fiber optic communications channels are required between the MAIT Ring Bus substation and the AE1-129 Generation facility to be used for relay communication based high speed tripping.

Generation 115kV Substation Protection Requirement

The 115kV AE1-129 line exit breaker shall have two sets of C800 current transformers with a thermal factor of at least 2.0 available on the 115kV Bus side of the breaker(s) to be used for protection of the 115kV intertie line. Additional CTs required for the protection of plant equipment are to be determined by developer. The 115kV breakers shall have two independent trip coils. A 115kV three phase potential source (CCVT or equivalent) is required for line exit relaying.
Faults within any 115kV piece of equipment must be detected by two (primary and backup) independent high-speed zones of protection.

- It is the responsibility of the Generator Owner (GO) to assure protection, coordination and equipment adequacy within their facility for conditions including but not limited to:
    - System Faults
    - Equipment Failures
    - Deviations from Nominal Voltage or Frequency
    - Lightning and Switching Surges
    - Harmonic Voltages
    - Negative Sequence Voltages
    - Separation from FE Supply
    - Synchronizing Generation
    - Synchronizing Facilities between Independent Transmission System and FE
    - Transmission System
- 115kV Interconnected Line Protection:
    - The terminal breaker at the GO end of the direct connected line is to be included in the zone protection.
    - Dual SEL-411L fiber shall be used for protection of the interconnected line, to match the companion relays at MAIT Ring Bus Substation.
    - The dual SEL-411L part # and Firmware ID shall be coordinated and matched with dual SEL-411L at MAIT Ring Bus Substation in order to establish communication successfully.
- Generator Step Up Transformer (GSUT) protection:

  - GSUT shall consist of a primary current differential scheme and a backup Overcurrent scheme (or) preferably differential scheme, utilizing separate current transformers and an independent transformer neutral overcurrent relay.
  - Backup protection shall be completely independent from the primary protection, including separate current transformers, potential transformer windings (wherever applicable) and DC control circuits.
  - The primary and backup protection shall provide high speed fault protection.
- 115 kV Circuit Breaker: a separate tripping path energizing separate breaker trip coils is required for primary and backup relaying.
- Breaker Failure Protection:
  - A breaker failure relay (such as SEL-501) shall be utilized on all 115 kV circuit breakers. Any protective relay that trips a 115kV breaker shall initiate, the failure to trip scheme for that breaker.
  - The re-trip feature for the BFT (Breaker Failure to Trip) scheme shall be utilized and trip the 115kV circuit breaker.
  - The 115kV breaker failure scheme shall operate a hand reset lockout relay which shall trip and block close all electrically adjacent circuit breakers.
  - Tripping of the breakers shall be accomplished via the fiber optic cables and the tie line primary and backup protective relays (DTT).
- Anti-Islanding Protection:
  - There should be two levels of anti-islanding 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-islanding protection.
  - The second level of anti-island protection, the intertie relay, could be a SEL-351-7S and provide just the intertie functionality (over & Under voltage, Over & Under Frequency, Ground Overvoltage) or this functionality can be placed inside the SEL-351-7S that are used for fault protection. This relay is to be located on the high side of the 115/34.5kV transformer. This relay can also be used for Backup Protection of the GSUT.
- Install three-Phase PTs (potential transformers) [WYE Gnd-WYE Gnd-Broken Delta) on the 115kV side of the GSU
- All primary relaying is required to be connected to the CT's installed on the inner breaker bushing looking through the breaker into the protected zone.
- All backup relaying is required to be connected CTs on the outer breaker bushing looking through the breaker into the protected zone. The protection should trip the associated breakers, initiate breaker failure-to-trip schemes and reclosing schemes where applicable.
- The relaying system 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.
- All relays, relay schemes and relay settings that include 115 kV voltages or currents or trip any 115 kV circuit breakers shall require the review and approval of FirstEnergy.

- 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.
- Additional items:
    - GPS clock
    - SCADA
    - SEL RTAC
    - Test switches
    - Etc.

