

***Generation Interconnection
Facilities Study Report***

For

***PJM Transmission Interconnection Request
Project Identifier AG1-363***

“Black Oak-Hatfield 500 kV”

October 2024

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Preface

The intent of the Facilities 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 Project Developer. As a requirement for interconnection, the Project Developer 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.

The Facilities Study estimates attempt to identify the estimated time required to obtain property rights and permits for construction of the required facilities. The Project Developer is responsible for the right-of-way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

A. Transmission Owner Facilities Study Summary

1. Description of Project

The Project Developer has proposed a solar/storage generating facility located in Garrett County, Maryland. The total installed facilities for AG1-363 will have a total capability of 300 MW (300 MW PV and 100 MW BESS limited to combined 300MW output) with 220 MW of this output being recognized by PJM as capacity. The generation facility will interconnect with Potomac Edison Company (PE), a FirstEnergy Company (FE), hereinafter referred to as “Transmission Owner” (TO), by constructing a new 500kV three-breaker ring bus substation and looping the Black Oak-Hatfield 500kV Line into the new station. The transmission line tap will be located approximately 5.3 miles from Black Oak Substation (PE owned) and 56 miles from Hatfield substation (KATCo owned).

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

None

3. Project Developer’s Milestone Schedule

Project Developer’s Commercial Operation Date (COD) for the generation facility is **3/31/2028**.

Project Developer’s Milestone Schedule:

January 31, 2028	Initial back-feed through Project Substation Date
March 31, 2028	Project Commercial Operation Date

4. Project Developer's Scope of Work

Project Developer is responsible for all design and construction related to activities on their side of the Point of Change in Ownership (PCO).

Point of Change in Ownership: The PCO will be located within the new 500 kV substation where Project Developer-owned 500 kV interconnection line conductor will terminate on the insulators on the dead-end takeoff structure.

Project Developer 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 Transmission Owner's applicable standards as well as with PJM requirements.

Site Grading and Preparation Requirements:

It is the responsibility of the developer to properly vet a proposed substation location. The proposed location should be reviewed by a Civil Engineer to determine the site's suitability for construction and operation as a substation (refer to Attachment 5 to FE's Geotechnical summary report). This should include a review of available information regarding the specific site location that should be considered when estimating constructability, risk, cost, and schedule. The substation is considered the substation and all associated FirstEnergy Facilities needed to operate and maintain the site such as, access roads, stormwater management facilities, walls/structures, and utilities. This review should include, but is not limited to:

- **Geologic Hazards**
 - Karst
 - Geologic formation/group
 - Hard bedrock (shallow bedrock difficult to excavate)
 - Weak bedrock
 - Landslide susceptibility and topography
 - Surficial soils survey
 - Coal resource mapping
- **Environmental Hazards**
 - Flood mapping
 - Wetland Mapping
 - Any pollution information that could affect construction.
 - Corrosivity
- **Past development**
 - Previous mine activity
 - Previously reclaimed site

Assumptions / Notes:

- Project Developer will coordinate design and alignment of proposed 500 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.

- Project Developer will coordinate design and construction of proposed 500 kV generator lead line. For these areas, the Project Developer 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 500 kV terminal positions. As a minimum, Project Developer facilities should not encroach within 100 feet of TO centerline at blowout conditions. If Project Developer'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 Project Developer, if final alignment of the 500 kV generator lead line causes encroachments, changes, or modifications to any existing or relocated TO facilities. See Section B7 if this report for additional information.

5. Description of Facilities Included in the Facilities Study

Transmission Owner Interconnection Facilities

AG1-363 Collector Substation

Integrate Interconnection Facilities protection and controls to the transmission system.

Stand-Alone Network Upgrades

AG1-363 Interconnection Substation 500 kV (Option to Build) (PJM Network Upgrade n8840.0)

A new three breaker ring bus substation will be constructed by the Project Developer (who has elected the Option to Build) along the Black Oak- Hatfield 500 kV transmission line to interconnect the AG1-363 solar project. Transmission Owner will install security and camera system, indoor security cabinet, program Supervisory Control and Data Acquisition Remote Terminal Unit at AG1-363 interconnection substation.

Black Oak-AG1-363 Interconnection Substation (PJM Network Upgrade n8841.0)

Install/Test approximately 3,115 feet underground and 96,888 feet aerial 48F/SM ADSS from the Jade Meadow AG1-363 substation control house to the Black Oak #1 substation control house.

Network Upgrades

AG1-363 Interconnection Substation (PJM Network Upgrade n8842.0)

Design, installation, and testing/commissioning for MPLS equipment for SCADA transport at Hatfield Substation.

