Transmission Interconnection Facilities Study Report

For

PJM Generation Interconnection Request
Queue Position AF2-150

"Galion 138 kV"

March 2023

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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 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

1. Description of Project

Blossom Solar, LLC, (hereinafter referred to as "IC") has proposed a solar generating facility located in York County, Pennsylvania. The installed facilities for AF2-150 will have a total capability of 88 MW with 36.96 MW of this output being recognized by PJM as capacity. The generation facility will interconnect with American Transmission Systems, Inc. (ATSI) a First Energy Company (FE), hereinafter referred to as "Transmission Owner" (TO), at the Galion 138 kV substation via the addition of a new 138 kV breaker and associated switches and buswork.

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

No amendments to the System Impact Study or System Impact Study Results posted on PJM's website in January 2023 were identified.

3. Interconnection Customer's Milestone Schedule

IC's requested Commercial Operation Date (COD) for the generation facility is **April 30, 2026**.

Assumed Milestone Schedule:

1/31/2026	Initial Back-feed through Project Substation Date
4/30/2026	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 (AF2-150/AG1-039) generator lead line and connection to the interconnection substation.

Point of Interconnection (POI): the point where IC's 138 kV generator Lead Line crossed the property line to the Galion Substation, approximately 0.3 miles from the fence line.

IC is required to own, install, and maintain a fully-rated, fault-interrupting circuit breaker on the 138 kV generator lead line that connects to the POI as well as the necessary revenue metering equipment. The revenue metering current and voltage transformers shall be installed 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 First Energy's applicable standards as well as with PJM requirements.

Developer will also purchase and install the minimum required FirstEnergy generation interconnection relaying and control facilities. This includes over/under voltage protection, over/under frequency protection, and zero sequence voltage protection relays The Developer will also purchase and install supervisory control and data acquisition (SCADA) equipment to provide information in a compatible format to the FirstEnergy Transmission System Control Center. Developer will provide for establishment of dedicated communication circuits for SCADA report to the FirstEnergy Transmission System Control Center.

The easements and associated rights of way for the 138 kV line will be acquired by the IC. Site preparation for the line including clearing, grading and an access road, as necessary, is assumed to be by the IC. 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

AF2-150Customer Substation

Customer protection and controls will be integrated into the FirstEnergy transmission system.

Galion-AF2-150 138 kV Line (New Asset) Interconnection

Approximately 0.3 miles of transmission line will be built from the Galion substation to the proposed AF2-150 POI.

Non-Direct Connection

Galion Substation (n8337.1)

A new line exit will be constructed via the addition of a 138 kV circuit breaker and associated equipment.

Roberts Substation (n8337.2)

Relay settings will be modified.

Cardington Substation (n8337.3)

Relay settings will be modified.

Leaside Substation (n8337.4)

Relay settings will be modified.

Ontario Substation (n8337.5)

Relay settings will be modified.

Other

AF2-150 Blossom Solar Generation Facility

Assistance will be provided in the design, checkout, and installation of the revenue metering system.

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

Description	Total
Attachment Facilities:	**$2,504,251**
Total Direct Connection (DC) Costs:	**$ 0**
Total Non-Direct Connection (NDC) Upgrade Costs:	**$2,524,159**
New System Upgrades	**$ 0**
Other	**$3,180**

TOTAL Costs (ALL Categories)	**$5,031,590**

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

Attachment Facility	*Duration*
Engineering, Procurement, and Construction	24 months

B. Transmission Owner Facilities Study Results

This section describes facilities identified to be installed (attachment facilities), replaced, and/or upgraded (upgrade facilities) by First Energy 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

Galion-AF2-150 138 kV Line (New Asset)