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

Metering Requirements

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

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

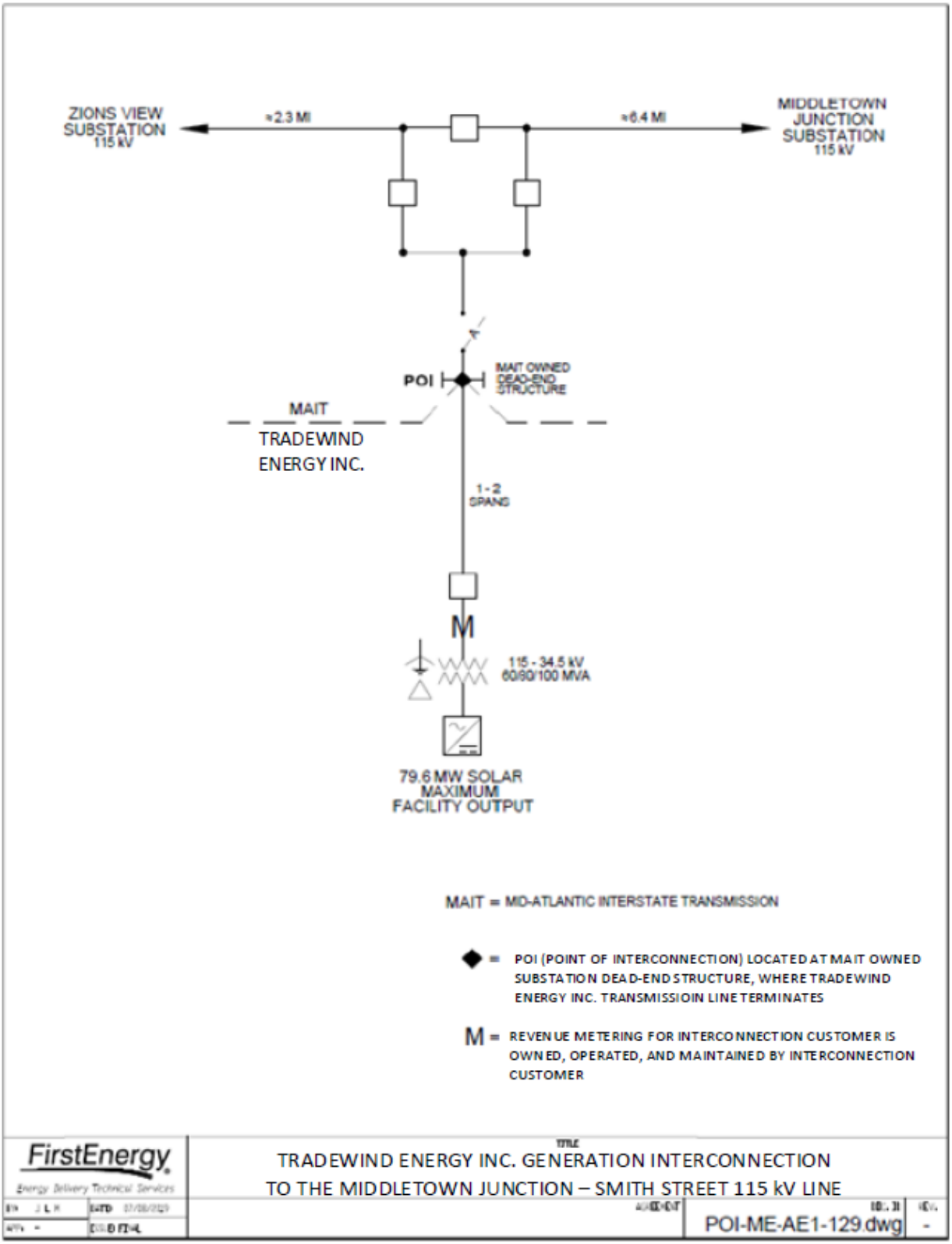
These requirements are in addition to any metering required by PJM.

