Generation Interconnection Facilities Study Report

For

PJM Generation Interconnection Request Queue Position AE2-230/AF1-291A/AF2-075

"Bartonville-Meadow Brook 138 kV"

June 2022

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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

Bartonsville Energy Facility LLC, (hereinafter referred to as "IC") has proposed a solar generating facility located in Frederick County, Virginia. The installed facilities for AE2-230 will have a total capability of 70 MW with 42 MW of this output being recognized by PJM as capacity. The IC has proposed an uprate to a solar generating facility under the AE2-230 project. The AF1-291A queue position is a 10 MW energy uprate to the AE2-230 project, with 6 MW of this uprate being recognized by PJM as capacity. The AF2-075 queue position is a 50 MW energy uprate to the AE2-230/AF1-291A project, with 30 MW of this uprate being recognized by PJM as capacity. The total installed facilities will have a capability of 130 MW with 78 MW of this output being recognized by PJM as capacity. The generation facility will interconnect with Potomac Edison Company (APS), a First Energy Company (FE), hereinafter referred to as "Transmission Owner" (TO), at the new 138kV three breaker ring bus Long Creek Substation and looping the Bartonville-Meadow Brook 138 kV line into the new station.

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

The following amendments to the System Impact Study posted February 2020 for AE2-230, January 2020 for AF1-291A and April 2022 for AF2-075:

- Point of interconnection has been moved approximately 1 mile south along the Bartonville-Meadow Brook 138 kV line towards Meadow Brook**.** New ring bus will be 3.67 miles from

Bartonville substation and 2.33 miles from Meadow Brook substation.

- New Scope of work was added on Stephenson Substation
- New Scope of work was added on Stonewall Substation
- Reconductor the Meadow Brook-Redbud 138kV Line in the vicinity of the loop in for the new interconnection substation.
- IC elected Option to Build the new 138 kV three breaker ring bus substation

3. Interconnection Customer's Milestone Schedule

IC's requested Commercial Operation Date (COD) for the generation facility is **December 31, 2022**. A Project Kickoff meeting must occur by <*to be filled in by PJM*> to meet Transmission Owner's Assumed Milestone Schedule listed below.

IC's Requested Milestone Schedule:

09/01/2022	Initial Back-feed through Project Substation Date
12/01/2022	Project Commercial Operation Date

Transmission Owner's Assumed Milestone Schedule:

09/01/2023	Initial Back-feed through Project Substation Date
12/01/2023	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, 138 kV (AE2-230/AF1-291A/AF2-075) generator lead line and connection to the new 138 kV three breaker ring bus interconnection substation.

The IC has elected the Option to Build 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 where IC-owned 138 kV attachment line conductor will terminate on the insulators on the dead-end takeoff structure.

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 First Energy'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 plan and profile or PLS-CADD 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.
- The interconnecting 138-34.5kV transformer shall be connected wye grounded on the transmission (138kV) side and delta connected on the low (34.5kV) side.
- 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

5. Description of Facilities Included in the Facilities Study

Attachment Facilities

Transmission Owner will design, furnish and construct the new 138 kV line terminal and take off structure under Option to Build. 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. Ownership of these assets will be turned over to the Transmission Owner.

AE2-230/AF1-291A/AF2-075Customer Substation

Drawings, nameplates, and relay settings will be reviewed, and the substation will be added to high voltage circuit diagrams.

Direct Connection

Long Creek AE2-230/AF1-291A/AF2-075 138 kV (new interconnection substation)

A new three breaker ring bus substation will be constructed along the Bartonville- Meadow Brook 138 kV transmission line to interconnect the AE2-230/AF1-291A/AF2-075 solar project with the APS transmission system. The POI will be at the TO-owned deadend structure inside the substation yard where the generator lead line terminates.

Non-Direct Connection

Bartonville-Meadow Brook 138kV Line

The Bartonville to Meadow Brook 138 kV line will be cut and looped into the new 138 kV interconnect substation. This cut will take place at a location that is approximately 3.67 miles from the Bartonville substation and 2.33 miles from the Meadow Brook Substation. It is assumed that the interconnection substation will be located within one span (approximately 0.1 mile) from the existing line.

Meadow Brook-Redbud 138kV Line

Reconductor the Meadow Brook-Redbud 138 kV Line between the new structure installed.

Bartonville Substation

Line relaying will be replaced, Single frequency line traps will be retuned and line tuner on Stephenson line will be replaced.

Meadow Brook Substation

Line relaying will be replaced, nameplates will be modified and drawings for line name will be changed.

Stephenson Substation

Single frequency line traps will be retuned and line tuner for Bartonville and Stonewall lines will be replaced.

Stonewall Substation

Single frequency line traps will be retuned and line tuner on Stephenson lines will be replaced.