Hatfield-Black Oak 500kV Line (PJM Network Upgrade n8843.0)

Cut the existing Hatfield-Black Oak 500kV Line approximately 5.3 miles from the Black Oak Substation and 56 miles from the Hatfield substation (near structures 227 and 228) to create a loop into the new substation.

Black Oak Substation (PJM Network Upgrade n8844.0)

One (1) line relaying panel with (1) SEL-421, (1) SEL-411L, and (1) SEL-2505 will be installed.

Hatfield Substation (KATCo) (PJM Network Upgrade n8845.0)

One (1) line relaying panel with (1) SEL-421, (1) SEL-411L, (1) carrier panel with (3) UPLC and (3) PCM-5350 will be installed.

Other**AG1-363 Interconnection Substation 500 kV (Option to Build)**

A new three breaker ring bus substation will be constructed by the Project Developer. Transmission Owner will provide oversight to assure TO standards and requirements are met.

Revenue Metering

Revenue metering installation support.

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

Description	Total (w/o Tax)
Transmission Owner Interconnection Facilities:	\$60,521
Total Stand-Alone Network Upgrades Costs:	\$4,565,471
Total Network Upgrades Costs:	\$8,354,515
Other Costs:	\$1,281,525

TOTAL Costs (ALL Categories):	\$14,262,032
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7. Summary of the Schedule for Completion of Work for the Facilities Study

<i>Activity</i>	<i>Timeframe</i>
Engineering, Procurement, and Construction	57 months

B. Transmission Owner Facilities Study Results

This section describes facilities identified to be installed, replaced, and/or upgraded by Transmission Owner 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*

Hatfield-Black Oak 500kV Line

- Description of Work
 - Cut the existing Hatfield-Black Oak 500kV Line approximately 5.3 miles from the Black Oak Substation and 56 miles from the Hatfield substation (near structures 227 and 228) to create a loop into the new substation.
- Existing Conditions
 - The line is built on single circuit steel lattice towers. Per TAMI, the conductor is bundled 2032 kcmil 72/7 ACSR shielded by (2) 7#6 alumoweld shieldwires.
 - The existing line is strung horizontally.
- Structures Installed
 - (2) 500kV single circuit steel 3-pole deadend structures on drilled shaft foundations.
 - (2) spans of bundled 2032 kcmil 72/7 ACSR conductor (approximately (0.1) circuit miles total) shielded by (2) 7#8 alumoweld shieldwires (approximately (0.2) miles total).
 - Per the scooping checklist each phase is to be comprised of (2) conductors
 - (6) 500kV substation deadend insulator assemblies
 - Transfer the existing bundled conductor and shieldwire onto the new deadend structures.
 - 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) circuit miles of bundled 2032 kcmil 72/7 ACSR shielded by approximately (0.1) miles of 7#6 alumoweld shieldwire.
- Construction Considerations
 - None
- Siting/Licensing
 - Due to line voltage and project location, it is assumed that a full application will be required.
- Assumptions
 - Assume the outage requirements for construction on the line can be met.
 - A ground survey will be required.
 - Assume adjacent existing structures have adequate capacity to handle the new loading. A PLS-Tower model and an engineering analysis during project development will be required to confirm.

- Transmission line design is based on the approximate location of the new substation bays and new fence line as shown in the preliminary substation layout. Once the exact location of the new substation bays has been finalized, a detailed engineering analysis will need to be conducted to confirm feasibility. Any changes to the preliminary substation design will likely result in a change to the transmission line scope.
- **Support Estimates**
 - PROJECT MANAGEMENT (PM)
 - Project management will be required for this asset.
 - FORESTRY
 - Some clearing will be required. Priority tree rights may be expanded.
 - RE/ROW
 - Assume all work will be performed within the existing ROW or on substation property.
 - A rights and restrictions review by Real Estate will be required.
 - Georeferenced ROW extents will be required to be provided to engineering.
 - Real estate \$s have been included for:
 - ~Internal support including document review, project planning meetings, subcontractor oversight and assistance with transfer of assets if required.
 - ~External support for an acquisition of 1 access road (Assumed) rights & restrictions reviews, general project support, and minimal construction support and damage settlements/releases.
 - ~We have not included acquisition labor or cost of potential priority tree rights unless specified as needed in the scope and assumptions.
 - ~Direct damage payments not included in estimate.
 - ENVIRONMENTAL
 - An environmental review will be required to identify any construction constraints and additional permitting requirements.
 - REVENUE METERING
 - None
 - IT/NETWORK
 - FIBER (RELAYING AND COMMUNICATION)
 - None
 - SCADA
 - None
 - ACCESS ROAD CONSTRUCTION
 - An existing dirt road is present in the area. Assuming that road is not adequate for access, approximately 0.5 miles of access roads will be required. The terrain is hilly.
 - DISTRIBUTION
 - None