Generator Step-Up Transformer Requirements

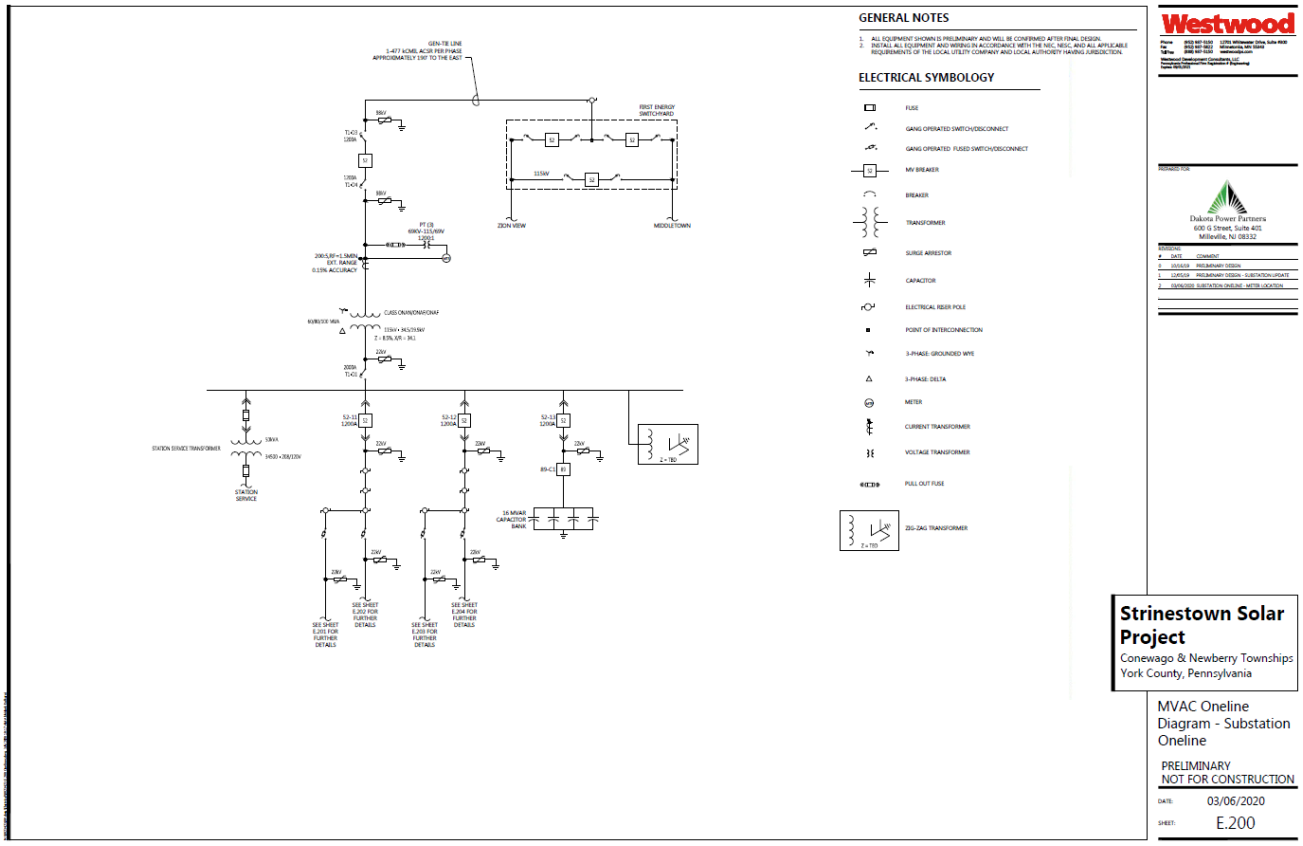
As per section 14.2.6 of the FE Requirements for Transmission Connected Facilities document, because this area of the system is effectively grounded the transformer shall have a WYE Grounded winding on the High (transmission system (side and a DELTA connected winding on the Low side. This is required to maintain proper ground relay coordination on the FE System. No exceptions to this standard shall be granted.

