

***Generation Interconnection  
Facilities Study Report***

***For***

***PJM Transmission Interconnection Request  
Queue Position AE2-226***

***“Millville-Old Chapel 138 kV”***

***September 2022***

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## ***Preface***

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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 IC 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**

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### ***1. Description of Project***

TCE Virginia Development LLC, (hereinafter referred to as “Developer”) has proposed a solar generating facility located in Jefferson County, West Virginia. The installed facilities for AE2-226 will have a total capability of 99 MW with 59.4 MW of this output being recognized by PJM as capacity. The generation facility will interconnect with The Potomac Edison Company (PE) a FirstEnergy Company (FE), hereinafter referred to as “Transmission Owner” (TO), at a newly constructed 138 kV three-breaker ring bus substation tapped off of the Wheatland (proposed)-Old Chapel -Double Toll Gate 138 kV transmission line.

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

The scope of work in this report is based on the revised System Impact Study Report posted on the PJM website dated February 2021 except as noted.

The PJM Queue Position AD2-158 has executed an ISA and is responsible to construct an Interconnection Substation for their project (known as Wheatland) approximately 1.2 miles from AE2-226 proposed point of interconnection on the Millville-Old Chapel portion of the 138kV line.

This report does not include any Rappahannock REC scope of work.

The IC has elected the Option to Build the interconnection substation.

### **3. Interconnection Customer's Milestone Schedule**

IC's requested Commercial Operation Date (COD) for the generation facility is **August 29, 2025**.

#### **Milestone Schedule:**

|                 |                                                   |
|-----------------|---------------------------------------------------|
| May 31, 2025    | Initial Back-feed through Project Substation Date |
| August 29, 2025 | 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, 138 kV (AE2-226) generator lead line and connection to the new 3 breaker ring bus interconnection substation.

**Point of Interconnection (POI):** The POI will be located within the new 138 kV ring bus interconnection substation where IC-owned 138 kV attachment line conductor will terminate on the insulators on the dead-end takeoff structure and will be defined as the POI.

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 138 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 138 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 138 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 138 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 138 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.

## ***5. Description of Facilities Included in the Facilities Study***

### **Attachment Facilities**

The IC has exercised their option-to-build these facilities, so they will design, furnish and construct the new 138 kV line terminal and take off structure in the new AE2-226 ring bus substation. This work will include, but not be limited to, installation of a 138 kV line exit take-off structure, foundations, disconnect switch and associated equipment to accommodate the termination of the 138 kV generator lead line. Transmission Owner will oversee the design and construction and perform testing and commissioning.

### **Direct Connection**

#### **AE2-226 Interconnection Substation**

The IC has exercised their option-to-build these facilities, so they will design, furnish and construct a new 138 kV three breaker ring bus substation along the Millville-Wheatland (proposed)-Old Chapel-Double Toll Gate 138 kV transmission line to interconnect the AE2-226 solar project with the PE transmission system. The POI will be at the TO-owned dead-end structure inside the Kabletown substation yard where the generator lead line terminates. Transmission Owner will oversee the design and construction and perform testing and commissioning.

#### **Kabletown Substation Fiber Installation**

Install fiber from Kabletown Substation to AD2-158 Interconnection for communication transport.

#### **SCADA/Fiber Communication**

Design, install, and test/commission MPLS Equipment at Kabletown for SCADA transport.

### **Non-Direct Connection**

#### **Old Chapel to Millville 138 kV line**

The Old Chapel to Wheatland (proposed) 138 kV line will be cut and looped into the interconnection substation. This cut will take place at a location that is approximately 8.4 miles from the Old Chapel substation and 6.0 miles from the Millville substation. It is assumed that the new interconnection substation will be located within one span (approximately 300 feet) from the existing line.

#### **Old Chapel Substation**

The existing SCADA RTU will be modified and drawings and nameplates will be updated.

**Double Toll Gate Substation**

A new wave trap and line tuner will be installed and relay settings will be adjusted. Drawings and nameplates will be updated.

**Wheatland Substation (AD2-158 Interconnect)**

The existing wave trap and line tuner will be removed. A fiber converter will be installed and relay settings will be adjusted. Drawings and nameplates will be updated.

**Other Work****AE2-226 Interconnection Substation**

Oversight for construction of new Kabletown 138 kV substation as a 3-breaker ring bus looping in and out the Old Chapel – Millville 138 kV line.

**AE2-226 Customer Substation**

Drawings, nameplates, and high voltage circuit diagram will be reviewed.

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

| <b>Description</b>                                      | <b>Total</b>          |
|---------------------------------------------------------|-----------------------|
| <b>Attachment Facilities:</b>                           | <b>\$0</b>            |
| <b>Total Direct Connection (DC) Costs:</b>              | <b>\$414,269.50</b>   |
| <b>Total Non-Direct Connection (NDC) Upgrade Costs:</b> | <b>\$1,474,024.74</b> |
| <b>Other Costs:</b>                                     | <b>\$2,302,847.00</b> |
| <b>New System Upgrades</b>                              | <b>\$0</b>            |

|                                     |                       |
|-------------------------------------|-----------------------|
| <b>TOTAL Costs (ALL Categories)</b> | <b>\$4,237,195.24</b> |
|-------------------------------------|-----------------------|

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

For this project which the Interconnection Customer has elected Option to Build the Transmission Owner Attachment and Direct Connection facilities, a proposed **twenty (20) month** schedule is estimated to complete the engineering, construction and the associated Non-direct Connection activities, from the later of the date of a fully executed Interconnection Construction Service Agreement and Construction Kick-Off Meeting or upon TO's receipt of IC's locational data and design parameters for the dead-end structure(s) for final tie-in connections. 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 or January through March) will occur as planned. Construction cannot begin until after all applicable permits and/or easements have been obtained.

| <i>Attachment Facility</i>                 | <i>Duration</i> |
|--------------------------------------------|-----------------|
| Engineering, Procurement, and Construction | 20 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