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:	**$37,395.69**	**$5,459.77**	**$42,855.46**
Total Direct Connection (DC) Costs:	**$2,021,745.38**	**$295,174.82**	**$2,316,920.20**
Total Non-Direct Connection (NDC) Costs:	**$3,332,241.95**	**$486,507.32**	**$3,818,749.27**
New System Upgrades	**$0**	**$0**	**$0**
TOTAL Costs (ALL Categories)	**$5,391,383.02**	**$787,141.91**	**$6,178,524.93**

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

Attachment Facility	*Timeframe*
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 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

None

2. Transmission Lines – Upgrade

Bartonville-Meadow Brook 138kV Line

- Loop the Bartonville-Meadow Brook 138kV line into the new Long Creek substation (approximately 2.3 miles from the Meadow Brook substation).
- Proposed layout is shown in the attached KMZ and includes the following.
- The existing line is constructed on double circuit steel monopoles, mutual with the Meadow Brook-Redbud 138kV line. Existing conductor is 795 kcmil 26/7 ACSS on the Bartonville-Meadow Brook 138kV line and existing shield wire is two (2) 7#9 Alumoweld (shared with the Meadow Brook-Redbud circuit).
- Per the RPA documents, new conductor on the loop will be bundled 1272 kcmil 45/7 ACSR. New shield wire on the loop is assumed to be one (1) 7#8 Alumoweld.
- The line will be cut between existing structures 23 and 24 and the following will be required:

  - Replacing double circuit steel monopole tangent (structure 24) with (1) double circuit steel monopole deadend structure on a drilled shaft foundation.
    - Costs for the hardware associated with the Meadow Brook-Redbud 138kV line shall be captured in the PE-T-121B estimate.
  - Approximately 400' of new conductor and shield wire will be installed to the FE Switching Station from structure 23 and 24.
  - Approximately 400' of existing conductor and shield wire will be removed between structures 23 and 24.
- Existing conductor and shield wire will be transferred on the north side of the new structure 24.
  - Assume existing conductor and shield wire are in good condition and can be transferred to new structure
- Construction Considerations
  - The Bartonville-Meadow Brook 138kV line and Meadow Brook-Redbud 138kV line are adjacent to a CSX Transportation railroad.
- Siting/Licensing
  - Assume a LON will be required.
  - Assume minimal social and ecological impacts.
- Assumptions
  - Assume existing structures 23 and 25 are in good condition and have adequate capacity for any new loading arrangement. An engineering analysis will be required to confirm.
  - Existing aerial LiDAR survey is assumed to be sufficient for design.
  - Assume OPGW is not required.
  - Assume site access will be provided by the interconnection work.
  - Assume the Bartonville and Meadow Brook substations will remain energized during construction. Temporary construction may be required.

Meadow Brook-Redbud 138kV Line

- Reconductor the Meadow Brook-Redbud 138kV Line between the new structure installed per the PE-T-120B Bartonville-Meadow Brook 138kV Line estimate.
- Per TAMI, the existing conductor is 954 kcmil 45/7 ACSR on the Meadow Brook-Redbud 138kV line and existing shield wire is (2) 7#9 Alumoweld (shared with the Bartonville-Meadow Brook circuit).
- Per the RPA documents, to meet the required line rating of 516 the new conductor between structures 23 and 24 shall be 795 kcmil 26/7 ACSS.
- Install the following:
  - (3) 138kV ACSR deadend hardware assemblies (North side of structure 24).
  - (6) 138kV ACSS deadend hardware assemblies (South side of structure 24, North side of structure 23).
  - Approximately 400' of 795 kcmil 26/7 ACSS conductor.
- Remove the following:
  - Approximately 400' of the existing 954 kcmil 45/7 ACSR conductor between structures 23 and 24.
- Transfer the following:
  - The existing conductor will be transferred to the north side of structure 24.
  - The existing shield wire will be transferred onto the new structure.
  - Assume existing conductor and shield wire are in good condition and can be transferred to new structure

- Siting/Licensing
    - Assume minimal social and ecological impacts.
- Assumptions
    - It is assumed that for the required line rating per the RPA, the span between structure 23 and 24 will be reconductored using 795 kcmil ACSS.
    - Assume existing structures 23 and 25 are in good condition and have adequate capacity for any new loading arrangement. An engineering analysis will be required to confirm.
        - Costs for the analysis shall be captured in the PE-T-120B estimate.
    - Existing aerial LiDAR survey is assumed to be sufficient for design.
    - Assume the Bartonville and Meadow Brook substations will remain energized during construction. Temporary construction may be required.

3. New Substation/Switchyard Facilities

AE2-230/AF1-291A/AF2-075 Customer Sub

- Below Grade
    - None
- Above Grade
    - Review drawings, nameplates, and relay settings to meet FE standards
    - Add to HV circuit diagram.
- R&C
    - None
- Additional Equipment to be Removed
    - None
- Assumptions
    - None

AE2-230/AF1-291A/AF2-075: Long Creek New Interconnection Substation (To be built by Interconnection customer under Option to Build. FE to provide oversight, security, MPLS installation, and other items not subject to election of option to build)

- Below Grade
    - Stone, fence for new substation.
    - Foundations, conduit, grounding for new equipment.
    - Conduit for new fiber connections
- Above Grade
    - Install (3) 138kV, 3000A circuit Breakers
    - Install (6) 138kV, 2000A Disconnect switches
    - Install (3) 138kV, 2000A MOABs
    - Install (9) 138kV surge arresters
    - Install (9) 138kV CVTs
    - Install (2) 138kV SSVTs
    - Install (1) control building.
    - 1 Lot of steel supports, dead ends, connectors, fittings, rigid bus, strain bus, as indicated on the attached layout.
- R&C

    - Install new SCADA RTU, HMI, Fiber Patch Panel, GPS Clock, SEL RTAC, and other standard communications equipment.
    - Bartonville line terminal
    - Install (1) prewired relaying panel consisting of (2) SEL-411L
    - Install (1) prewired control panel including (1) SEL501 BFT & (1) SATEC Meter
    - Meadow Brook line terminal
    - Install (1) prewired relaying panel consisting of (2) SEL-411L
    - Install (1) prewired control panel including (1) SEL501 BFT & (1) SATEC Meter
    - Developer line terminal
    - Install (1) prewired relaying panel consisting of (2) SEL-411L
    - Install (1) prewired control panel including (1) SEL501 BFT & (1) SATEC Meter
- Additional Equipment to be Removed
    - None
- Assumptions
    - Access road to be provided by developer.