- Description of Work
  - Build approximately (0.3) miles of 138 kV 795 kcmil 26/7 ACSR from the Galion substation to the proposed AF2-150 POI.
- Existing Conditions
  - None
- Structures Installed
  - (1) single circuit wood monopole deadend structure TR-138030.
  - (2) single circuit wood monopole tangent structure TR-138010.
  - (1) single circuit wood monopole light angle structure TR-138020.
  - (1) single circuit steel monopole deadend structure on a drilled shaft foundation TR-138375.
  - (3) Substation deadend insulators
  - Approximately (0.3) circuit miles of 795 kcmil 26/7 ACSR conductor.
  - Approximately (0.3) miles ofOPGW.
- Structures Removed
  - None
- Construction Considerations
  - New line will cross under Galion-Roberts North 138 kV and Galion-Roberts South 138 kV.
- Siting/Licensing
  - Assume a LON will be required.
- Assumptions
  - A ground survey will be required.
  - Assume Galion Substation will remain energized during construction.
  - Structure location can be seen in the attached KMZ. Detailed modeling will be required in project development to confirm there is enough clearance under the existing 138 kV lines to construct the new line.

- **<u>Ancillary Line Estimates</u>**
  - PROJECT MANAGEMENT (PM)
    - Project management will be required for this asset.
  - FORESTRY
    - Some clearing may be required.
  - RE/ROW
    - A rights and restrictions review by Real Estate will be required.
    - New easements will be required
    - Georeferenced ROW extents will be required to be provided to engineering.
  - ENVIRONMENTAL
    - An environmental review will be required to identify any construction constraints or additional permitting requirements.
    - Tree clearing will be required for this line
  - REVENUE METERING
    - None
  - IT/NETWORK
    - FIBER (RELAYING AND COMMUNICATION)
      - (1) OPGW
    - SCADA
      - None
  - ACCESS ROAD CONSTRUCTION

- Access roads will be required along the entire route, approximately (0.3) miles. Terrain is flat
- DISTRIBUTION
  - None

2. Transmission Lines – Upgrade

None

3. New Substation/Switchyard Facilities

AF2-150 Generation Sub

- Below Grade
  - None
- Above Grade
  - Integrate customer protection and controls to the FirstEnergy transmission system.
- Relay & Control
  - None
- Additional Equipment to be Removed
  - None
- Assumptions
  - None

- **<u>Ancillary Substation Estimates</u>**
  - PROJECT MANAGEMENT (PM)
    - Project management will be required for this asset.
  - FORESTRY (FOR)
    - None
  - RE/ROW (RE-ROW)
    - None
  - ENVIRONMENTAL (ENV)
    - None
  - REVENUE METERING (METER)
    - None
  - IT/NETWORK
    - FIBER (RELAYING AND COMMUNICATION)
      - None
    - SCADA
      - Add customer substation to EMS screen.
  - TESTING & COMMISSIONING (TSCS)
    - Testing and commissioning services as required

4. Substation/Switchyard Facility Upgrades

Galion (n8337.1)

- Below Grade

  - Install foundations, conduit, and grounding for new equipment.
  - Conduit for fiber to AF2-150.
- Above Grade
  - Install (1) 138 kV, 3000A, 40kAIC circuit breaker.
  - Install (2) 138 kV 2000A GOAB breaker disconnect switches.
    - Install (1 lot) steel to create switch mounts on dead end structure.
  - Install (3) 138 kV CVTs on new support structure(s).
  - Install (3) 108 kV (84 kV MCOV) polymer surge arresters.
  - Install (1 lot) rigid bus, cable, grounding, fittings, and support structures.
    - Conductor to meet or exceed: SN:278MVA SE:339MVA WN:315MVA WE:401MVA.
- Relay & Control
  - Install (1) standard transmission relay panel with: (2) SEL411Ls and (1) SEL451 BFT.
  - Install (1) fiber distribution panel.
  - Install (1) lot of control cable.
- Additional Equipment to be Removed
  - Remove (1 lot) bus and support structures for new equipment.
- Assumptions
  - Line MOD not required due to station's current configuration.
  - New switches can be mounted to existing dead end structure with new steel beams.
  - New surge arresters can be mounted to existing dead end structure.
  - AC and DC services are adequate for new equipment.
  - SCADA RTU is adequate for new equipment.
  - Control house had adequate space for new equipment.