#### Old Chapel – Millville 138kV Line

- Description of Work
  - Loop the Old Chapel-Millville 138kV line in and out of the new Kabletown substation (see proposed layout KMZ for line layout)
- Existing Conditions
  - The existing line is constructed on single circuit wood h-frame structures. Per TAMI, existing conductor is 556.5 kcmil 26/7 ACSR, and existing shield wire is (2) 1/2" 7 Strand EHS Steel.
- Structures Installed
  - (2) 138kV single circuit wood monopole dead-end structures (TR-138030)
  - Approximately (0.1) circuit miles of 556.5 kcmil 26/7 ACSS "Dove" shielded by (2) 7#8 Alumoweld shield wires.
  - Existing conductor and shield wire will be transferred to the west side of structure 131A, and the east side of structure 131B. See the KMZ for approximate locations of structure 131A and 131B.
    - It is assumed that the existing conductor and shield wire are in good condition and can be transferred to the new structures.
- Structures Removed
  - Approximately (0.1) miles of the existing conductor and shield wire between the new structures 131A and 131B will be removed.
- Construction Considerations
  - The line will be rolled from a horizontal configuration to a vertical configuration on the new dead-end structures.
- Siting/Licensing

- A LON will be required.
- Assumptions
  - The developer drawing shows the proposed switchyard under the current 138kV line between structures 130 and 131. It is proposed that the new switchyard and corresponding loop structures will be located between structures 131 and 132 in order to locate both the switchyard and substation outside of the Line ROW.
  - Assume existing structures 131 and 132 are in good condition and have adequate capacity for any new loading arrangement. An engineering analysis during project development will be required to confirm.
  - A ground survey of the project area will be required.
  - Assume OPGW is not required.
- Ancillary Line Estimates
  - PROJECT MANAGEMENT (PM)
    - Project management will be required for this asset.
  - FORESTRY
    - Some clearing may be required, priority tree rights may be expanded.
  - RE/ROW
    - Assume all work will be performed within the existing ROW or on substation property. However, guying rights may need to be modified.
    - Additional ROW may be required to accommodate guying.
    - New Tline easement may be required on FE owned substation property.
    - 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 permitting requirements.
  - REVENUE METERING
    - None
  - IT/NETWORK
    - FIBER (RELAYING AND COMMUNICATION)
      - None
    - SCADA
      - None
  - ACCESS ROAD CONSTRUCTION
    - Assume the site will be accessed from the substation property and only minor additional access improvements will be required.
  - DISTRIBUTION
    - None

### **3. New Substation/Switchyard Facilities**

#### **Kabletown (Customer has selected the Option-To-Build)**

- Below Grade
  - Drainage, stone, and fence as required for the new 138kV yard
  - Foundations, conduit & cable trench, and ground grid as required for new 138kV equipment

- Conduit from AE2-226 line and Wheatland terminals to control building for fiber termination.
- Above Grade
  - Install (3) 138kV SF6 circuit breakers
  - Install (6) 138kV 2000A manual, GOAB breaker disconnect switches
  - Install (3) 138kV 2000A motor-operated line disconnect switches
  - Install (1) 138kV 2000A wave traps, line tuner, and coax
  - Install (9) 138kV CVTs
  - Install (9) 138kV surge arresters
  - Install (1) 138kV SSVT
  - Install (1) prefabricated control building
  - Install (2) 240/120V fused disconnects
  - Install (1 lot) steel structures and insulators for bus supports
  - Install (1 lot) steel and insulators for (2) H-frame dead-ends
  - Install (1 lot) steel for (7) switch stands
  - Install (1) SSVT stand
  - Install (1 lot) rigid bus, wire, insulators and fittings
- Relay & Control
  - Double Toll Gate Line Terminal:
    - Install (1) line relaying panel consisting of PR SEL-421 and BU SEL-411L
    - Install (1) carrier panel consisting of (1) RFL-9785, (1) RFL-9780 RX, (1) Powercomm PCM 5350, and (1) RFL Hybrid Chassis
  - Wheatland Line Terminal:
    - Install (1) line relaying panel consisting of PR SEL-421 with SEL-2829MXO and BU SEL-411L
  - AE2-226 Line Terminal:
    - Install (1) line relaying panel consisting of dual SEL-411L
  - Install (3) BF relay panel with metering and breaker controls
  - Install (1) SCADA RTU
  - Install (1) HMI panel
  - Install (1) lot of standard communication equipment (RTAC, GPS clock, etc)
- Additional Equipment to be Removed
  - None
- Assumptions
  - Rough graded site and access road provided by developer
  - Property can be obtained and sited as required for new 138kV substation
  - Outages can be obtained to complete work by need date
  - Emergency AC source will be offsite distribution source
- **Ancillary Substation Estimates**
  - PROJECT MANAGEMENT (PM)
    - Project management will be required for this asset.
    - Support as required for off-site AC source
  - FORESTRY
    - None

- RE/ROW
  - Provided by developer
- ENVIRONMENTAL
  - Support as required for new substation
- REVENUE METERING
  - None
- IT/NETWORK
  - FIBER (RELAYING AND COMMUNICATION)
    - Support as required for fiber comms to AE2-226
    - Support as required for fiber comms to Wheatland
  - SCADA
    - Install new RTU and HMI panel for three breaker ring bus

#### **AE2-226 Customer Substation**

- Below Grade
  - None
- Above Grade
  - Review nameplates, drawings, and high voltage circuit diagram
- Relay & Control
  - None
- Additional Equipment to be Removed
  - None
- Assumptions
  - None
- Ancillary Substation Estimates
  - PROJECT MANAGEMENT (PM)
    - Project management will be required for this asset.
  - FORESTRY
    - None
  - RE/ROW
    - None
  - ENVIRONMENTAL
    - None
  - REVENUE METERING
    - Support as required for revenue metering at customer substation
  - IT/NETWORK
    - FIBER (RELAYING AND COMMUNICATION)
      - None
    - SCADA
      - Modify EMS Screen

#### **4. Substation/Switchyard Facility Upgrades**

##### **Old Chapel**

- Below Grade
  - None
- Above Grade
  - Update drawings and nameplates for line name change
- Relay & Control
  - None
- Additional Equipment to be Removed
  - None
- Assumptions
  - None
- Ancillary Substation Estimates
  - PROJECT MANAGEMENT (PM)
    - Project management will be required for this asset.
  - FORESTRY
    - None
  - RE/ROW
    - None
  - ENVIRONMENTAL
    - None
  - REVENUE METERING
    - None
  - IT/NETWORK
    - FIBER (RELAYING AND COMMUNICATION)
      - None
    - SCADA
      - Modify existing SCADA RTU