Attachment #2: One-Line Diagrams

FirstEnergy Facilities One-Line

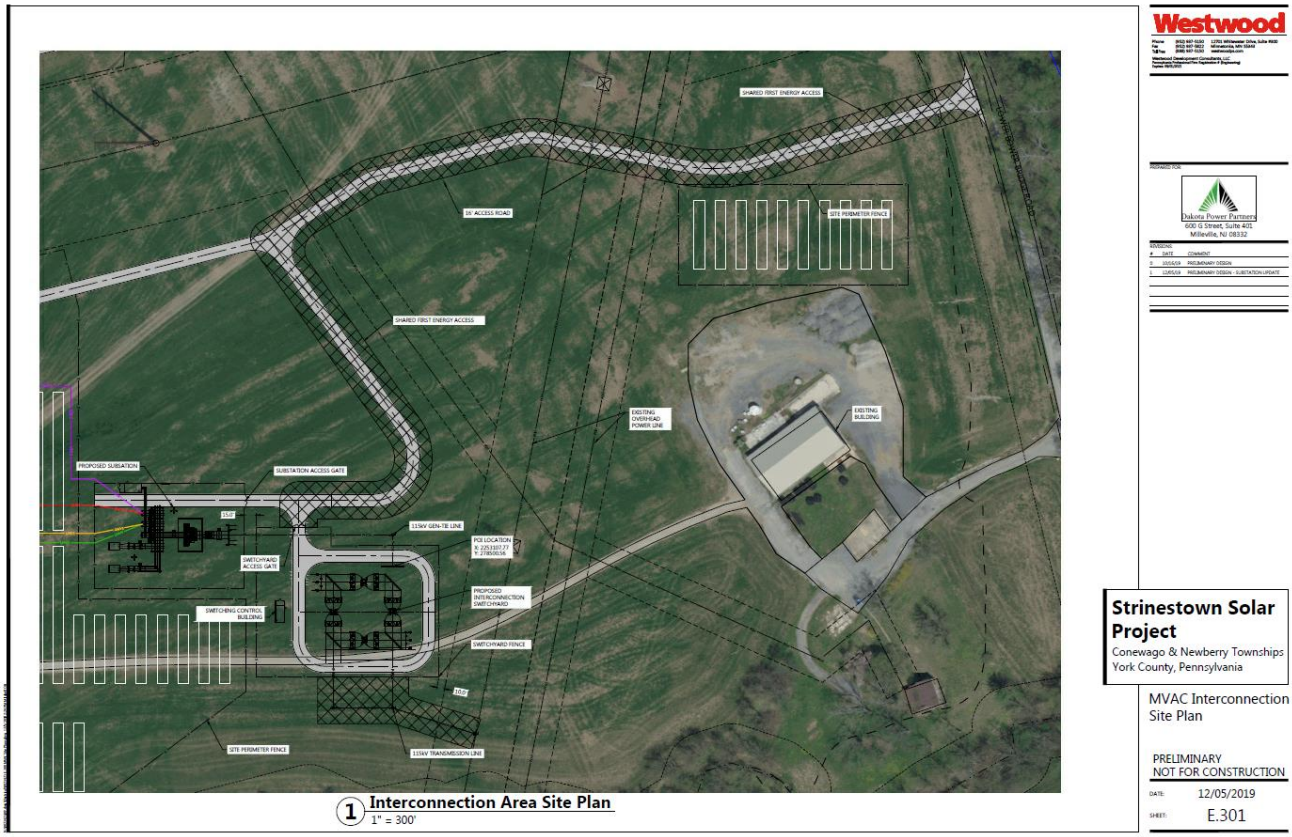


IC Facilities One-Line



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:	115 kV
• Maximum phase-to-phase:	121 kV
• Basic impulse level (BIL):	550 kV
• Maximum continuous current carrying capacity:	2000 A

- Design fault current: 40 kA
- Single Contingency (breaker failure) clearing time: 30 cycles

Clearances and Spacing

- Recommended rigid bus center-to-center phase spacing: 84”
- Minimum phase-to-phase, metal-to-metal distance: 53”
- Recommended phase-to-ground: 45”
- Minimum phase-to-ground: 42”
- Minimum vertical clearance from live parts to grade: 11’-7”
- Minimum horizontal clearance from live parts: 6’-1”
- Minimum conductor clearance above roads in switchyard: 20’-2”
- Minimum bottom of insulator to top of foundation: 8’-6”