3. New Substation/Switchyard Facilities

AG1-363 Collector Sub

- Below Grade
 - None
- Above Grade
 - None
- Relay & Control
 - Integrate Interconnection Facilities protection and controls to the transmission system.
- Additional Equipment to be Removed
 - None
- Assumptions
 - None
- **Support Estimates**
 - PROJECT MANAGEMENT (PM)
 - Project management will be required for this asset.
 - FORESTRY
 - None
 - RE/ROW
 - None
 - ENVIRONMENTAL
 - None
 - REVENUE METERING
 - Located at AG1-363 collector substation.
 - IT/NETWORK
 - FIBER (RELAYING AND COMMUNICATION)
 - None.
 - SCADA
 - None.
 - TESTING & COMMISSIONING (TSCS)
 - Testing and commissioning services as required.

AG1-363: Interconnection Substation

- Below Grade
 - None
- Above Grade
 - Install (1) Security System and Camera System.
 - Install (1) Indoor Security AC Cabinet.
- Relay & Control
 - Install (1) Network fiber termination rack
 - Programming of SCADA RTU
- Additional Equipment to be Removed
 - None
- Assumptions
 - Assumed Project Developer will install camera foundations and conduits to Transmission Owner Standards.

- Assumed 2 Weeks of Testing and Commissioning for testing to Transmission Control Centers.
- Assumed Project Developer will install fiber from AG1-363 Collector Substation to AG1-363 Interconnection Substation and bring fiber into control house.
- Transmission Owner will be responsible for network fiber
- **Support 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)
 - Install/Test approximately 3,115 feet underground and 96,888 feet aerial 48F/SM ADSS from the Jade Meadow AG1-363 substation control house to the Black Oak #1 substation control house.
 - SCADA
 - SCADA work at AG1-363 Substation to camera installation, as well as the installation of a SAS-K12 Switch with drawing updates.
 - Estimated design, installation, and testing/commissioning for MPLS equipment for SCADA transport at Hatfield Substation.
 - TESTING & COMMISSIONING (TSCS)
 - Testing and commissioning services as required for new equipment and relays.

AG1-363: Interconnection Substation (Option to Build Oversight)

- Below Grade
 - Must Meet Transmission Owner Standards-Option to Build.
- Above Grade
 - Must Meet Transmission Owner Standards-Option to Build.
- Relay & Control
 - Must Meet Transmission Owner Standards-Option to Build.
- Assumptions
 - Engineering Oversight for review/comment of OTB site design for meeting Transmission Owner Standards.
 - Geotechnical/Site/Civil oversight for review/comment of OTB site grading design for meeting Transmission Owner Standards.
 - Construction Oversight assumed for 6 months.
 - Developer responsible for apparatus testing of devices and supplying results to Transmission Owner.
 - Transmission Owner commissioning oversight is assumed for duration of Construction.

- **Support Estimates**
 - PROJECT MANAGEMENT (PM)
 - Coordinate with developer and provide project management, coordination, administration, scheduling, material management and project development for Transmission Owner scope of work.
 - Provide construction oversight for duration of project construction.
 - FORESTRY (FOR)
 - None
 - RE/ROW (RE-ROW)
 - Support as required for Transfer of Property to Transmission Owner upon construction completion.
 - Internal support including document review, project planning meetings, and assistance with transfer of assets as required.
 - ENVIRONMENTAL (ENV)
 - Environmental Review of Proposed Site
 - REVENUE METERING (METER)
 - None
 - DISTRIBUTION (DX)
 - Responsibility of the Project Developer – Transferred to Transmission Owner at station completion
 - IT/NETWORK
 - FIBER (RELAYING AND COMMUNICATION)
 - Captured under Transmission Owner work for new Interconnection Substation
 - SCADA
 - Captured Under Transmission Owner work for new Interconnection Substation
 - TESTING & COMMISSIONING (TSCS)
 - Commissioning review of developer supplied information and witness of critical testing.