##### **Double Toll Gate**

- Below Grade
  - None
- Above Grade
  - Update drawings and nameplates for line name change
- Relay & Control
  - Adjust relay settings for Millville terminal for Kabletown
- Additional Equipment to be Removed
  - None
- Assumptions
  - Relay upgrades associated with AD2-158 have been completed
  - New wave trap and tuner can be mounted on existing structures

- Existing SCADA RTU is sufficient for upgrades
- Existing control building has room for new panel
- Existing AC and DC station service are sufficient for upgrades
- Ancillary Substation Estimates
  - PROJECT MANAGEMENT (PM)
    - Project management will be required for this asset.
  - FORESTRY
    - None
  - RE/ROW
    - None
  - ENVIRONMENTAL
    - None
  - REVENUE METERING
    - None
  - IT/NETWORK
    - FIBER (RELAYING AND COMMUNICATION)
      - None
    - SCADA
      - Modify existing SCADA RTU

#### **Wheatland (AD2-158 Interconnection)**

- Below Grade
  - Conduit for fiber into control building
- Above Grade
  - Drawing updates and nameplates to change Double Toll Gate Terminal to Kabletown
- Relay & Control
  - Double Toll Gate Terminal (future Kabletown)
    - Add (1) SEL-2829MXO fiber converter to PR SEL-421
    - Adjust relay settings to use mirrored bits in the line relays for anti-islanding
    - Adjust Double Toll Gate relays for Kabletown
  - Install (1) FDP and fiber jumpers
- Additional Equipment to be Removed
  - (1) 138kV 2000A wave trap and line tuner
  - (1) RFL-9785, (1) RFL-9780, (1 lot) hybrids
- Assumptions
  - None
- Ancillary Substation Estimates
  - PROJECT MANAGEMENT (PM)
    - Project management will be required for this asset.
  - FORESTRY
    - None
  - RE/ROW

- None
- ENVIRONMENTAL
  - None
- REVENUE METERING
  - None
- IT/NETWORK
  - FIBER (RELAYING AND COMMUNICATION)
    - Support as required for fiber connection
  - SCADA
    - Support as required for point changes/additions

## 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 IC’s substation control house.

Transmission Owner will make the fiber termination connections for its cable(s) at the interconnection 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.

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 backfeeding 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 in the *Requirements for Transmission Connected Facilities* document located at the following links:

[www.firstenergycorp.com/feconnect](http://www.firstenergycorp.com/feconnect)

[www.pjm.com/planning/design-engineering/to-tech-standards.aspx](http://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.

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 West Virginia Public Service Commission (WVPSC) notifications vary, some up to twelve (12) months after preliminary engineering is completed to secure the required approvals.
- Prior to agreement by IC to purchase the property, a Phase 1 Environmental Assessment should be conducted for the entire site to avoid assumption of environmental liabilities by IC or Transmission Owner.
- The Transmission Owner interconnection substation may involve environmental surveys, permits, approvals and plans with federal, state, and/or local agencies.
- Assumed IC 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 IC, twelve (12)-to-eighteen (18) months should be added to the Project Schedule to secure necessary permits, and additional costs would apply.
- IC will provide copies of all of the relative environmental permits and other necessary approvals to Transmission Owner before Transmission Owner accepts the interconnection facilities.
- IC 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. IC is responsible to maintain access road and ensure unimpeded access for Transmission Owner at all times.
- IC is responsible for all property acquisition (including easements/rights-of-way (ROW)) for transmission, distribution and communication facilities needed for the generator interconnection.
- If IC 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. IC is responsible for all costs, including but not limited to subdivision, associated with the property transfer.
- If IC leases the project property, the IC 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 West Virginia Public Service Commission (WVPSC) notification/approval.
- All work occurs within an existing transmission line right-of-way or on IC’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.
- IC will develop, and secure regulatory approval for, all necessary Erosion and Sediment Control (E&SC) plans and National Pollutant Discharge Elimination System (NPDES) permits within their scope of work.
- IC will obtain all necessary permits within their scope of work. IC will not be responsible for permitting of work that is in the TO’s scope to complete.
- IC will conduct all necessary wetlands and waterways studies and permits within their scope of work. IC will not be responsible for studies and permits of work that is in the TO’s scope to complete.
- IC will conduct all necessary historical and archaeological studies within their scope of work. IC will not be responsible for historical and archaeological studies of work that is in the TO’s scope to complete.
- If the IC 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-ofway.html#ROWform>

## **8. Summary of Results of Study**

The following table provides a breakdown of the costs according to the description of work required to accommodate the requested interconnection. The estimated costs are in 2022 dollars. This cost excludes a Federal Income Tax Gross Up charges (CIAC (Contribution in Aid of Construction)). This tax may or may not be charged based on whether this project meets all qualifications and requirements as set forth in Section 118(a) and 118(b) of the Internal Revenue Code of 1986, as amended and interpreted by Notice 2016-36, 2016-25 I.R.B. (6/20/2016) (the “IRS Notice”). If at a future date it is determined that the Federal Income Tax Gross charge is required, the Transmission Owner shall be reimbursed by the Interconnection Customer for such taxes.