- **Ancillary Substation Estimates**
  - PROJECT MANAGEMENT (PM)
    - Project management will be required for this asset.
  - FORESTRY
    - None
  - RE/ROW
    - None
  - ENVIRONMENTAL
    - None
  - REVENUE METERING
    - Revenue metering at customer
  - IT/NETWORK
    - FIBER (RELAYING AND COMMUNICATION)
      - Support as required for fiber comms to AF2-150.
    - SCADA
      - Support as require for point changes/additions for new equipment.
  - TESTING & COMMISSIONING (TSCS)
    - Testing and commissioning services as required for new 138 kV equipment

Ontario (n8337.5)

- Below Grade
  - None
- Above Grade
  - None
- Relay & Control

- Revise relay settings.
- Additional Equipment to be Removed
  - None
- Assumptions
  - None

- **Ancillary Substation Estimates**
  - PROJECT MANAGEMENT (PM)
    - Project management will be required for this asset.
  - FORESTRY (FOR)
    - None
  - RE/ROW (RE-ROW)
    - None
  - ENVIRONMENTAL (ENV)
    - None
  - REVENUE METERING (METER)
    - None
  - IT/NETWORK
    - FIBER (RELAYING AND COMMUNICATION)
      - None
    - SCADA
      - None
  - TESTING & COMMISSIONING (TSCS)
    - Testing and commissioning services as required for revised relay settings.

Leaside (n8337.4)

- Below Grade
  - None
- Above Grade
  - None
- Relay & Control
  - Revise relay settings.
- Additional Equipment to be Removed
  - None
- Assumptions
  - None

- **Ancillary Substation Estimates**
  - PROJECT MANAGEMENT (PM)
    - Project management will be required for this asset.
  - FORESTRY (FOR)
    - None
  - RE/ROW (RE-ROW)
    - None
  - ENVIRONMENTAL (ENV)
    - None
  - REVENUE METERING (METER)
    - None
  - IT/NETWORK

        - FIBER (RELAYING AND COMMUNICATION)
            - None
        - SCADA
            - None
    - TESTING & COMMISSIONING (TSCS)
        - Testing and commissioning services as required for revised relay settings.

Cardington (n8337.3)

- Below Grade
    - None
- Above Grade
    - None
- Relay & Control
    - Revise relay settings.
- Additional Equipment to be Removed
    - None
- Assumptions
    - None

- **<u>Ancillary Substation Estimates</u>**
    - PROJECT MANAGEMENT (PM)
        - Project management will be required for this asset.
    - FORESTRY (FOR)
        - None
    - RE/ROW (RE-ROW)
        - None
    - ENVIRONMENTAL (ENV)
        - None
    - REVENUE METERING (METER)
        - None
    - IT/NETWORK
        - FIBER (RELAYING AND COMMUNICATION)
            - None
        - SCADA
            - None
    - TESTING & COMMISSIONING (TSCS)
        - Testing and commissioning services as required for revised relay settings.

Roberts (n8337.2)

- Below Grade
    - None
- Above Grade
    - None
- Relay & Control
    - Revise relay settings.
- Additional Equipment to be Removed
    - None
- Assumptions
    - None

- **Ancillary Substation Estimates**
    - PROJECT MANAGEMENT (PM)
        - Project management will be required for this asset.
    - FORESTRY (FOR)
        - None
    - RE/ROW (RE-ROW)
        - None
    - ENVIRONMENTAL (ENV)
        - None
    - REVENUE METERING (METER)
        - None
    - IT/NETWORK
        - FIBER (RELAYING AND COMMUNICATION)
            - None
        - SCADA
            - None
    - TESTING & COMMISSIONING (TSCS)
        - Testing and commissioning services as required for revised relay settings.

5. Telecommunications Facilities – Upgrades

IC will design, provide, install, own and maintain a fiber-optic communications cable between Galion 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 its interconnection 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. IC shall provide Transmission Owner with dial-up communication to the revenue meter.

The revenue metering system (particularly the revenue metering current transformers) shall be designed to accurately meter the light loads that will occur when the facility is not generating power and only back-feeding station service from the Transmission Owner. This 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 (exception: For the AF2 queue, see above regarding ownership, from the AG2 queue forward, FE will own the revenue metering):

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 (Galion).