4. Substation/Switchyard Facility Upgrades

Black Oak Substation

- Below Grade
 - Conduit for fiber run to control building
- Above Grade
 - None
- Relay & Control
 - Replace 500kV Hatfield line relaying with:
 - (1) line relaying panel with (1) SEL-421, (1) SEL-411L, and (1) SEL-2505.
 - Install (1) lot of control cables, SEL cables, and fiber.
 - Install (1) fiber distribution panel.
- Additional Equipment to be Removed

- Remove wave trap, line tuner, coax, including foundations and steel structures, and carrier set.
- Assumptions
 - Breaker failure does not require replacement
 - Control building has adequate space for new panels
 - DC system and SCADA RTU are adequate
 - Existing fiber patch panel is adequate
 - There may be a need for lead abatement and asbestos removal, but neither are included in this estimate. Please review at substation site visit and make determination.
- **Support 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)
 - Support as required for fiber communication.
 - SCADA
 - Points list changes for new equipment
 - TESTING & COMMISSIONING (TSCS)
 - Testing and commissioning services as required for new relays.

Hatfield Substation

- Below Grade
 - None
- Above Grade
 - None
 - Replace 500kV Black Oak line relaying and carrier with:
 - (1) line relaying panel with (1) SEL-421, (1) SEL-411L.
 - (1) carrier panel with (3) UPLC and (3) PCM-5350.
 - Install (1) lot of control cables and SEL cables.
- Additional Equipment to be Removed
 - None
- Assumptions
 - Breaker failure does not require replacement.
 - Wave trap and line tuner do not require replacement.
 - Control building has adequate space for new panels.
 - DC system and SCADA RTU are adequate.
 - There may be a need for lead abatement and asbestos removal, but neither are included in this estimate. Please review at substation site visit and make determination.

- **Support 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
 - Points list changes for new equipment
 - TESTING & COMMISSIONING (TSCS)
 - Testing and commissioning services as required for new relays.

5. Telecommunications Facilities – Upgrades

Project Developer will design, provide, install, own and maintain a fiber-optic communications cable between the new interconnection substation, and Project Developer'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 Project Developer will make the fiber-optic cable termination connections for its cable(s) at the interconnection substation control house. Project Developer is responsible for obtaining and maintaining all associated Rights-of-Way (ROW), Easements, and Permits for its fiber cable.

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

6. Metering & Communications

Project Developer shall install, own, operate, test and maintain the necessary revenue metering equipment to provide revenue metering (KWH, KVARH) and real time data (KW, KVAR) for the Project Developer's Facility that comply with the requirements set forth in PJM Manuals M-01 and M-14D.

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 obtain real-time, site-specific, generation data from PJM, via the required communication link from Project Developer to PJM. Transmission Owner will work with PJM and Project Developer to ensure the generation data provided to PJM meets Transmission Owner's requirements.

7. *Environmental, Real Estate and Permitting*

The following are possible environmental, real estate and permitting issues:

- Environmental permitting, Real Estate acquisition, and Maryland Public Service Commission notifications vary, some up to twenty-four (24) months after preliminary engineering is completed to secure the required approvals.
- Project Developer 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 Project Developer's property with access to all existing structures possible via that property and the right-of-way following established access routes that do not cross wetlands or streams.
- Project Developer will develop, and secure regulatory approval for, all necessary Erosion and Sediment Control (E&SC) plans and National Pollutant Discharge Elimination System (NPDES) permits.
- Project Developer will obtain all necessary permits.
- Project Developer will conduct all necessary wetlands and waterways studies and permits.
- Project Developer will conduct all necessary historical and archaeological studies.
- If the Project Developer plans to cross the transmission line right of way with facilities or access roads, please refer to the Transmission Rights-of-Way Restrictions information located at: <https://www.firstenergycorp.com/help/safety/real-estate-power-lines/transmission-right-of-way.html#ROWform>

8. *Summary of Results of Study*

The cost estimates provided in this report were developed as of **6/19/24**. Hence, they are subject to significant changes in the event that project implementation is delayed for over one year. Notwithstanding the cost estimates from this report being used in the Generator Interconnection Agreement for the related project, Transmission Owner reserves the right to re-evaluate and provide a more accurate cost estimate during the implementation phase of the project.