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

| Work Description                                                                                                                                                                      | Direct                |                    | Indirect            |                    | Total Cost without Tax |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|--------------------|---------------------|--------------------|------------------------|
|                                                                                                                                                                                       | Labor                 | Material           | Labor               | Material           |                        |
| <b>Total Attachment Facilities Cost</b>                                                                                                                                               | <b>\$0</b>            | <b>\$0</b>         | <b>\$0</b>          | <b>\$0</b>         | <b>\$0</b>             |
| <b>Kabletown Substation Fiber Installation:</b> Install fiber from Kabletown Substation to AD2-158 Interconnection for communication transport. (PJM Network Upgrade n7970)           | \$111,512.00          | \$11,660.00        | \$35,756.14         | \$3,762.04         | \$162,690.18           |
| <b>SCADA/Fiber Communication:</b> Design, install, and test/commission MPLS Equipment at Kabletown for SCADA transport. (PJM Network Upgrade n7971)                                   | \$110,452.00          | \$79,924.00        | \$35,416.26         | \$25,787.06        | \$251,579.32           |
| <b>Total Direct Connection Cost</b>                                                                                                                                                   | <b>\$221,964.00</b>   | <b>\$91,584.00</b> | <b>\$71,172.40</b>  | <b>\$29,549.10</b> | <b>\$414,269.50</b>    |
| <b>Millville-Old Chapel 138 kV Line:</b> Loop the Millville-Old Chapel 138 kV line into new AE2-226 interconnection sub. (PJM Network Upgrade n7965)                                  | \$741,549.12          | \$33,206.13        | \$237,776.54        | \$10,713.79        | \$1,023,245.58         |
| <b>Double Toll Gate:</b> Adjust relay settings and update drawings and nameplates. (PJM Network Upgrade n7966)                                                                        | \$39,205.25           | \$582.00           | \$12,571.10         | \$187.78           | \$52,546.13            |
| <b>Old Chapel:</b> Modify SCADA RTU and update drawings and nameplates. (PJM Network Upgrade n7967)                                                                                   | \$30,254.71           | \$579.40           | \$9,701.12          | \$186.94           | \$40,722.17            |
| <b>Wheatland (AD2-158 Interconnect):</b> Upgrade relaying as needed to accommodate the new AE2-226 generation queue project interconnection of 99 MW MFO. (PJM Network Upgrade n7968) | \$260,818.19          | \$9,875.46         | \$83,630.94         | \$3,186.27         | \$357,510.86           |
| <b>Total Non-Direct Connection Costs</b>                                                                                                                                              | <b>\$1,071,827.27</b> | <b>\$44,242.99</b> | <b>\$343,679.70</b> | <b>\$14,274.78</b> | <b>\$1,474,024.74</b>  |

|                                                                                                                                                                                                                          |                       |                     |                     |                     |                       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|---------------------|---------------------|---------------------|-----------------------|
| <b>AE2-226 Customer:</b> Review drawings and nameplates for FE standards.                                                                                                                                                | \$34,872.26           | \$0                 | \$11,181.74         | \$0                 | \$46,054.00           |
| <b>AE2-226 Interconnect:</b> Customer has selected the Option-To-Build: Oversight for construction of new Kabletown 138 kV substation as a 3-breaker ring bus looping in and out the Old Chapel – Millville 138 kV line. | \$1,412,159.37        | \$331,064.69        | \$452,806.64        | \$106,816.30        | \$2,302,847.00        |
| <b>Total Other Costs</b>                                                                                                                                                                                                 | <b>\$1,447,031.63</b> | <b>\$331,064.69</b> | <b>\$463,988.38</b> | <b>\$106,816.30</b> | <b>\$2,348,901.00</b> |
| <b>Total Project Costs</b>                                                                                                                                                                                               | <b>\$2,740,822.90</b> | <b>\$466,891.68</b> | <b>\$878,840.48</b> | <b>\$150,640.18</b> | <b>\$4,237,195.24</b> |

### 9. Schedules and Assumptions

For this project which the Interconnection Customer has elected Option to Build the Transmission Owner Attachment and Direct Connection facilities, a proposed **twenty (20) month** schedule is estimated to complete the engineering, construction and the associated **Non-direct Connection activities**, from the later of the date of a fully executed Interconnection Construction Service Agreement and Construction Kick-Off Meeting or upon TO's receipt of IC's locational data and design parameters for the dead-end structure(s) for final tie-in connections. 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 or January through March) will occur as planned. Construction cannot begin until after all applicable permits and/or easements have been obtained.

#### 20 month Schedule

|                                    | Start | End   |
|------------------------------------|-------|-------|
| Activity                           | Month | Month |
| Preliminary Engineering            | 1     | 5     |
| Siting, Permits & Real Estate      | 2     | 10    |
| Detailed Engineering               | 2     | 10    |
| Equipment Delivery                 | 10    | 15    |
| Below Grade Construction – T-Lines | 15    | 16    |
| Above Grade Construction – T-Lines | 17    | 19    |
| Remote End Relay Installation      | 15    | 17    |
| Testing & Commissioning            | 17    | 20    |

FE will need to conduct an environmental survey for the loop and proposed interconnect substation. If permits are necessary to complete the project, approximately 6-12 months will be needed to draft and receive agency approvals.

## **Attachment #1: Protection Study**

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### **PROTECTION SCOPE**

SHORT CIRCUIT DATA for a fault at the proposed location of the connection of Kabletown SS on the existing Double Toll Gate - Wheatland 138kV line (Symmetrical Values Only) Initial conditions (percent on 100 MVA base)

#### **138kV**

$$Z1 = 0.647 + j 3.723\%$$

$$Z0 = 0.986 + j 5.530\%$$

3 phase fault – 11,109A

Single line to ground fault – 9957A 3I0

Note: These fault values do not include the AE2-226 Generator or GSU step up transformer nor AD2-158 Generator or GSU step up transformer as being modeled in the calculations.

Impedances are given on a 100 MVA and 138kV bases. The faults provided are bolted, symmetrical values for normal system conditions. 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.

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

These requirements assume the protection requirements and upgrades as part of AD2-158 (Wheatland) have been completed. If those have not been completed these requirements must be revised.