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 Galion 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 Ohio Power Siting Board (OPSB) notifications vary, some up to twelve (12) months after preliminary engineering is completed to secure the required approvals.
- 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 responsible for all property acquisition (including easements/rights-of-way (ROW)) for transmission, distribution and communication facilities needed for the generator interconnection.
- 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 permitting 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 studies for 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-of-way.html#ROWform

8. Summary of Results of Study

Work Description	Direct Labor	Direct Material	Indirect Labor	Indirect Material	Total Cost
AF2-150Customer: Integrate customer protection and controls to the FirstEnergy transmission system.	$447,091	$4,266	$140,955	$1,839	$594,151
Galion-AF2-150 138 kV Line (New Asset) Interconnection: Build approximately (0.3) miles of 138 kV 795 kcmil 26/7 ACSR from the Galion substation to the proposed AF2-150 POI.	$1,310,139	$149,441	$413,048	$37,472	$1,910,100
Total Attachment Facilities Cost	**$1,757,230**	**$153,707**	**$554,003**	**$39,311**	**$2,504,251**
Total Direct Connection Cost	$0	$0	$0	$0	$0
Galion: Construct a new line exit out of the Galion Substation by adding a new 138 kV breaker. (n8337.1)	$1,274,981	$333,215	$401,964	$124,815	$2,134,975
Roberts: Modify Relay Settings (n8337.2)	$73,974	$0	$23,322	$0	$97,296
Cardington: Modify Relay Settings (n8337.3)	$73,974	$0	$23,322	$0	$97,296
Leaside: Modify Relay Settings (n8337.4)	$73,974	$0	$23,322	$0	$97,296
Ontario: Modify Relay Settings (n8337.5)	$73,974	$0	$23,322	$0	$97,296
Total Non-Direct Connection Cost	$1,570,877	$333,215	$495,252	$124,815	$2,524,159
Customer-owned 138 kV revenue metering at AF2-150 Blossom Solar generation facility. Meter Engineering will provide assistance to the developer on the revenue metering design, perform a remote meter checkout, and facilitate the meter's installation in the FE MV-90 system.	$2,418	$0	$762	$0	$3,180
Other Costs	**$2,418**	**$0**	**$762**	**$0**	**$3,180**
Total Project Costs	**$3,330,525**	**$486,922**	**$1,050,017**	**$164,126**	**$5,031,590**

[redacted]

The table above provides a breakdown of the costs according to the description of work required to accommodate the requested interconnection. The estimated costs are in 2021 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.

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. This must be included in Schedule E of the Interconnection Service Agreement.

9. Schedules and Assumptions

A proposed **twenty-four (24) 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.

24 month Schedule

Activity	Start Month	End Month
[redacted]		
Preliminary Engineering	1	3
Siting, Permits & Real Estate	2	8
Detailed Engineering	6	9
Equipment Delivery	9	10
Below Grade Construction – Substation	10	17
Below Grade Construction – T-Lines	10	17
Above Grade Construction – Substation	17	23
Above Grade Construction – T-Lines	17	23
Testing & Commissioning	23	24

Permitting may be needed for the substation and permitting can take anywhere from 6-12 months after preliminary engineering is received. The schedule above assumed 6 months, and actual timing will be determined after advanced engineering.

Attachment #1: Protection Study

PJM AF2-150Preliminary Short Circuit Duties & Protection Requirements

(11-09-2021)

Short Circuit Analysis

Short Circuit Values

The preliminary 138 kV fault values at the AF2-150interconnection location is: Three phase

= 23kA
Single line to ground = 22.7kA
Z1= (0.2 + j 1.83)%
Z0= (0.3 + j 1.74)%

These values are provided for bolted, symmetrical faults under present normal system conditions and are provided on a 138 kV, 100MVA base. Future increases in fault currents are possible and it is the customer's responsibility to upgrade their equipment and/or protective equipment coordination when necessary. These are present short circuit values do not consider the impacts of the AF2-150or any other project presently being studied as part of the PJM New Services Queue.

Protection Requirements

The AF2-150 facility shall consist of inverter-based PV and connect directly to the Galion substation 138 kV bus via a dedicated line. It is understood that the customer will be using a single 138-34.5 kV transformer rated 57/75/95 MVA to step up for all queue positions.