4. Substation/Switchyard Facility Upgrades

Bartonville

- Below Grade
    - Conduit for new fiber connection
    - Conduit and grounding for new equipment
- Above Grade
    - Retune (1) single frequency line trap on Stephenson line
    - Replace (1) line tuner with (1) wide band line tuner on Stephenson line
    - Modify nameplates and drawings for line name change.

- R&C
    - Replace (1) line panel with (1) prewired relaying panel consisting of (2) SEL-411L and (1) SEL-501
    - Install (1) Fiber Patch Panel
    - Install (1) RFL-9780, (1) PCM5350, and (1) skewed hybrid on Stephenson line
- Additional Equipment to be Removed
    - Line tuner, wave trap, and DCB carrier set on Long Creek line exit
- Assumptions
    - New panels and equipment will fit in existing control building.
    - Existing AC, DC, and SCADA are sufficient for upgrades.
    - Existing line trap is sufficient and can be retuned.

Meadow Brook

- Below Grade
    - Conduit for new fiber connection
- Above Grade
    - Modify nameplates and drawings for line name change.
- R&C
    - Replace (1) line panel with (1) prewired relaying panel consisting of (2) SEL-411L and (1) SEL-501
    - Install (1) Fiber Patch Panel
- Additional Equipment to be Removed

    - Line tuner, wave trap, and DCB carrier set on Long Creek line exit
- Assumptions
    - New panels will fit in existing control building.
    - Existing AC, DC, and SCADA are sufficient for upgrades.

Stephenson

- Below Grade
    - None
- Above Grade
    - Retune (2) single frequency line traps for Bartonville and Stonewall lines
    - Replace (2) line tuners with (2) wide band line tuners for Bartonville and Stonewall lines
- R&C
    - Install (2) RFL-9780, (2) PCM5350, and (2) hybrid for Bartonville and Stonewall lines
- Additional Equipment to be Removed
    - None
- Assumptions
    - New equipment will fit in existing control building.
    - Existing AC, DC, and SCADA are sufficient for upgrades.

Stonewall

- Below Grade
    - None
- Above Grade
    - Retune (1) single frequency line trap on Stephenson line
    - Replace (1) line tuner with (1) wide band line tuner on Stephenson line
- R&C
    - Install (1) RFL-9780, (1) PCM5350, and (1) balanced hybrid on Stephenson line
- Additional Equipment to be Removed
    - None
- Assumptions
    - None

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 interconnection substation control house.

Transmission Owner will make the fiber termination connections for its cable(s) at the line dead end termination structures in 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:

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 **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 Potomac Edison Company (part of APS) notifications vary, some up to twelve (12) months after preliminary engineering is completed to secure the required approvals.
- 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.
- 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-of-way.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 2020 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.

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
AE2-230/AF1-291A/AF2-075 Customer Sub: Modify drawings, relay setting and nameplates for FE standards.	$28,316.16	$0.00	$9,079.53	$0.00	$37,395.69
Total Attachment Facilities Cost	$28,316.16	$0.00	$9,079.53	$0.00	$37,395.69
AE2-230/AF1-291A/AF2-075 Interconnection Sub: Option to Build to construct a new 138 kV three breaker ring bus looping in the Bartonville-Meadow Brook 138kV line to provide interconnection facilities for AE2-230/AF1-291A/AF2-075	$509,467.25	$0.00	$163,359.86	$0.00	$672,827.11
Customer has selected Option to Build. First Energy Scope of work for OTB Station: Site Network & Security Costs	$406,727.97	$427,417.51	$130,416.67	$137,904.04	$1,102,466.19
Bartonville Sub to Backbone Fiber Communication: Install fiber from Bartonville substation to backbone for relaying communications transport	$172,002.00	$17,985.00	$55,152.17	$1,312.91	$246,452.08
Total Direct Connection Cost	$1,088,197.22	$445,402.51	$348,928.70	$139,216.95	$2,021,745.38
Bartonville-Meadow Brook 138 kV Line Loop: Loop the Bartonville-Meadow Brook 138kV into the new long Creek Substation	$655,633.45	$256,873.76	$210,227.82	$82,878.98	$1,205,614.01
Bartonville-Meadow Brook 138 kV Line Loop: New structure installation per the Bartonville-Meadow Brook 138kV Line estimate	$329,528.59	$59,615.37	$105,662.82	$19,234.59	$514,041.37
Stonewall Substation: Retune single frequency line trap and replace line tuner on Stephenson line	$150,811.12	$30,796.56	$48,357.34	$2,248.15	$232,213.17
Stephenson Substation: Retune single frequency line trap and replace line tuner for Bartonville and Stonewall lines	$322,715.04	$61,914.74	$103,478.06	$4,519.78	$492,627.62
Meadow Brook: Replace line relaying, modify nameplates and drawings for line name change	$235,240.90	$44,470.22	$75,429.62	$3,246.33	$358,387.07
Bartonville Substation: Replace line relying, retune single frequency line trap and replace line tuner on Stephenson line	$339,053.84	$76,037.09	$108,717.07	$5,550.71	$529,358.71
Total Non-Direct Connection Cost	$2,032,982.94	$529,707.74	$651,872.73	$117,678.54	$3,332,241.95
Total Project Costs	$3,149,496.32	$975,110.25	$1,009,880.96	$256,895.49	$5,391,383.02

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

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 deadend 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 (assume *[To be filled in by PJM]* **start)**

	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

Attachment #1: Protection Study

PROTECTION SCOPE

SHORT CIRCUIT DATA for a fault at the proposed location of the connection of Long Creek SS on the existing Bartonville - Meadow Brook 138kV line (Symmetrical Values Only)
Initial conditions (percent on 100 MVA base)

138kV
Z1 = 0.265 + j 2.298%
Z0 = 0.808 + j 4.838%

3 phase fault – 18,134A
Single line to ground fault – 13,179A 3I0

Note: These fault values do not include the AE2-230 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.

