

***Generation Interconnection
Facilities Study Report***

For

***PJM Generation Interconnection Request
Queue Position AE2-316***

“Brookville-Squab Hollow 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

Walden Solar PA Jefferson LLC, (hereinafter referred to as “IC”) has proposed a solar generating facility located in Jefferson County, Pennsylvania. The installed facilities for AE2-316 will have a total capability of 90 MW with 41.22 MW of this output being recognized by PJM as capacity. The AF1-302 queue position, which is a 42 MW uprate (18 MW capacity uprate) to the previous project, is not included in this report. The generation facility will interconnect with Mid-Atlantic Interstate Transmission, LLC (MAIT), a FirstEnergy Company (FE), hereinafter referred to as “Transmission Owner” (TO), at a newly constructed 138 kV three-breaker ring bus substation tapped off of the Brookville-Squab Hollow 138 kV transmission line at 41.191167, -78.941080, 20.37 miles to Squab Hollow, 8.32 miles to Brookville.

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

Installing fibers from the new interconnect substation to the backbone was not identified in the scope of the System Impact Study or System Impact Study Results posted on PJM’s website dated August 2022.

3. Interconnection Customer’s Milestone Schedule

IC’s requested Commercial Operation Date (COD) for the generation facility is **December 31, 2025**.

Transmission Owner’s Assumed Milestone Schedule:

August 1, 2025	Initial Back-feed through Project Substation Date
December 31, 2025	Project Commercial Operation Date

4. Customer’s Scope of Work

IC is responsible for all design and construction related to activities on their side of the Point of Interconnection (POI). This includes, but is not limited to, the the generation step-up (GSU) transformer, 138 kV (AE2-316) generator lead line and connection to the new 3 breaker ring bus interconnection substation.

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

IC is required to own, install, and maintain a fully-rated, fault-interrupting circuit breaker on the high-side of the GSU transformer, as well as the necessary revenue metering equipment. The revenue metering current and voltage transformers shall be installed on the high voltage side of the GSU, on the generation side of the fault-interrupting device, and within the local zone of fault protection for the facility. The protective relaying and metering design must comply with FirstEnergy’s applicable standards as well as with PJM requirements.

The easements and associated rights of way for the TO owned substation along with the 138 kV line taps to the substation will be acquired by the IC and transferred to the TO at no cost. Site preparation for the TO owned substation, including clearing, grading and an access road, as necessary, is assumed to be by the IC. The access road design must be approved by FirstEnergy to ensure it provides adequate access to the substation to support construction and maintenance activities. Route selection, line design, and right-of-way acquisition for the IC’s facilities are not included in this report and are the responsibility of the IC.

Assumptions / Notes:

- IC will coordinate design and alignment of proposed 138 kV generator lead line with the Transmission Owner for review of any clearance, right-of-way or right-of-way encroachment issues with TO owned facilities.
- IC will coordinate design and construction of proposed 138 kV Lead Line. For these areas, the IC shall provide TO with proposed drawings prior to construction and as-built drawings, confirmed by as-built survey data post-construction.
- Transmission Owner’s preference would be to limit interference and avoid transmission line crossings with new 138 kV terminal positions. As a minimum, IC facilities should not encroach within 100 feet of TO centerline at blowout conditions. If IC’s line design does not comply with this requirement TO would need to review this area as a special exception.
- Additional costs will be incurred by the IC, if final alignment of the 138 kV generator lead line causes encroachments, changes, or modifications to any existing or relocated TO facilities.
- IC is responsible to make all arrangements for electric distribution service (if required) for its generation station. No costs or schedule are included herein.

5. Description of Facilities Included in the Facilities Study – Transmission Owner

Attachment Facilities

The IC has exercised their option-to-build these facilities, so they will design, furnish and construct the new 138 kV line terminal and take off structure in the new AE2-316 ring bus substation. This work will include, but not be limited to, installation of a 138 kV line exit take-off structure, foundations, disconnect switch and associated equipment to accommodate the termination of the 138 kV generator lead line. Transmission Owner will oversee the design and construction and perform testing and commissioning.