AF2-150138 kV Station

Main 138/34.5 kV Transformer

- The interconnecting 138-34.5 kV transformer shall be connected wye grounded on the transmission (138 kV) side and delta connected on the low (34.5 kV) side.
- One 138 kV, three-phase circuit breaker will be required on the FE side of the customer's main 138/34.5 kV wye grounded/delta transformer.
- The circuit breaker shall be fully rated to interrupt available fault current when calculated according to the latest ANSI standard.
    - Bypass switches shall NOT be installed across the breaker. If the customer desired the added reliability benefit of being able to keep the substation energized while performing breaker maintenance, a ring bus or dedicated sparing circuit breaker is required.
    - If the circuit breaker uses gas as an interrupting medium, the device shall be equipped with a low gas pressure alarming/tripping/lockout scheme (as appropriate for the particular device) in order to minimize the possibility of a transmission fault resulting from a loss of insulating gas.
- The interconnecting transformer and all 138 kV facilities at the customer substation shall have redundant, high-speed protection inclusive of the 138 kV breaker and high-side metering and

shall trip, at minimum, this breaker. Separate CTs and tripping paths are required between the primary and backup relaying.

- Primary Transformer Differential Protective Relay – minimum functions: 87TP. (FE standard device is SEL-587 or SEL-487E)
  - The 138 kV source for primary transformer differential protection shall be CTs on the utility source side of the transformer breaker. The low side source for primary differential protection shall be CTs on the bus side of the low side transformer breaker
- Backup Transformer Differential Protective Relay - minimum functions: 87TB. (FE standard device is SEL-587 or SEL-487E)
  - The 138 kV source for backup transformer differential protection shall be CTs on the utility source side of the transformer breaker separate from the primary differential relay. The low side source for backup differential protection shall be CTs on the bus side of the low side transformer breaker separate from the primary differential relay
- Breaker Failure (BF) Relay – Dedicated breaker failure relay with associated hand-reset lock out relay (LOR). Will be wired to transfer trip the breakers at Galion to isolate from the transmission system if there is a failure to trip operation. (FE standard device is SEL-501 or SEL-451-5).
  - Direct transfer trip for breaker failure, anti-islanding, and other functions as needed shall be communicated via fiber using the associated SEL-411L primary and backup relays. Trip on loss of channel to both the primary and backup schemes.

- CTs used for the zones of protection covering the high voltage portion of the customer's system shall use C800 relay accuracy CTs. These CTs should not saturate for the maximum through-fault current that can be experienced by the relay for the tap ratio in use.
- The relaying system shall have a reliable source of power independent from or immune to disturbances/loss of the AC system (e.g. DC battery and charger) to ensure proper operation of the protection schemes and tripping of the circuit breakers.
- The customer will be required to coordinate with upstream protection. It is solely the customer's responsibility to install and design their relaying to ensure adequate protection of their equipment.
- Detailed one-line diagrams with proposed protection should be provided well in advance of design and engineering to allow for approval of the protection scheme and preliminarily validate coordination with FE system.
- The low-side of the transformer shall have a dedicated circuit breaker with CTs adequate for use with, at minimum, the transformer differential relaying.

138 kV Line and Intertie Relaying

- The line between Galion and AF2-150station will require redundant fiber optic based communications channels to be installed and maintained between the facilities for use with high-speed line current differential protection.
  - Separate primary and backup SEL-411L relays at the AF2-150station will be required. Separate primary and backup SEL-411L relays will also be required at Galion.
  - Intertie relay functionality (e.g. overfrequency, underfrequency, phase and ground overvoltage, directional overcurrent, and directional power) will be incorporated into the SEL-411L line relaying as necessary

- The source CTs for the line current differential relays at the customer station shall be separate sets of 2000:5 CTs (C800 or better). These shall be located in the transformer-side bushings of the customer's high-side breakers
  - Line and transformer zones of protection overlap through the breaker.
- The primary SEL-411L relays shall be sourced from an inner set of CTs and the backup SEL-411L relays sourced from an outer set of CTs on the transformer side of the customer's high-side breaker such that the backup SEL-411L scheme encompasses the primary.
- PTs with separate secondary windings on the high/transmission-side of the interconnecting transformer with separate tripping paths are required for the line/intertie relays.
- Any sync check for manual/SCADA close on the interconnecting line is to be done at the AF2-150generating station.