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
Integrate Interconnection Facilities protection and controls to the Transmission System	\$57,236	\$0	\$3,285	\$0	\$60,521
Total Transmission Owner Interconnection Facilities Cost	\$57,236	\$0	\$3,285	\$0	\$60,521
OTB Estimate: Installation of security and camera system, indoor security cabinet, program Supervisory Control and Data Acquisition Remote Terminal Unit at AG1-363 interconnection substation. (PJM Network Upgrade n8840.0)	\$594,590	\$268,310	\$31,632	\$6,493	\$901,025
Install/Test approximately 3,115 feet underground and 96,888 feet aerial 48F/SM ADSS from the Jade Meadow AG1-363 substation control house to the Black Oak #1 substation control house. (PJM Network Upgrade n8841.0)	\$2,627,422	\$645,141	\$139,779	\$15,612	\$3,427,954
Total Stand-Alone Network Upgrades Cost	\$3,222,012	\$913,451	\$171,411	\$22,105	\$4,328,979
Design, install, and test/commission MPLS Equipment for SCADA transport. (PJM Network n8842.0)	\$136,391	\$90,651	\$7,256	\$2,194	\$236,492
Hatfield-Black Oak 500kV Line: Cut the existing Hatfield-Black Oak 500kV Line approximately 5.3 miles from the Black Oak Substation and 56 miles from the Hatfield substation (near structures 227 and 228) to create a loop into the new substation. (PJM Network n8843.0)	\$5,854,227	\$819,493	\$311,445	\$23,711	\$7,008,876
Black Oak Substation: Replace line relaying equipment (PJM Network n8844.0)	\$592,830	\$37,732	\$31,539	\$913	\$663,014
Hatfield Substation (KATCo): Replace Relay Panel (PJM Network n8845.0)	\$517,866	\$112,896	\$45,676	\$6,187	\$682,625
Total Network Upgrades Cost	\$7,101,314	\$1,060,772	\$395,916	\$33,005	\$8,591,007

OTB Oversight Estimate	\$1,212,500	\$0	\$64,505	\$0	\$1,277,005
Revenue Metering	\$3,390	\$0	\$1,130	\$0	\$4,520
Other Cost	\$1,215,890	\$0	\$65,635	\$0	\$1,281,525
Total Project Costs	\$11,596,452	\$1,974,223	\$636,247	\$55,110	\$14,262,032

Generation projects meeting IRS "Safe Harbor" provisions generally do not incur tax on "CIAC" (Contribution in Aid to Construction), a tax collected by the utility for the state or federal government. Transmission Owner does not expect to collect tax on CIAC for this project. If for any reason, tax on "CIAC" would be required for this project, it would be the responsibility of the party owning the generator to pay this cost.

Transmission Owner reserves the right to charge the Project Developer operation and maintenance expenses to maintain the Interconnection Facilities, including metering facilities, owned by Transmission Owner.

9. Schedules and Assumptions

A proposed **fifty-seven (57) month Direct Connection** schedule is estimated to complete the engineering, construction and the associated activities, from the date of a fully executed Generator Interconnection 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. Construction cannot begin until after all applicable permits and/or easements have been obtained.

FirstEnergy's ability to support this schedule also depends on the feasibility of taking the required outages to support construction. Outages that are determined to negatively impact system reliability or cause congestion may be delayed or denied, at any time, even if they are submitted on time based on the Outage Submittal Rules in section 4.2.1 of PJM Manual 03. This includes, but is not limited to, outages requested between the months of June and September, as well as January and March, which typically get denied due to summer and winter peak conditions. Therefore, the construction schedule will be adjusted as needed to accommodate any outage restrictions that have been identified by FirstEnergy or the Transmission Provider.

57-month Schedule

Activity	Start Month	End Month
Preliminary Engineering	1	2
Detailed Engineering	3	54
Siting, Permits & Real Estate	4	49
Equipment Delivery	47	52
Construction	49	57
Testing & Commissioning	56	57

Attachment #1: Protection Study

This protection scope matches the requirements from system impact except due to the location of the three-breaker ring bus moving fiber between the ring bus station and Black Oak is now required. Also Project Developer protection requirements have been added.

AG1-363 Interconnection Substation

- Install (3) 500kV breakers.
- Install (3) SEL-451 for breaker failure protection.
- Install (3) sets of three, CCVTs. One set for each line exit.
- Install dual SEL-411L Standard BES line protection for primary and backup line differential schemes communicating over fiber channels for interconnection tie line to generator collector substation.
- Install SEL-421/SEL-411L Standard BES line protection for primary DCB over fiber and backup current differential line protection for the Black Oak 500kV line.
- Install SEL-421/SEL-411L Standard BES line protection for primary DCB and backup step distance line protection for the Hatfield 500kV line, and carrier equipment, including carrier transmitter receiver (UPLCII) and PCM-5350 power line carrier monitor, wide band line tuner, and wide band line trap.
- Install SEL-2505 or equivalent device to send/receive breaker failure transfer trip.
- Install (2) UPLC-II FSK Tx/Rx to transmit and receive dual channel transfer trip to and from Hatfield.
- SEL-3530 RTAC data concentrator for relay distance to fault information to SCADA, and remote access to relays if a network connection is available.