AE2-316 Customer Substation

Energize and integrate attachment facilities to the FirstEnergy transmission system.

Direct Connection

AE2-316 Interconnection Substation

The IC has exercised their option-to-build these facilities, so they will design, furnish and construct a new three breaker ring bus substation, AE2-316 138 kV, along the Brookville-Squab Hollow 138 kV transmission line to interconnect the AE2-316 solar project with the MAIT transmission system. The POI will be at the TO-owned deadend structure inside the substation yard where the generator lead line terminates. Transmission Owner will oversee the design and construction and perform testing and commissioning.

Non-Direct Connection

Brookville to Squab Hollow 138 kV line

(Network Upgrade Number n8188.1)

The Brookville to Squab Hollow 138 kV line will be cut and looped into the interconnection substation. This cut will take place at a location that is approximately 20.37 miles from the Squab Hollow substation and 8.32 miles from the Brookville substation. It is assumed that the new interconnection substation will be located within one span (approximately 300 feet) from the existing line.

Brookville Substation

(Network Upgrade Number n8188.2)

New anti-islanding will be installed.

6. Description of Facilities Included in the Facilities Study – Affected Transmission Owner

Non-Direct Connection

Brookville to Squab Hollow 138 kV line

(Network Upgrade Number n8188.1)

The Brookville to Squab Hollow 138 kV line will be cut and looped into the interconnection substation. This cut will take place at a location that is approximately 20.37 miles from the Squab Hollow substation and 8.32 miles from the Brookville substation. It is assumed that the new interconnection substation will be located within one span (approximately 300 feet) from the existing line.

Armstrong Substation

(Network Upgrade Number n8188.3)

New anti-islanding will be installed.

Squab Hollow Substation

(Network Upgrade Number n8188.4)

New anti-islanding will be installed.

7. Total Cost of Transmission Facilities Included in the Facilities Study

Description	Total
Attachment Facilities:	\$88,382.99
Total Direct Connection (DC) Costs:	\$2,487,494.90
Total Non-Direct Connection (NDC) Upgrade Costs:	\$2,251,117.31
New System Upgrades	\$ 0
Other	\$944,771.69

TOTAL Costs (ALL Categories)	\$5,771,766.89
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8. Summary of the Schedule for Completion of Work for the Facilities Study

<i>Attachment Facility</i>	<i>Duration</i>
Engineering, Procurement, and Construction	28 months

B. Transmission Owner Facilities Study Results

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

Brookville-Squab Hollow 138kV Line

- Description of Work
 - Loop the Brookville-Squab Hollow 138kV line into the new AE2-316 interconnection substation at existing structure 238.
- Existing Conditions
 - The existing line is constructed on single circuit wood h-frame structures. Per TAMI, existing conductor is 954 kcmil 45/7 ACSR “Rail”, and existing shield wire is (1) 7#9 Alumoweld and (1) AFL AC-57/465 OPGW
- Structures Installed
 - Per the POI location shown on the developer’s layout drawing, the line will be cut approximately 8.3 miles from Brookville substation, at existing structure 238. The following will be installed:
 - (2) 138kV single circuit wood 3-pole deadend structures (TR-138075).
 - Approximately (0.1) circuit miles of 1033.5 kcmil 54/7 ACSR “Curlew” shielded by (1) 7#8 alumoweld and (1) OPGW.
 - Existing conductor and shield wire will be transferred to the new deadend structures.
- Structures Removed
 - (1) 70’ 138kV single circuit wood H-frame tangent structure (TR-138045)
 - Existing conductor and shield wire between the new deadend structures will be removed, approximately 0.1 miles total.
- Construction Considerations
 - None
- Siting/Licensing
 - A LON will be required to be filed with the PaPUC.
 - Assume minimal ecological impacts.
- Assumptions
 - OPGW is assumed to be installed on each loop span into the new substation. Confirm the need for OPGW and type before detailed engineering.
 - Assume existing structures 237 and 239 are in good condition and have adequate capacity for any new loading arrangement. An engineering analysis during project development will be required to confirm.
 - See the attached .kmz file for the assumed loop configuration.
 - A ground survey of the project area will be required.
- **Ancillary Line Estimates**
 - PROJECT MANAGEMENT (PM)
 - Project management will be required for this asset.
 - FORESTRY
 - None
 - RE/ROW
 - New ROW will be required for the line loop.
 - A rights and restrictions review by Real Estate will be required.