The attached relay sketch provides details of relay requirements for AE2-230 Generation interconnection substation (Long Creek Substation) and is considered part of the Facilities Study Report.

AE2-230 Interconnection Substation (henceforth to be known as Long Creek Substation)

RELAY AND COMMUNICATION EQUIPMENT SCOPE

At Long Creek SS:

138kV Line Exit to Bartonville

Install the following:

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

The protective relaying for the 138kV line to Bartonville 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 Bartonville 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 Bartonville
- SATEC digital multimeter
- RFL Hybrid chassis with one skewed hybrid
- PowerComm PCM5350

138kV Line Exit to Meadow Brook

Install the following:

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

The protective relaying for the 138kV line to Meadow Brook 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 Meadow Brook 138kV line
- SEL-501 relay for Bkr B-3 breaker failure
- LOR relay for Bkr B-3 breaker failure tripping
- RFL-9785 for DCB blocking carrier
- RFL-9780 Tx/Rx, for anti-islanding transmit and receive from Meadow Brook
- SATEC digital multimeter
- RFL Hybrid chassis with one skewed and one balanced hybrid
- PowerComm PCM5350

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)

AE2-230 will only close into this line of 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 remote substations:

At Bartonville SS:

- Add RFL-9780 Tx, for anti-islanding transmit to Long Creek
- Add RFL-9780 Rx, for anti-islanding receive from Stephenson
- RFL Hybrid chassis with one balanced and one skewed hybrid
- Change frequency for existing DCB scheme
- Add PowerComm PCM5350s on both 138kV lines
- Replace single frequency tuners with wide band tuners on both 138kV lines
- Re-tune traps as necessary on both 138kV lines

At Meadow Brook SS:

Replace line relays to properly operate with new relays at Long Creek SS as follows:

- 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
- RFL-9785 for DCB blocking carrier
- RFL-9780 Tx, for anti-islanding transmit to Long Creek
- SATEC digital multimeter
- RFL Hybrid chassis with one balanced hybrid
- PowerComm PCM5350

At Stephenson SS:

- Add RFL-9780 Tx, for anti-islanding transmit to Bartonville
- Add RFL-9780 Rx, for anti-islanding receive from Stonewall
- RFL Hybrid chassis with one balanced and one skewed hybrid
- Add PowerComm PCM5350s on both 138kV lines
- Replace single frequency tuners with wide band tuners on both 138kV lines
- Re-tune traps as necessary on both 138kV lines

At Stonewall SS:

- Add RFL-9780 Tx, for anti-islanding transmit to Bartonville
- RFL Hybrid chassis with one balanced hybrid
- Add PowerComm PCM5350 on the Stephenson 138kV line
- Replace single frequency tuner with wide band tuner on the Stephenson 138kV line
- Re-tune trap as necessary on the Stephenson 138kV line

Generation Substation Protection Requirements for 138kV line to Long Creek 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 AE2-230 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.

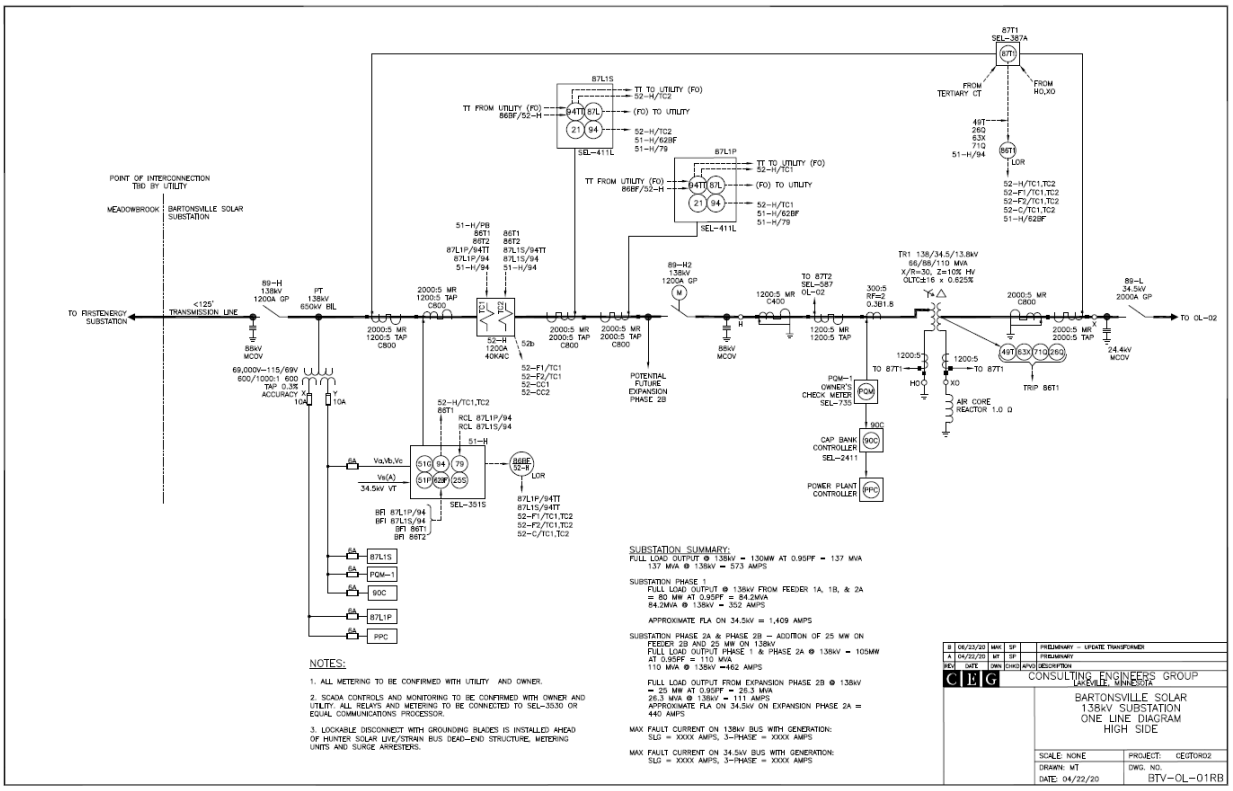
Operational metering is also required for this generation connection. These requirements are also outlined in FirstEnergy's "Requirements for Transmission Connected Facilities" document. These requirements are in addition to any metering required by PJM.