### **RELAY AND COMMUNICATION EQUIPMENT SCOPE**

#### **At Kabletown SS:**

#### **138kV Line Exit to Double Toll Gate**

Install the following:

- Three single-phase dual winding capacitor voltage transformers, dual ratio = 1200/700/1 (carrier facilities are only required on phase Z, but may be included with all three CVTs)
- 2000A wide band line trap (phase Z only)
- Wide band line tuner (phase Z only)

The protective relaying for the 138kV line to Double Toll Gate shall contain the following:

- SEL-421 relay for the primary line protection, which shall utilize a DCB scheme
- SEL-411L relay for the backup line protection, which shall utilize a step distance scheme, and also reclose the B-1 breaker for faults on the Double Toll Gate 138kV line
- SEL-501 relay for Bkr B-1 breaker failure
- LOR relay for Bkr B-1 breaker failure tripping
- RFL-9785 for DCB blocking carrier
- RFL-9780 Rx, for anti-islanding receive from Double Toll Gate
- SATEC digital multimeter
- RFL Hybrid chassis with one skewed hybrid
- PowerComm PCM5350

### **138kV Line Exit to Wheatland**

Install the following:

- Three single-phase dual winding capacitor voltage transformers, dual ratio = 1200/700/1
- OPGW fiber termination, including splice box at the base of the dead-end structure, and underground non-metallic fiber to a new fiber patch panel in the control building, with applicable fiber termination equipment.
- OPGW fiber to Wheatland SS for relay communication

The protective relaying for the 138kV line to Wheatland shall contain the following:

- SEL-421 relay for the primary line protection, which shall utilize a DCB scheme over mirrored bits
- SEL-2829MXO fiber converter for the SEL-421 relay
- SEL-411L relay for the backup line protection, which shall utilize a line differential scheme, and also reclose the B-1 breaker for faults on the Wheatland 138kV line
- SEL-501 relay for Bkr B-3 breaker failure
- LOR relay for Bkr B-3 breaker failure tripping
- SATEC digital multimeter

### **138kV Line Exit to Generator – Customer SS**

Install the following:

- Three single-phase dual winding capacitor voltage transformer, dual ratio = 1200/700/1 (carrier facilities are not required)
- OPGW fiber optic cable to customer substation for relaying digital communication channel

The protective relaying for the 138kV line to the generator shall contain the following:

- SEL-411L relay for the primary line protection, which shall utilize a line differential scheme with step distance backup
- SEL-411L relay for the backup line protection, which shall utilize a line differential scheme with step distance backup
- SEL-501 relay for Bkr B-2 breaker failure
- LOR relay for Bkr B-2 breaker failure tripping
- LOR relay for generation station breaker failure tripping (operate from transfer trip receive)
- SATEC digital multimeter

- SD relay (“27L”) for line potential monitoring (blocks all closing of Bkrs B-2 and B-3 if line from generator is hot)

AE2-226 will only close into this line if it is dead. All synchronizing is to be performed at the Generator Substation. No automatic reclosing will be applied.

#### **Additional items**

- GPS Clock, Arbiter 1094B, with antenna, 50 feet of cable, and antenna mounting kit
- SCADA and annunciator, details to be determined by Real Time Operations
- SEL RATC for remote access to SEL protective relays
- Test switches, fuses, and terminal blocks as deemed necessary

#### **At Wheatland SS:**

##### **138kV Line Exit to Kabletown**

Remove the following:

- 2000A wide band line trap
- Wide band line tuner
- RFL-9785
- RFL-9780
- Hybrid

Add the following:

- OPGW fiber termination, including splice box at the base of the dead-end structure, and underground non-metallic fiber to a new fiber patch panel in the control building, with applicable fiber termination equipment.
- SEL-2829MXO fiber converter to the SEL-421 relay
- Reconfigure the anti-islanding transfer trip connections from the RFL-9780 (which is to be removed) to the SEL-421 and SEL-411L, in parallel, with relay I/O as designated below:
- Key anti-islanding send: SEL-421 IN106, SEL-411L IN206
- Anti-islanding receive: SEL-421 OUT205, SEL-411L OUT305

##### **Generation Substation Protection Requirements for 138kV line to Kabletown SS**

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:

- Single phasing of supply
- 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

The generator owner (GO) is to design their protective system to clear any faults within their zones of protection with one or more of their local breakers. Each zone of protection covering the 138kV portion of the GO system (including the GSU(s)) is to be protected by two fully independent relay schemes that each provides high speed fault protection. The terminal breaker at the GO end of the direct connection line is to be included in one of these zones of protection. Two SEL-411L relays shall be used for protection of the interconnect line, to match the companion relays at AE2-226 Substation.