- Georeferenced ROW extents will be required to be provided to Engineering.
- ENVIRONMENTAL
 - An environmental review will be required to identify any construction constraints or permitting requirements.
- REVENUE METERING
 - None
- IT/NETWORK
 - FIBER (RELAYING AND COMMUNICATION)
 - Transfer existing OPGW to new loop structures and install new OPGW on each leg of the loop, approximately (0.1) miles total.
 - SCADA
 - None
- ACCESS ROAD CONSTRUCTION
 - Assume the site will be accessed from the substation property and only minor additional access improvements will be required.
- DISTRIBUTION
 - None

3. New Substation/Switchyard Facilities

AE2-316 Interconnect (Customer has selected the Option-To-Build)

- Below Grade
 - Foundations, conduit, and grounding for new equipment.
 - Drainage, fence, stone, ground grid, trench, and fence for new substation.
 - Conduit for fiber from customer substation.
- Above Grade
 - Install (3) 138kV, 2000A circuit breakers.
 - Install (6) 138kV, 2000A disconnect switches.
 - Install (3) 138kV, 2000A line MOABs.
 - Install (9) 138kV surge arresters.
 - Install (9) 138kV CVTs.
 - Install (1) control building.
 - Install (1) 138kV SSVT.
 - Install (2) 138kV, 2000A wide band wave trap, line tuner, and coax.
 - Install (2) 138kV dead end H frames.
 - Install (1) lot of rigid bus, strain bus, connectors, and steel supports
 - All equipment must exceed ratings of 309/376 MVA SN/SSTE.
- R&C
 - Install (1) SCADA RTU, (1) HMI, and (1) lot of standard communication equipment.
 - Install (1) prewired relaying panel consisting of dual SEL-411L.
 - Install (1) prewired relaying panel consisting of (1) SEL-421 and (1) SEL-411L for Squab Hollow line terminal.
 - Install (1) carrier panel consisting of (1) UPLC, (1) PCM 5350, and (1) RFL 9780 for Squab Hollow line terminal.
 - Install (1) prewired relaying panel consisting of (1) SEL-421 and (1) SEL-411L BFT for Brookville line terminal.
 - Install (1) carrier panel consisting of (1) UPLC, (1) PCM 5350, and (1) RFL 9780 for Milesburg line terminal.
 - Install (3) breaker control panels with SEL-501 BFT.

- Install (1) fiber patch panel.
- Additional Equipment to be Removed
 - None
- Assumptions
 - Rough graded site and access road provided by customer.
- **Ancillary Substation Estimates**
 - PROJECT MANAGEMENT (PM)
 - Project management will be required for this asset.
 - Backup station service by local distribution
 - FORESTRY
 - None
 - RE/ROW
 - None
 - ENVIRONMENTAL
 - Support as required for new substation
 - REVENUE METERING
 - Revenue metering for interconnection substation for the transition from West Penn Power to Penelec Utility.
 - IT/NETWORK
 - FIBER (RELAYING AND COMMUNICATION)
 - None
 - SCADA
 - New SCADA RTU
 - TESTING & COMMISSIONING (TSCS)
 - Testing and commissioning services as required for new equipment and relays.