Black Oak Substation

- Replace existing primary ALPS and backup electromechanical Black Oak line relays with SEL-421/SEL-411L Standard BES line protection for primary DCB over fiber and backup step distance line protection for the AG1-363 500kV line protection.
- All existing carrier equipment can be removed.
- Install SEL-2505 or equivalent device to send/receive breaker failure transfer trip
- AG1-363 Generator Substation: AG1-363 Interconnection Switching Station 500kV line exit – Install SEL-411L primary and SEL-411L backup line protection relays, each utilizing a current differential protection scheme over dedicated fiber, with backup overcurrent and step distance protection.
- The SEL-411L relays will also be used for sending and receiving breaker failure transfer trip, with the transfer trip I/O configured in the same manner as at the interconnection station.
- A dedicate breaker failure to trip relay is required for the 500kV breaker.
- Two independent relay schemes are required for clearing faults between the developer's 500kV breaker and the high-side windings of their generator step-up transformer high-speed. These schemes must include the 500kV breaker in their zones of protection. A protection scheme containing generator Intertie functions is required. Voltages and currents for the Intertie relaying must come from the 500kV system. Also, all requirements from "Requirements for Transmission Connected Facilities document" must also be adhered to.

Hatfield Substation

- Replace existing primary ALPS and backup electromechanical Hatfield line relays with SEL-421/SEL-411L Standard BES line protection for primary DCB and backup step distance line protection for the AG1-363 500kV line protection. Also replace existing CS61C ON/OFF carrier set with UPLCII. Install (2) PCM-5350 power line carrier monitors for DCB and DTT monitoring.
- Install (2) UPLC-II FSK Tx/Rx to transmit and receive dual channel transfer trip to and from AG1-363.

Short Circuit Analysis

Fault values for the AG1-363 Interconnection Substation location with no AG1-363 generation equipment in service are:

Three phase = 11,800 A

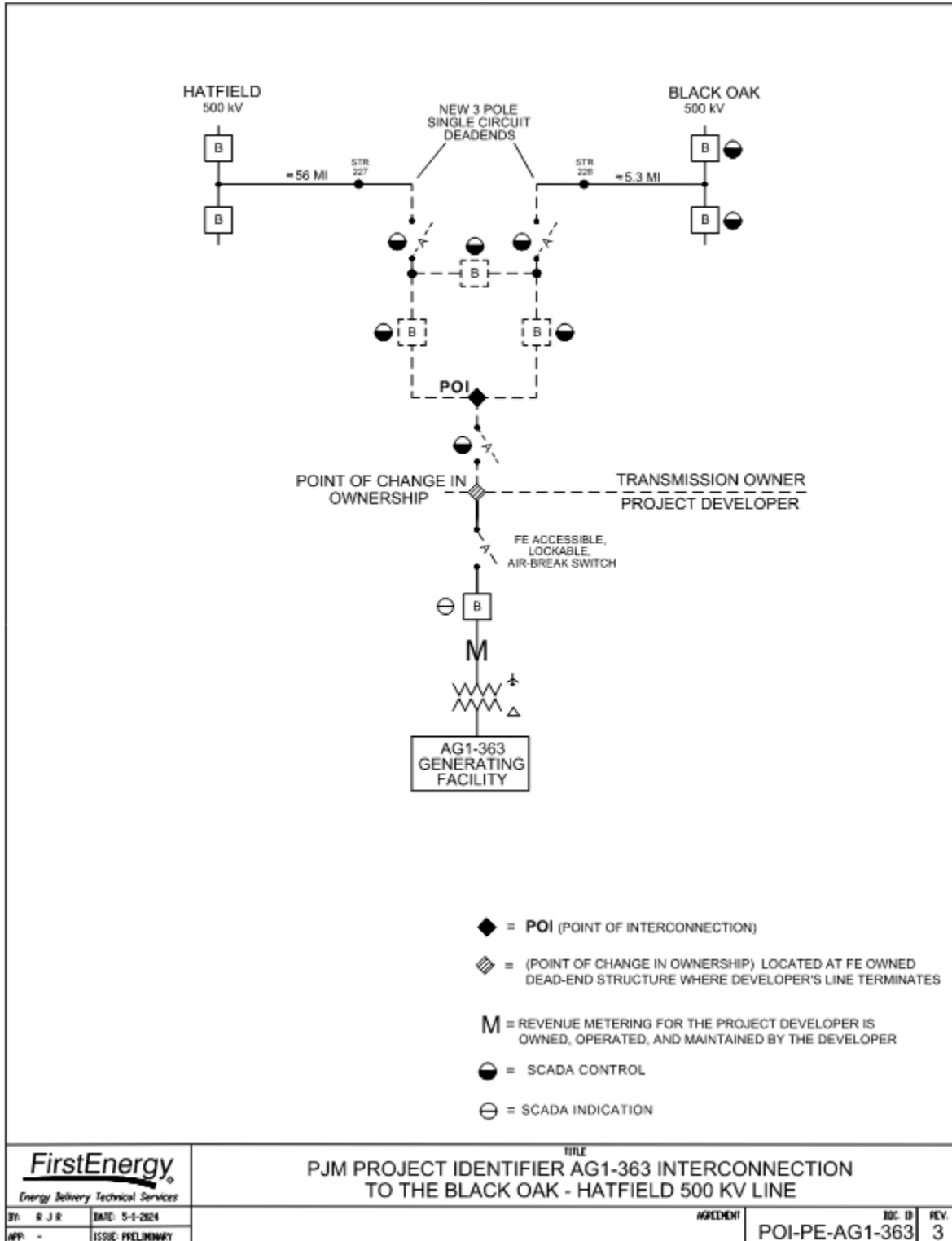
Single line to ground = 10,400 A

$Z1 = 0.049 + j 0.976 \%$

$Z0 = 0.241 + j 1.368 \%$

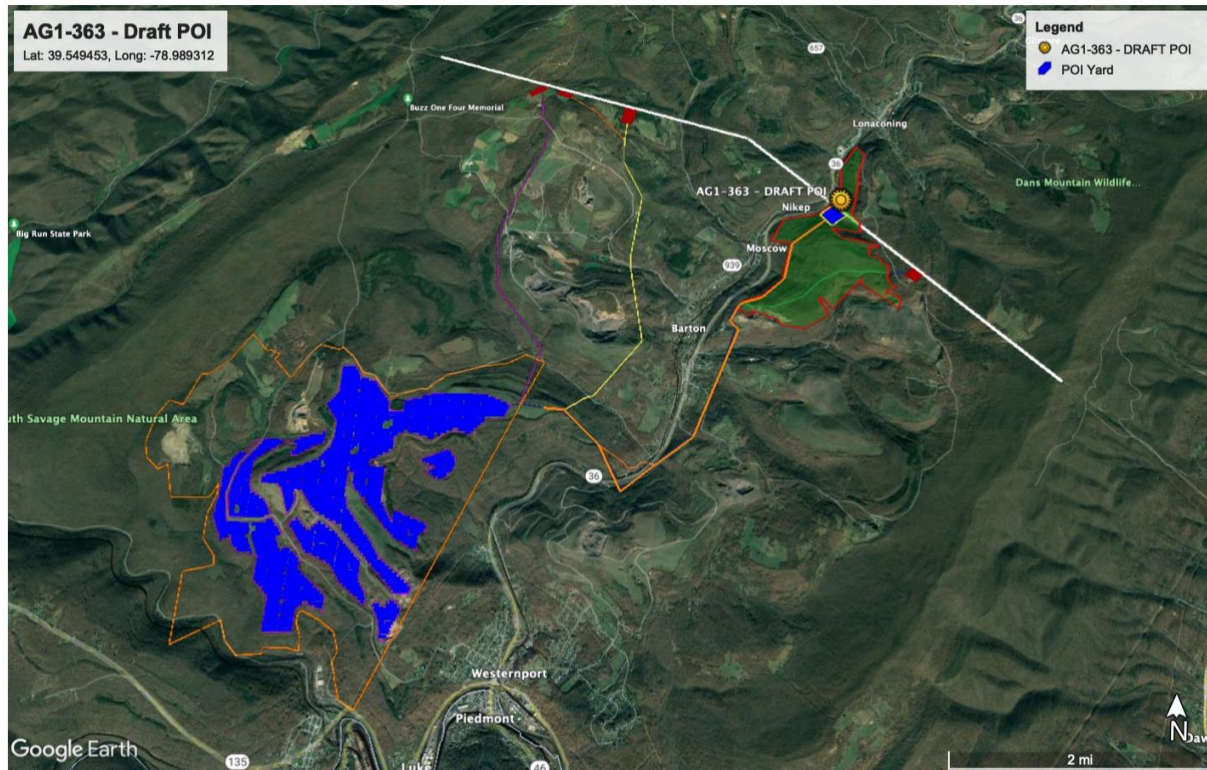
Impedances are given on a 100 MVA and 500kV base. The fault currents provided are bolted, symmetrical values for normal system conditions, using the PJM Short Circuit case. Future increases in fault currents are possible and it is the Developer's responsibility to upgrade its equipment and/or protective equipment coordination when necessary.