**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.**

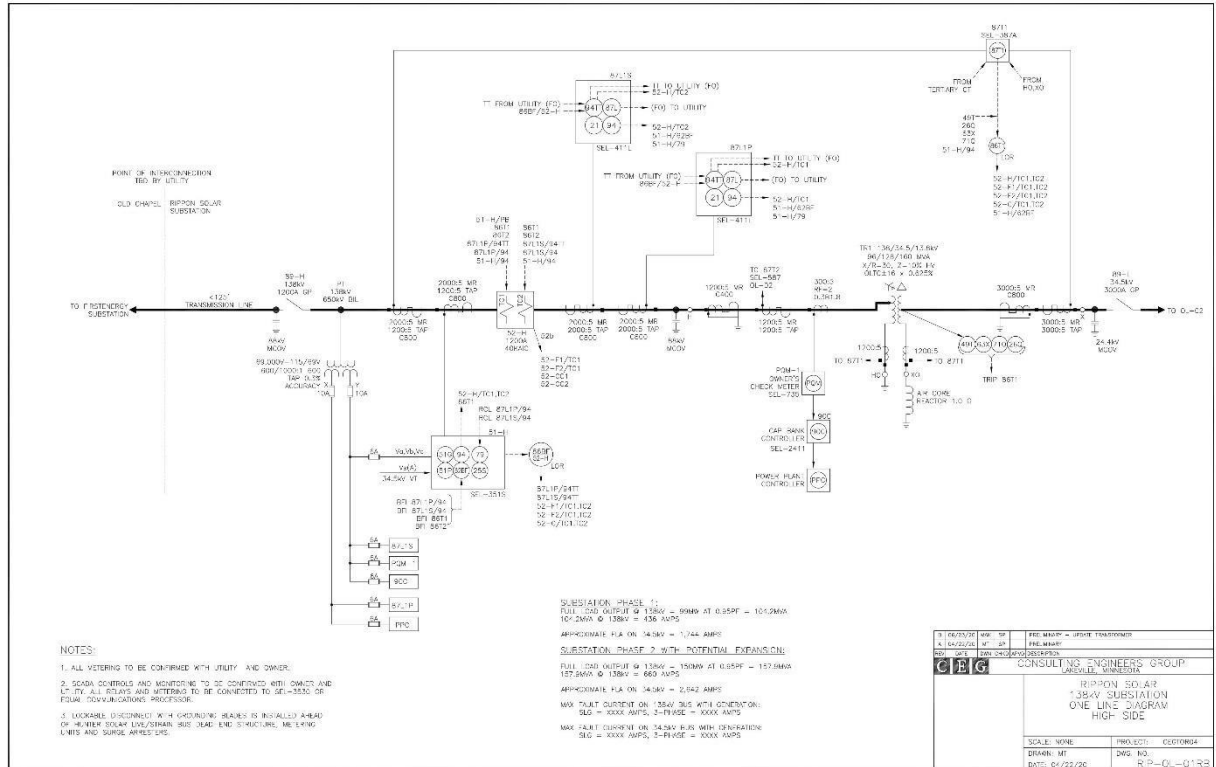
### **Metering Requirements**

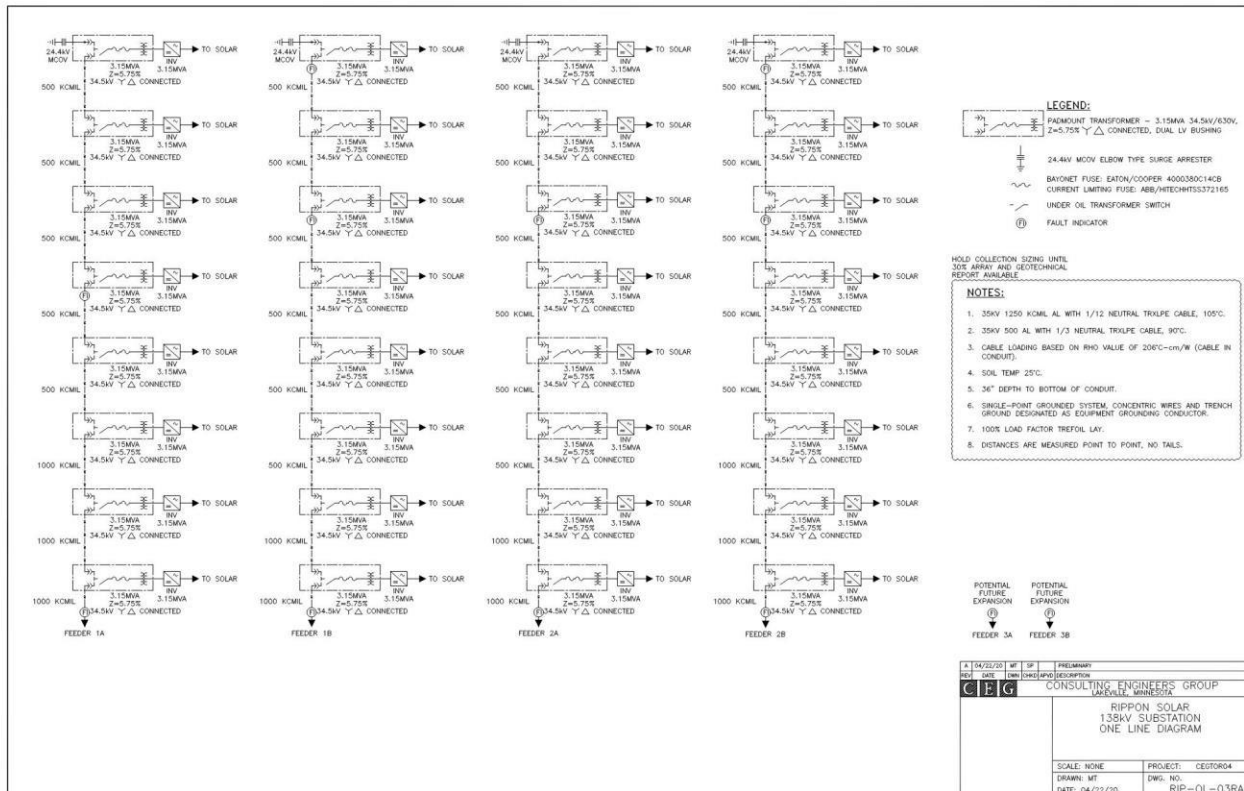
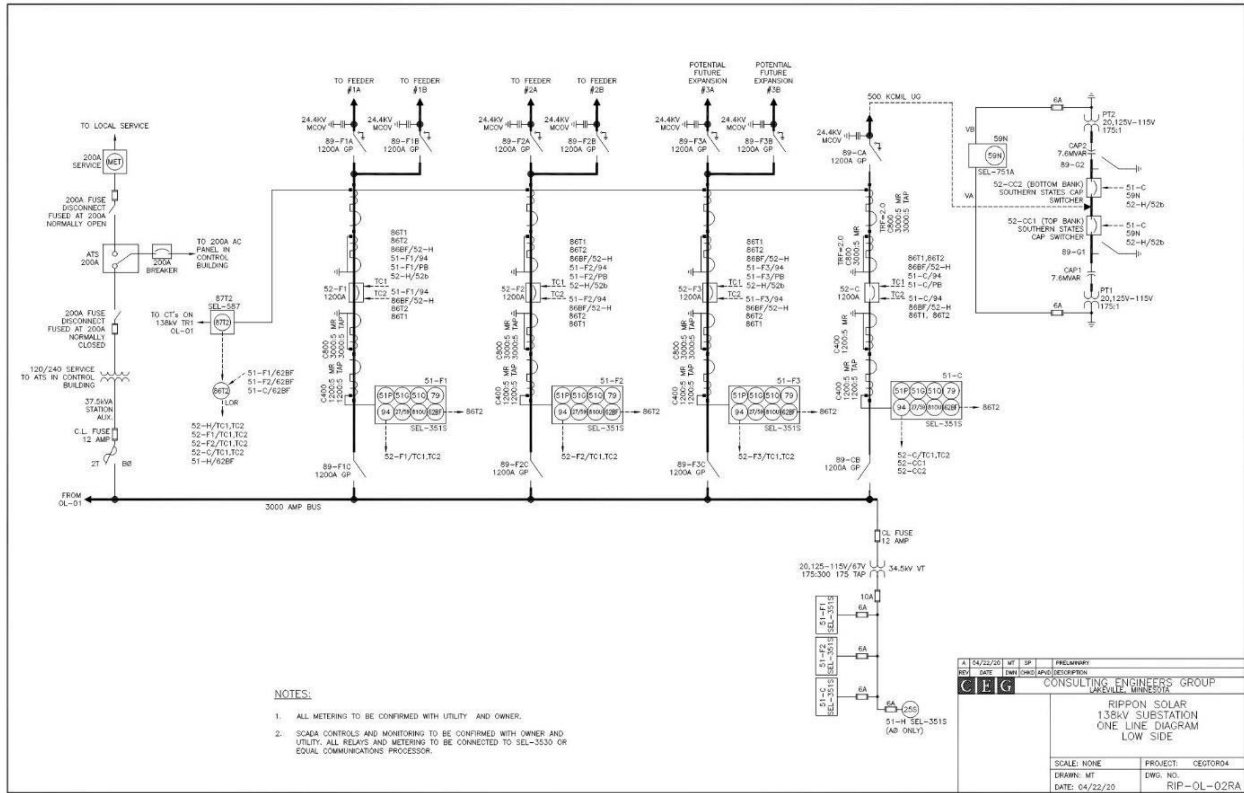
A revenue metering installation is required for this installation. Requirements are outlined in FirstEnergy's "Requirements for Transmission Connected Facilities" document.