AE2-316 Collector Sub

- Below Grade
 - None
- Above Grade
 - None
- R&C
 - Integrate customer protection and controls to the FirstEnergy transmission system.
- Additional Equipment to be Removed
 - None
- Assumptions
 - None
- **Ancillary Substation Estimates**
 - PROJECT MANAGEMENT (PM)
 - Project management will be required for this asset.
 - FORESTRY
 - None
 - RE/ROW
 - None
 - ENVIRONMENTAL
 - None
 - REVENUE METERING

- Located at customer substation.
- IT/NETWORK
 - FIBER (RELAYING AND COMMUNICATION)
 - Fiber communications to new customer substation.
 - SCADA
 - None
- TESTING & COMMISSIONING (TSCS)
 - Testing and commissioning support at customer substation.

4. Substation/Switchyard Facility Upgrades

Brookville

- Below Grade
 - None
- Above Grade
 - None
- R&C
 - Install (1) RFL9780 transmitter for anti-islanding.
 - Install (1) RFL9780 receiver on the Armstrong 138kV terminal.
- Additional Equipment to be Removed
 - None
- Assumptions
 - New RFL9780s will fit in existing panels.
- **Ancillary Substation Estimates**
 - PROJECT MANAGEMENT (PM)
 - Project management will be required for this asset.
 - FORESTRY
 - None
 - RE/ROW
 - None
 - ENVIRONMENTAL
 - None
 - REVENUE METERING
 - None
 - IT/NETWORK
 - FIBER (RELAYING AND COMMUNICATION)
 - None
 - SCADA
 - Modify points list for new equipment.
 - TESTING & COMMISSIONING (TSCS)
 - Testing and commissioning services as required for new relays.

5. Telecommunications Facilities – Upgrades

IC will design, provide, install, own and maintain a fiber-optic communications cable between the new **interconnection** substation, and IC's **generation** (collector) substation. Two (2) fiber-optic channels are

required for each generator protection scheme to obtain high-speed tripping capability for any fault within the zone of protection. Should subsequent/additional PJM studies indicate that stability issues exist, the primary and backup relay fiber-optic communication channels must be in separately-routed cable paths and additional fiber-optic connection costs would apply (not included herein).

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

Transmission Owner will make the fiber termination connections for its cable(s) at the interconnection substation control house. IC is responsible for obtaining and maintaining all associated Rights-of-Way (ROW), Easements, and Permits for its fiber cable.

6. Metering & Communications

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

The revenue metering system (particularly the revenue metering current transformers) shall be designed to accurately meter the light loads that will occur when the facility is not generating power and only 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 IC to PJM. Transmission Owner will work with PJM and IC to ensure the generation data provided to PJM meets Transmission Owner's requirements.