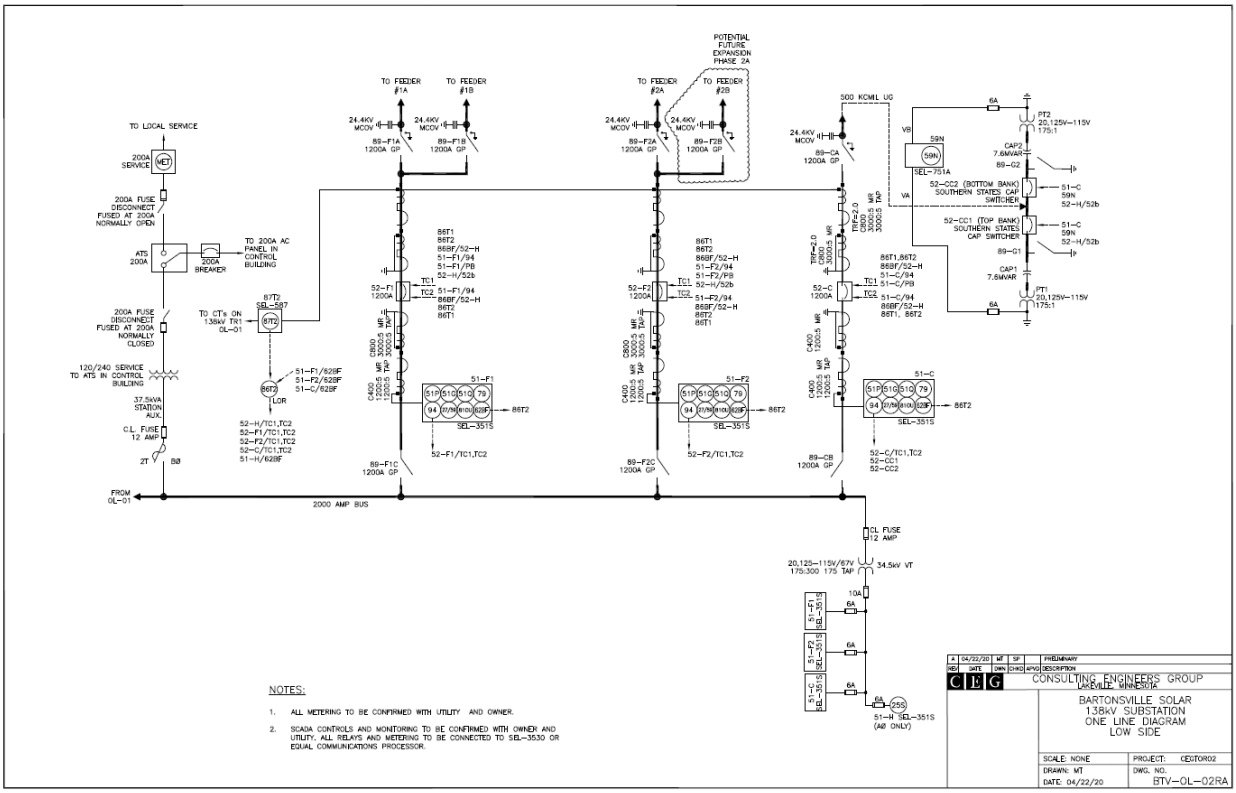
Generator Step-Up Transformer Requirements