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.

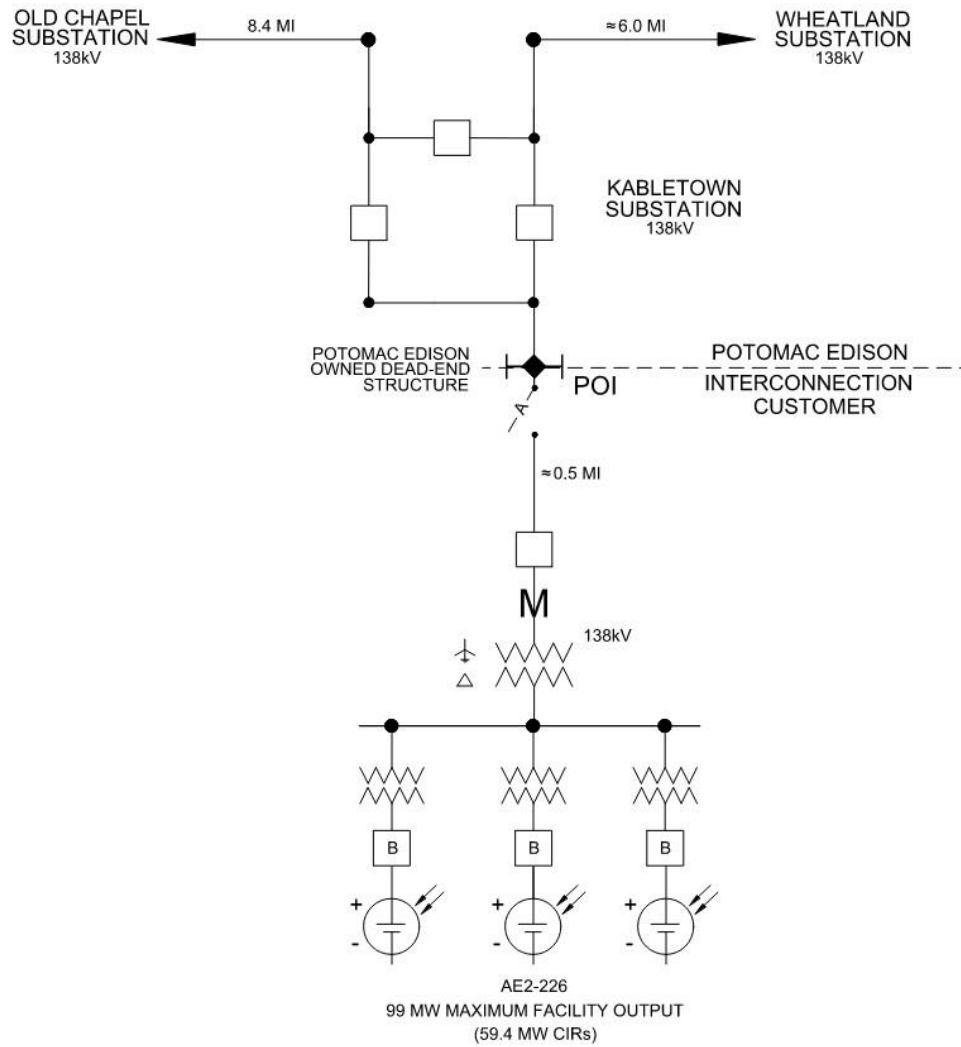
## Attachment #2: One-Line Diagrams

# IC One-Line (NOT APPROVED FOR CONSTRUCTION)





# FirstEnergy One-Line



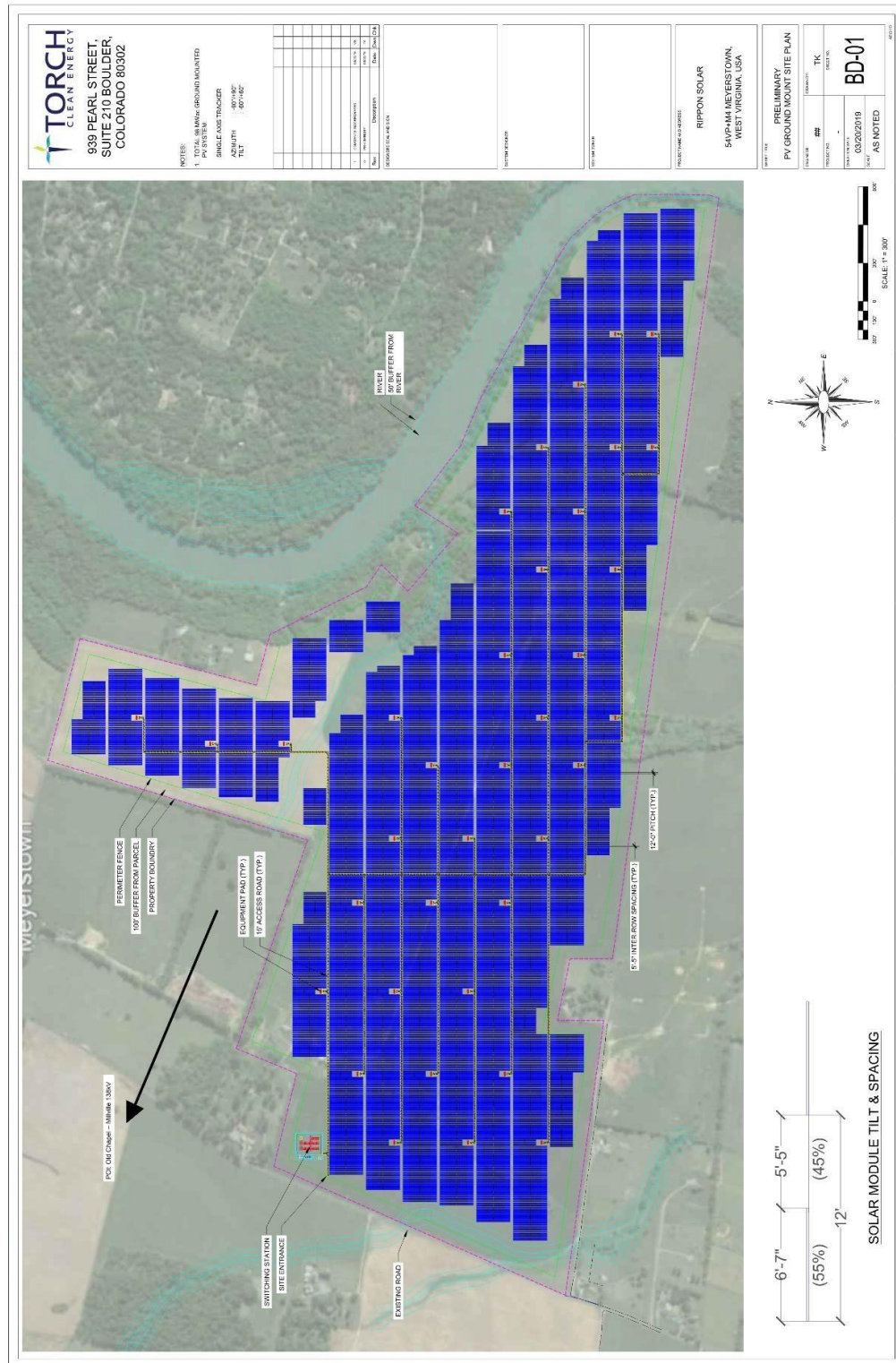
 = **POI (POINT OF INTERCONNECTION)** LOCATED AT POTOMAC EDISON SUBSTATION DEAD-END STRUCTURE, WHERE INTERCONNECTION CUSTOMER'S TRANSMISSION LINE TERMINATES

**M** = REVENUE METERING FOR INTERCONNECTION CUSTOMER IS OWNED, OPERATED, AND MAINTAINED BY THE INTERCONNECTION CUSTOMER

|                                                          |                    |                                                                                                   |                         |
|----------------------------------------------------------|--------------------|---------------------------------------------------------------------------------------------------|-------------------------|
| <b>FirstEnergy</b><br>Energy Delivery Technical Services |                    | <b>TITLE</b><br>AE2-226 INTERCONNECTION TO<br>THE POTOMAC EDISON OWNED KABLETOWN 138kV SUBSTATION |                         |
| BY: R J R                                                | DATE: 10/21/2021   | AGREEMENT                                                                                         | DOC. ID: POI-PE-AE2-226 |
| APP: -                                                   | ISSUE: PRELIMINARY |                                                                                                   | REV. A                  |

# Attachment #3: IC Site Plan and Substation Attachment Facilities

## IC Site Plan





## Attachment #4: Generation Connection Requirements

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### 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](http://www.firstenergycorp.com/feconnect)

[www.pjm.com/planning/design-engineering/to-tech-standards.aspx](http://www.pjm.com/planning/design-engineering/to-tech-standards.aspx)

*For projects that entered PJM's New Service Queue after November 1, 2016, the power factor requirement will be as follows:*

| Generation Type         | New / Increase | Size | Power Factor Requirement     | Measurement Location                              |