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

7. Environmental, Real Estate and Permitting

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

- Environmental permitting, Real Estate acquisition, and Pennsylvania Public Utility Commission (PAPUC) notifications vary, some up to twelve (12) months after preliminary engineering is completed to secure the required approvals.
- Prior to agreement by IC to purchase the property, a Phase 1 Environmental Assessment should be conducted for the entire site to avoid assumption of environmental liabilities by IC or Transmission Owner.
- The Transmission Owner interconnection substation may involve environmental surveys, permits, approvals and plans with federal, state, and/or local agencies.
- Assumed IC is to provide all access rights, easements, ROW and permits necessary to complete the Project to the satisfaction of Transmission Owner. Environmental permitting shall encompass all federal, state and local requirements, consultations and agency coordination. Confirmation of meeting all permitting requirements shall be provided to Transmission Owner, prior to start of construction. Following construction and energization, confirmation of permit closeout shall be provided to the satisfaction of Transmission Owner, prior to transfer of ownership. If any of these elements are not included in the final agreement between Transmission Owner and IC, twelve (12)-to-eighteen (18) months should be added to the Project Schedule to secure necessary permits, and additional costs would apply.
- IC will provide copies of all of the relative environmental permits and other necessary approvals to Transmission Owner before Transmission Owner accepts the interconnection facilities.
- IC is required to install an access road from the new interconnection substation to the nearest public road (must be approved by Transmission Owner), and obtain access rights for Transmission Owner. IC is responsible to maintain access road and ensure unimpeded access for Transmission Owner at all times.
- IC is responsible for all property acquisition (including easements/rights-of-way (ROW)) for transmission, distribution and communication facilities needed for the generator interconnection.
- If IC owns the project property, in fee title, Transmission Owner will require a fee property transfer for the interconnection substation site which may require subdivision approval, together with permanent access rights to and from the substation, as well as a perpetual easement for any transmission lines to the substation. IC is responsible for all costs, including but not limited to subdivision, associated with the property transfer.
- If IC leases the project property, the IC will be required to obtain fee property from the underlying fee property owner, on behalf of Transmission Owner, for the interconnection substation site, together with permanent access rights to and from the substation, as well as a perpetual easement for any transmission lines to the substation.
- All property rights must be surveyed and metes and bounds descriptions prepared for incorporation into Transmission Owner's document forms, for transfer of title.
- The Transmission Owner interconnection substation and transmission line loop will involve Pennsylvania Public Utility Commission (PAPUC) notification/approval.
- All work occurs within an existing transmission line right-of-way or on IC's property with access to all existing structures possible via that property and the right-of-way following established access routes that do not cross wetlands or streams.
- IC will develop, and secure regulatory approval for, all necessary Erosion and Sediment Control (E&SC) plans and National Pollutant Discharge Elimination System (NPDES) permits within their scope of work.
- IC will obtain all necessary permits within their scope of work. IC will not be responsible for permitting of work that is in the TO's scope to complete.
- IC will conduct all necessary wetlands and waterways studies and permits within their scope of work. IC will not be responsible for studies and permits of work that is in the TO's scope to complete.

- IC will conduct all necessary historical and archaeological studies within their scope of work. IC will not be responsible for historical and archaeological studies of work that is in the TO's scope to complete.
- If the IC plans to cross the transmission line right of way with facilities or access roads, please refer to the Transmission Rights-of-Way Restrictions information located at:
<https://www.firstenergycorp.com/help/safety/real-estate-power-lines/transmission-right-of-way.html#ROWform>

C. Affected Transmission Owner Facilities Study Results

This section describes facilities identified to be installed (attachment facilities), replaced, and/or upgraded (upgrade facilities) by WPP 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 – Upgrade

Brookville-Squab Hollow 138kV Line

- Description of Work
 - Loop the Brookville-Squab Hollow 138kV line into the new AE2-316 interconnection substation at existing structure 238.
- Existing Conditions
 - The existing line is constructed on single circuit wood h-frame structures. Per TAMI, existing conductor is 954 kcmil 45/7 ACSR “Rail”, and existing shield wire is (1) 7#9 Alumoweld and (1) AFL AC-57/465 OPGW
- Structures Installed
 - Per the POI location shown on the developer's layout drawing, the line will be cut approximately 8.3 miles from Brookville substation, at existing structure 238. The following will be installed:
 - (2) 138kV single circuit wood 3-pole deadend structures (TR-138075).
 - Approximately (0.1) circuit miles of 1033.5 kcmil 54/7 ACSR “Curlew” shielded by (1) 7#8 alumoweld and (1) OPGW.
 - Existing conductor and shield wire will be transferred to the new deadend structures.
- Structures Removed
 - (1) 70' 138kV single circuit wood H-frame tangent structure (TR-138045)
 - Existing conductor and shield wire between the new deadend structures will be removed, approximately 0.1 miles total.
- Construction Considerations
 - None
- Siting/Licensing
 - A LON will be required to be filed with the PaPUC.
 - Assume minimal ecological impacts.
- Assumptions
 - OPGW is assumed to be installed on each loop span into the new substation. Confirm the need for OPGW and type before detailed engineering.
 - Assume existing structures 237 and 239 are in good condition and have adequate capacity for any new loading arrangement. An engineering analysis during project development will be required to confirm.