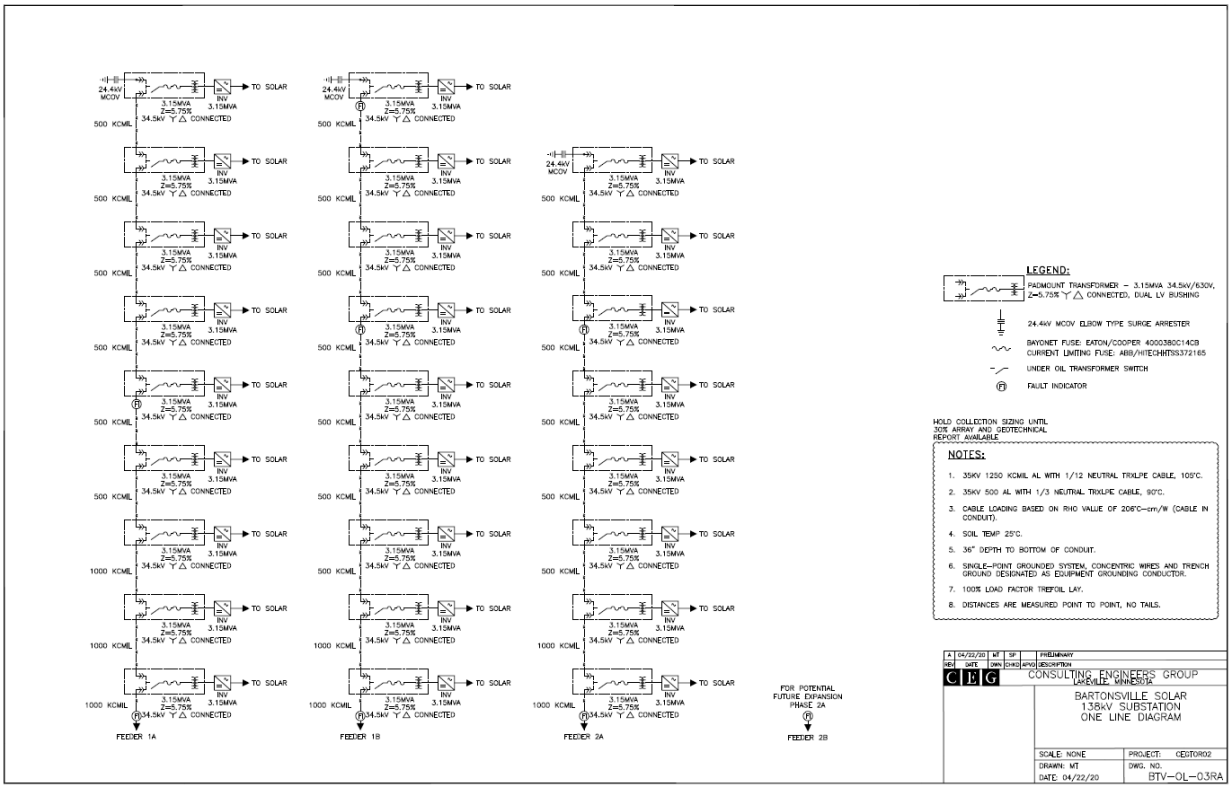
As per section 14.2.6 of the First Energy Requirements for Transmission Connected Facilities document, because this area of the system is effectively grounded, the transformer shall have a wye grounded winding on the high (transmission system) side and have a delta connected winding on the low side. This is required to maintain proper ground relay coordination on the First Energy system. No exceptions to this standard shall be granted.

Attachment #2: One-Line Diagrams

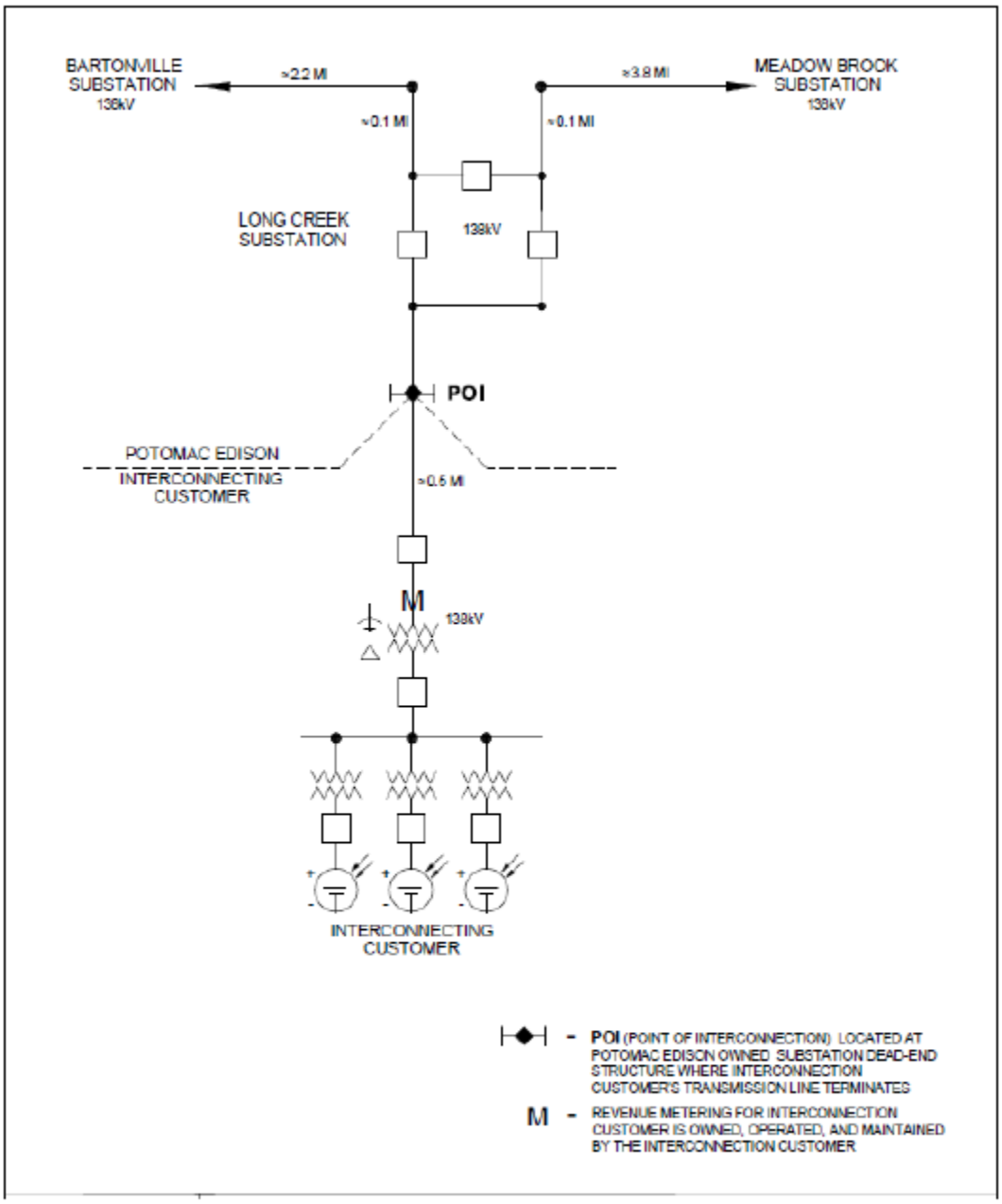
IC One-Lines
Not Approved for Construction