Generator Owner's System Protection

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

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

Relay	**Function**
Frequency	To detect underfrequency and overfrequency operation.
Overvoltage	To detect overvoltage operation.
Undervoltage	To detect undervoltage operation.
Ground Fault Detector	To detect a circuit ground on the FE Transmission System.
Phase Fault Detector	To detect phase to phase faults on the FE Transmission System.
Transfer Trip Receiver	To provide tripping logic to the generation owner for isolation of the generation upon opening of the FE supply circuits.
Directional Power	To detect, under all system conditions, a loss of FE primary source. The relay shall be sensitive enough to detect transformer magnetizing current supplied by the generation.

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

www.firstenergycorp.com/feconnect

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

FE System Modifications

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

Settings Changes

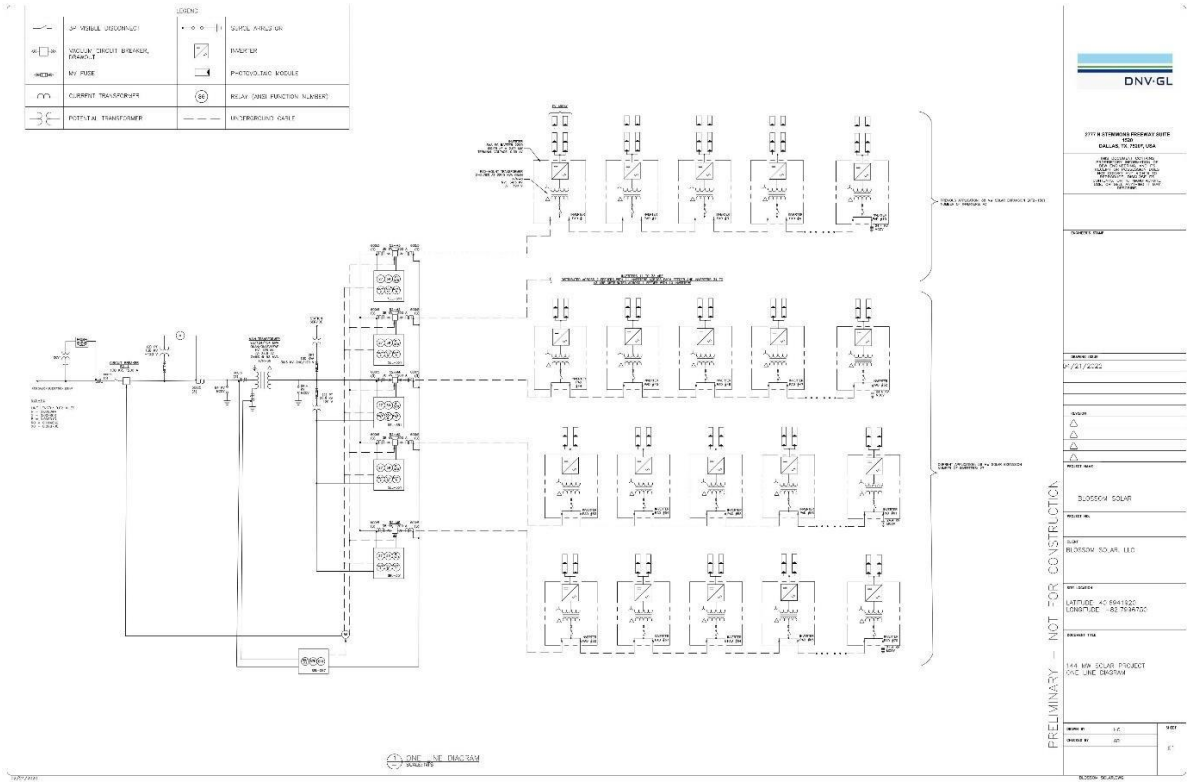
Settings changes are possible at, but not limited to, the following stations:

- Roberts N
- Roberts S
- Leaside
- Galion
- Ontario
- Cardington

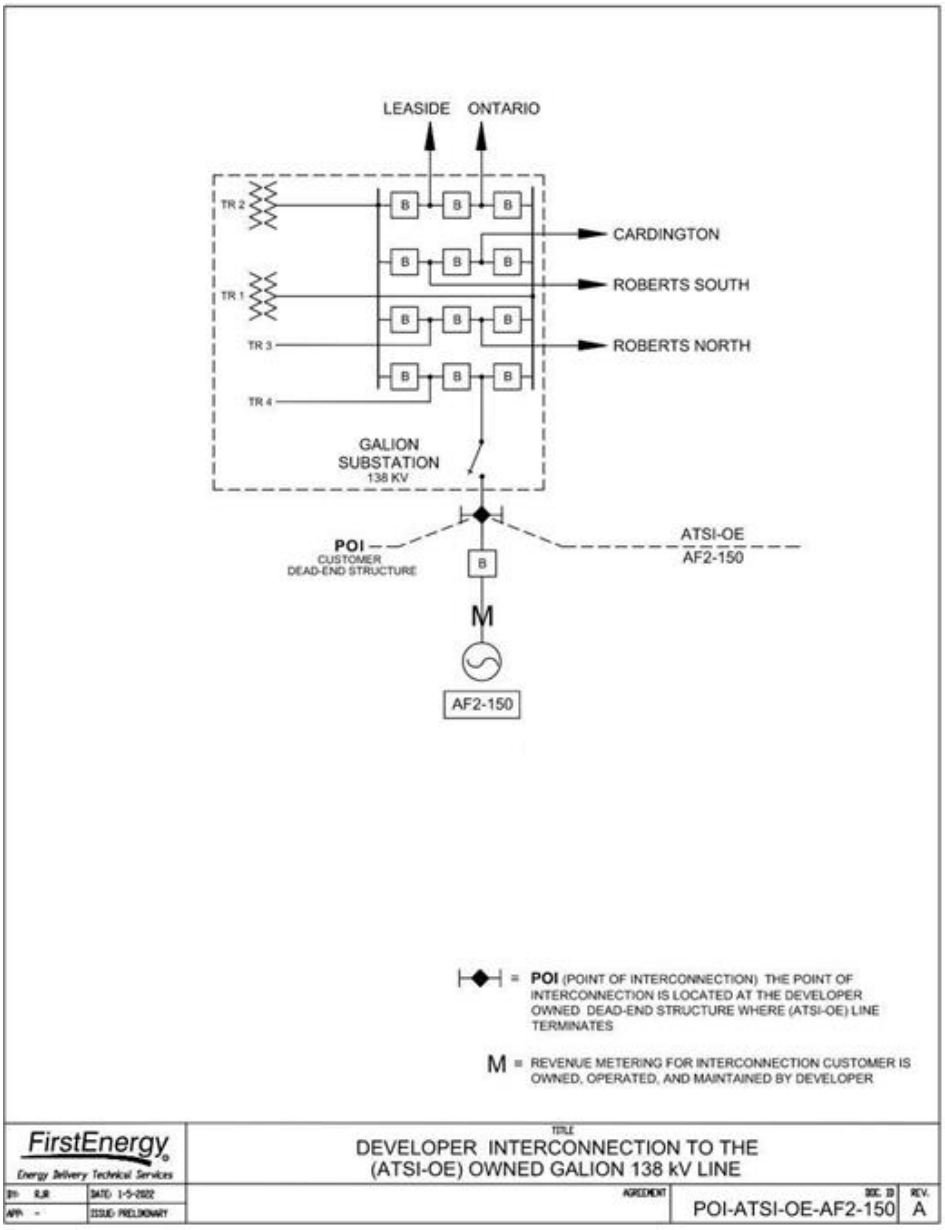
Attachment #2: One-Line Diagrams

IC One-Lines

Not for Construction

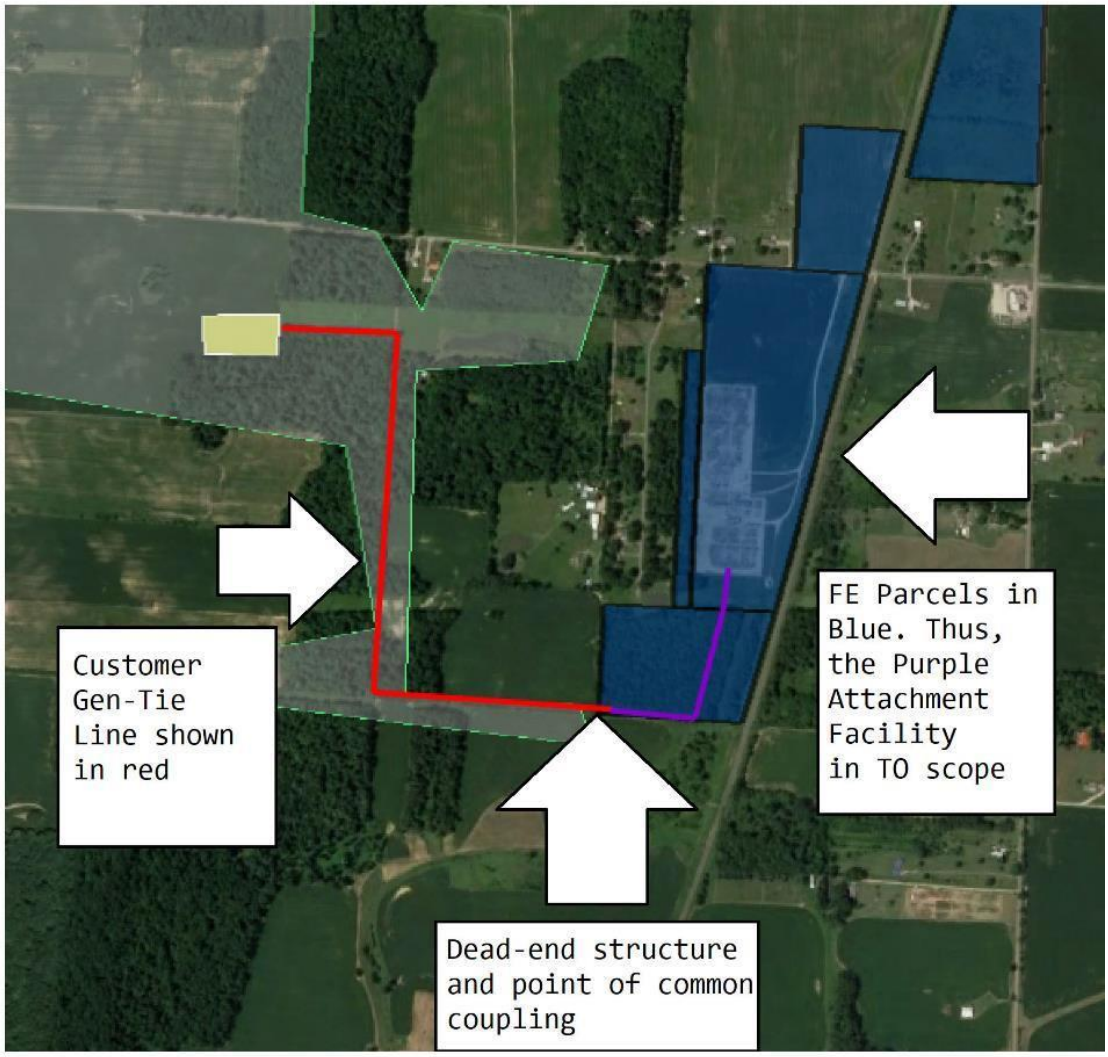


First Energy One-Line



Attachment #3: IC Site Plan and Substation Attachment Facilities

IC Site Plan



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

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

Generation	New / Increa	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-	New	All	0.95 leading to 0.95 lagging	High Side of the Facility Substation
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-	Increase	All	0.95 leading to 0.95 lagging	High Side of the Facility Substation

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”