|-------------------------|----------------|------|------------------------------|---------------------------------------------------|
| Wind or Non-Synchronous | New            | All  | 0.95 leading to 0.95 lagging | High Side of the Facility Substation Transformers |

*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

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

### Transmission Design Requirements 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. IC 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)       | X-Y-Z                                                                               |
| • 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 7-98, per Fig. 6-1 depending on location                                   |
| • Ice loading – Substations (no wind):     | 25 mm                                                                               |
| • Seismic zone:                            | 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:                             | 138 kV    |
| • Maximum phase-to-phase:                             | 145 kV    |
| • Basic impulse level (BIL):                          | 650 kV    |
| • Maximum continuous current carrying capacity:       | 2000 A    |
| • Design fault current:                               | 40 kA     |
| • Single Contingency (breaker failure) clearing time: | 60 cycles |

### **Clearances and Spacing**

|                                                              |        |
|--------------------------------------------------------------|--------|
| • Recommended rigid bus center-to-center phase spacing:      | 96"    |
| • Minimum phase-to-phase, metal-to-metal distance:           | 63"    |
| • Recommended phase-to-ground:                               | 52.5"  |
| • Minimum phase-to-ground:                                   | 50"    |
| • Low bus height above top of foundations (match existing):  | 16'-0" |
| • High bus height above top of foundations (match existing): | 24'-0" |
| • Minimum vertical clearance from live parts to grade:       | 12'-2" |
| • Minimum horizontal clearance from live parts:              | 6'-8"  |
| • Minimum conductor clearance above roads in switchyard:     | 25'-0" |
| • Minimum bottom of insulator to top of foundation:          | 8'-6"  |