TO LOCAL SERVICE
200A SERVICE
200A FUSE DISCONNECT FUSED AT 200A NORMALLY OPEN
ATS 200A
200A BREAKER
TO 200A AC PANEL IN CONTROL BUILDING
200A FUSE DISCONNECT FUSED AT 200A NORMALLY CLOSED
120/240 SERVICE TO ATS IN CONTROL BUILDING
37.5kVA STATION AUX.
C.L. FUSE 12 AMP
2T
BØ
FROM OL-01
TO CTs ON 138kV TR1 OL-01
87T2 SEL-587
87T2
LOR
51-F1/62BF
51-F2/62BF
51-C/62BF
52-H/TC1,TC2
52-F1/TC1,TC2
52-F2/TC1,TC2
52-C/TC1,TC2
51-H/62BF
TO FEEDER #1A
TO FEEDER #1B
24.4KV MCOV
89-F1A 1200A GP
89-F1B 1200A GP
89-F1C 1200A GP
86T1
86T2
86BF/52-H
51-F1/94
51-F1/PB
52-H/52b
52-F1 1200A
TC1
TC2
51-F1/94
86BF/52-H
86T2
86T1
C800 3000:5 MR
C800 3000:5 TAP
C400 1200:5 MR
C400 1200:5 TAP
51-F1
51P 51Q 51G 79
94 27/59 81O/U 62BF
86T2
SEL-351S
52-F1/TC1,TC2
2000 AMP BUS
POTENTIAL FUTURE EXPANSION PHASE 2A
TO FEEDER #2A
TO FEEDER #2B
89-F2A 1200A GP
89-F2B 1200A GP
89-F2C 1200A GP
52-F2 1200A
51-F2/94
86BF/52-H
51-F2/PB
52-H/52b
51-F2
52-F2/TC1,TC2
500 KCMIL UG
89-CA 1200A GP
89-CB 1200A GP
52-C 1200A
TRF=2.0
3000:5 MR
3000:5 TAP
86T1,86T2
86BF/52-H
51-C/94
51-C/PB
52-H/52b
51-C
52-C/TC1,TC2
52-CC1
52-CC2
6A
PT2 20,125V-115V 175:1
59N
SEL-751A
CAP2 7.6MVAR
89-G2
52-CC2 (BOTTOM BANK) SOUTHERN STATES CAP SWITCHER
52-CC1 (TOP BANK) SOUTHERN STATES CAP SWITCHER
89-G1
CAP1 7.6MVAR
PT1 20,125V-115V 175:1
CL FUSE 12 AMP
20,125-115V/67V 175:300 175 TAP
34.5kV VT
10A
51-F1/SS
51-F2/SS
51-H/SS
25S
51-H SEL-351S (A0 ONLY)
NOTES:
1. ALL METERING TO BE CONFIRMED WITH UTILITY AND OWNER.
2. SCADA CONTROLS AND MONITORING TO BE CONFIRMED WITH OWNER AND UTILITY. ALL RELAYS AND METERING TO BE CONNECTED TO SEL-3530 OR EQUAL COMMUNICATIONS PROCESSOR.
A 04/22/20 MT SP PRELIMINARY
NO DATE DWN CHKD APVD DESCRIPTION
CONSULTING ENGINEERS GROUP LAKEVILLE, MINNESOTA
BARTONSVILLE SOLAR
138kV SUBSTATION
ONE LINE DIAGRAM
LOW SIDE
SCALE: NONE
PROJECT: CEGTOR02
DRAWN: MT
DWG. NO. BTV-OL-02RA
DATE: 04/22/20