- See the attached .kmz file for the assumed loop configuration.
- A ground survey of the project area will be required.

2. Substation/Switchyard Facility Upgrades

Squab Hollow

- Below Grade
 - None
- Above Grade
 - None
- R&C
 - Install (1) RFL9780 transmitter for anti-islanding.
- Additional Equipment to be Removed
 - None
- Assumptions
 - New RFL 9780 will fit in existing panel.
- **Ancillary Substation Estimates**
 - PROJECT MANAGEMENT (PM)
 - Project management will be required for this asset.
 - FORESTRY
 - None
 - RE/ROW
 - None
 - ENVIRONMENTAL
 - None
 - REVENUE METERING
 - None
 - IT/NETWORK
 - FIBER (RELAYING AND COMMUNICATION)
 - None
 - SCADA
 - Modify points list for new equipment.
 - TESTING & COMMISSIONING (TSCS)
 - Testing and commissioning services as required for new relays.

Armstrong

- Below Grade
 - None
- Above Grade
 - None
- R&C
 - Install (1) RFL9780 transmitter for anti-islanding.
- Additional Equipment to be Removed
 - None
- Assumptions
 - New RFL 9780 will fit in existing panel.

- **Ancillary Substation Estimates**
 - PROJECT MANAGEMENT (PM)
 - Project management will be required for this asset.
 - FORESTRY
 - None
 - RE/ROW
 - None
 - ENVIRONMENTAL
 - None
 - REVENUE METERING
 - None
 - IT/NETWORK
 - FIBER (RELAYING AND COMMUNICATION)
 - None
 - SCADA
 - Modify points list for new equipment.
 - TESTING & COMMISSIONING (TSCS)
 - Testing and commissioning services as required for new relays.

8. Summary of Results of Study

The cost estimates provided in this report were developed as of 11/2022. 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 Interconnection Service Agreement for the related project, FirstEnergy 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	
AE2-316 Customer: Energize and integrate attachment facilities to the FirstEnergy transmission system. (MAIT)	\$71,854.91	\$0	\$16,528.08	\$0	\$88,382.99
Total Attachment Facilities Cost	\$71,854.91	\$0	\$16,528.08	\$0	\$88,382.99
AE2-316 Interconnect: FE installation of a security fence. (MAIT)	\$449,178.80	\$407,414.45	\$103,320.21	\$200,271.58	\$1,160,185.04
Install fiber from AE2-316 to Backbone for communication transport. @ AE2-316 Direct Connect – Squab Solar (MAIT)	\$757,831.00	\$77,274.00	\$174,316.46	\$37,985.36	\$1,047,406.82
Meter/SCADA/Fiber Communication: Design, install, and test/commission MPLS Equipment for SCADA transport and WPP/MAIT metering. (MAIT)	\$125,885.00	\$83,846.00	\$28,956.10	\$41,215.94	\$279,903.04
Total Direct Connection Cost	\$1,332,894.80	\$568,534.45	\$306,592.77	\$279,472.88	\$2,487,494.90
Brookville-Squab Hollow 138 kV Line: Loop the Brookville-Squab Hollow 138kV line into the new AE2-316 interconnection sub. (MAIT/WPP)	\$1,015,389.24	\$76,000.01	\$233,560.07	\$35,842.82	\$1,360,792.13
Brookville: Install new relays and modify relay settings. (MAIT)	\$335,760.62	\$29,898.12	\$73,531.12	\$14,508.53	\$453,698.40
Armstrong: Install anti-islanding transmitter. (WPP)	\$158,698.54	\$15,494.42	\$36,503.88	\$7,616.55	\$218,313.39
Squab Hollow: Install anti-islanding transmitter. (WPP)	\$158,698.54	\$15,494.42	\$36,503.88	\$7,616.55	\$218,313.39