Transmission Owner One-Line



Attachment #3: Project Developer Site Plan and Interconnection Facilities

Project Developer Site Plan





Attachment #4: Generation Connection Requirements

Generation Connection Requirements

The proposed interconnection facilities must be designed in accordance with the *First Energy Transmission Planning and Protection 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 the *First Energy Transmission Planning and Protection Requirements for Transmission Connected Facilities* document:

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 PCO 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 Request 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

Project Developer is responsible for specifying appropriate equipment and facilities such that the parallel generation is compatible with Transmission Owner's Transmission System. Project Developer 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. Project Developer must abide by any PJM, RFC or NERC criteria imposed that is more restrictive than those of Transmission Owner.

General Design Requirements

- | | |
|--|---|
| • System phasing (counter clockwise) | 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: | 500 kV |
| • Maximum phase-to-phase: | 550 kV |
| • Basic impulse level (BIL): | 1800 kV |
| • Maximum continuous current carrying capacity: | 4000 A |
| • Design fault current: | 40kA,
Confirm for site specific exception |
| • Single Contingency (breaker failure) clearing time: | 30 cycles |

Clearances and Spacing

- | | |
|---|------|
| • Recommended rigid bus center-to-center phase spacing: | 300" |
| • Minimum phase-to-phase, metal-to-metal distance: | 222" |
| • Recommended phase-to-ground: | 152" |
| • Minimum phase-to-ground: | 144" |

- Low bus height above top of foundations (match existing): 30'-0"
- High bus height above top of foundations (match existing): 55'-0"
- Minimum vertical clearance from live parts to grade: 20'-6"
- Minimum horizontal clearance from live parts: 15'-0"
- Minimum conductor clearance above roads in switchyard: 42'-0"
- Minimum bottom of insulator to top of foundation: 8'-6"

Attachment #5: Preliminary Geotechnical Summary

List of Observations/Concerns

- Potential for weak clayey soils (CL).
- Colluvium Material likely on-site.
- Deep organic soils identified on-site.
- Site geology consists of the Monongahela and Conemaugh formations. It is unlikely to have karst in these formations. These formations do have the potential for landslides and are known for large deposits of the Pittsburgh Coal seam.
- The proposed substation is located within hilly terrain. There is also a large ravine within the proposed substation location.
- This site is directly downslope of an active surface coal mine. The mine is called the "Watertank Pittsburgh Mine", owned by Cobra Mining, Inc. It is difficult to determine if the area directly upslope of proposed substation has already been mined and reclaimed or is clear cut and is planned to be mined in the future. Mines can significantly affect both surface storm water runoff and subsurface water. It is possible to have water management issues when developing adjacent to an active or reclaimed mine.

Recommendations

These recommendations assume this is an option to build project:

- Developer should provide a preliminary site investigation report. This should include:
 - Investigation of geotechnical risk which are:
 - deep organic soils.
 - hard shallow bedrock.
 - landslides cause by construction.
 - rutting of clayey soils.
 - Hydrological study of the site to investigate the large ravine and water from the upslope mine.
 - An understanding of previous and proposed mining activities upslope.
- Based on Tami 2 this is on the mine's property. Assuming the mine has sold the property already, we should review our easements and confirm the mine will not have domain over us.
- Developer should budget for higher-than-average civil construction costs due to steep terrain, organic soils, potential for hard shallow bedrock in some area and risk of the mine directly upslope

Preliminary Geotechnical Opinion

Based on a very high-level desktop study not backed with any field or testing verification there, appears to be a low risk of karst. Constructing 2 new substations and the associated access roads will be expensive because of the amount of earthwork to construct this on a side slope. As mentioned, the risk of karst is low but the risk of other geohazards should be considered moderate to high on this site. Our opinion of risk is:

- Karst – low.
- Deep organic soils (peat) – moderate.
- Hard shallow bedrock in some areas – moderate.
- Construction induced landslides – moderate to high.
- Rutting – high.
- Stormwater and drainage problems – high.

Building on significant side slopes will make it difficult to design a balanced earthwork site. FirstEnergy should have concerns about proposed fill pads, stockpiles, and over-steepened cutslopes. The Project Developer will need to provide FE with detailed slope stability analysis for all proposed significant slopes.

In our preliminary opinion, the proposed site location should be reconsidered based on the geotechnical risks. It is possible that some risks could be reduced by relocating the substation downslope at the base of the hill. This would need to be confirmed with a detailed subsurface investigation.

Estimating

Estimating construction costs for the proposed location is difficult at this stage in the development. Based on the opinion that site is a difficult site to develop, we recommend assuming 200%-300% increased cost compared to constructing a similar sized substation on flat terrain with no to low risks of geohazards.