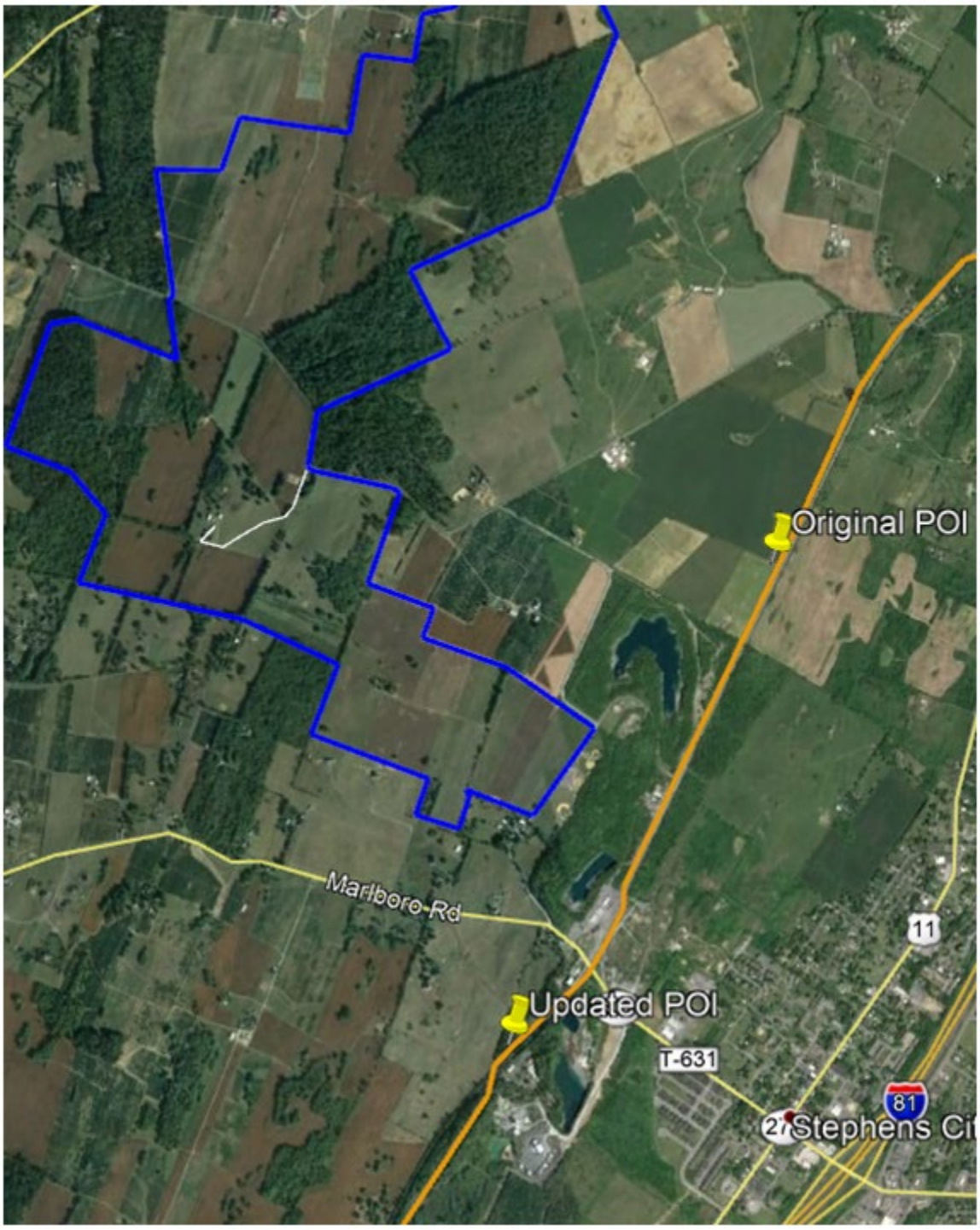

24.4KV MCOV
3.15MVA Z=5.75% 34.5kV Y △ CONNECTED
INV 3.15MVA
TO SOLAR
500 KCMIL
1000 KCMIL
FEEDER 1A
FEEDER 1B
FEEDER 2A
FOR POTENTIAL FUTURE EXPANSION PHASE 2A
FEEDER 2B
LEGEND:
PADMOUNT TRANSFORMER – 3.15MVA 34.5kV/630V, Z=5.75% Y △ CONNECTED, DUAL LV BUSHING
24.4kV MCOV ELBOW TYPE SURGE ARRESTER
BAYONET FUSE: EATON/COOPER 4000380C14CB
CURRENT LIMITING FUSE: ABB/HITECHNTSS372165
UNDER OIL TRANSFORMER SWITCH
FAULT INDICATOR
HOLD COLLECTION SIZING UNTIL 30% ARRAY AND GEOTECHNICAL REPORT AVAILABLE
NOTES:
1. 35KV 1250 KCMIL AL WITH 1/12 NEUTRAL TRIPLE CABLE, 105°C.
2. 35KV 500 AL WITH 1/3 NEUTRAL TRIPLE CABLE, 90°C.
3. CABLE LOADING BASED ON RHO VALUE OF 208°C-cm/W (CABLE IN CONDUIT).
4. SOIL TEMP 25°C.
5. 36" DEPTH TO BOTTOM OF CONDUIT.
6. SINGLE-POINT GROUNDED SYSTEM, CONCENTRIC WIRES AND TRENCH GROUND DESIGNATED AS EQUIPMENT GROUNDING CONDUCTOR.
7. 100% LOAD FACTOR TREFOIL LAY.
8. DISTANCES ARE MEASURED POINT TO POINT, NO TAILS.
A 04/22/20 MT SP PRELIMINARY
NO DATE DWN CHKD APVD DESCRIPTION
CONSULTING ENGINEERS GROUP LAKEVILLE, MINNESOTA
BARTONSVILLE SOLAR
138kV SUBSTATION
ONE LINE DIAGRAM
SCALE: NONE
PROJECT: CEGTOR02
DRAWN: MT
DWG. NO. BTV-OL-03RA
DATE: 04/22/20

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

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.*

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
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

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 (counterclockwise)	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”