Total Non-Direct Connection Network Upgrades	\$1,668,546.94	\$136,886.97	\$380,098.95	\$65,584.45	\$2,251,117.31
AE2-316 Interconnect: IC has selected the Option-To-Build: Oversight for Construction of new AE2-316 138 kV substation as a 3-breaker ring bus looping in and out the Brookville – Squab Hollow line.(MAIT)	\$756,511.02	\$6,519.24	\$174,012.84	\$3,204.64	\$940,247.74
Customer-owned Revenue meter at the new AE2-316 138 kV 3 Breaker Ring Bus on Brookville – Squab Hollow 230 kV Line.(MAIT)	\$3,677.95	\$ 0	\$846.00	\$ 0	\$4,523.95
Other Costs	\$760,188.97	\$6,519.24	\$174,858.84	\$3,204.64	\$944,771.69
Total Project Costs	\$3,833,485.62	\$711,940.66	\$878,078.64	\$348,261.97	\$5,771,766.89

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. FirstEnergy does not expect to collect CIAC for this project. If for any reason, tax gross up would be required for this project, it would be the responsibility of the party owning the generator to pay this cost.

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

9. Schedules and Assumptions

A proposed **twenty-eight (28) 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.

28 month Schedule (assume [PJM to fill in] start)

Activity	Start Month	End Month
Preliminary Engineering	1	3
Siting, Permits & Real Estate	2	12
Detailed Engineering	2	12
Equipment Delivery	14	15
Below Grade Construction – Substation	15	18
Below Grade Construction – T-Lines	21	23
Above Grade Construction – Substation	18	24
Above Grade Construction – T-Lines	24	27
Testing & Commissioning	27	28

FE will need to conduct an environmental survey for the loop and proposed interconnect substation. If permits are necessary to complete the project, approximately 3-6 months will be needed to draft and receive agency approvals.

Attachment #1: Protection Study

PROTECTION SCOPE

New 3-breaker ring bus

- Dual SEL-411L Standard BES line protection for primary and backup line differential schemes communicating over dedicated fiber channels for interconnection tie line to generator collector substation.
- SEL-421 and SEL-411L Standard BES line protection for primary DCB and backup step distance line protection for the Brookville 138kV line, and carrier equipment, including carrier transmitter receiver, wide band line tuner, and wide band line trap.
- SEL-421 and SEL-411L Standard BES line protection for primary DCB and backup step distance line protection for the Squab Hollow 138kV line, and carrier equipment, including carrier transmitter receiver, wide band line tuner, and wide band line trap.
- (3) SEL-501 for breaker failure protection
- (3) sets of 3-phase CCVTs, one for each 115kV line terminal
- RFL-9780 FSK Tx/Rx to receive breaker status from Squab Hollow for anti-islanding
- RFL-9780 FSK Tx/Rx to receive breaker status from Brookville for anti-islanding
- SEL-3530 RTAC to provide distance-to-fault information from the line protection relays to the EMS via the SCADA RTU, as well as for remote access to the relays if a network connection is available.

Brookville SS

- Reuse existing Squab Hollow SEL-421 primary line relay and SEL-411L backup line relay for primary DCB and backup step distance protection to the new 3 breaker ring bus substation
- Reuse existing Squab Hollow terminal line trap and line tuner for DCB carrier and anti-islanding breaker status communication to the new 3 breaker ring bus substation
- Install RFL-9780 FSK Tx/Rx to transmit breaker status for anti-islanding to the new 3 breaker ring bus substation
- Install RFL-9780 FSK Tx/Rx to receive breaker status for anti-islanding from Armstrong SS. A handoff scheme at Brookville shall forward this signal to the new 3 breaker ring bus.

Squab Hollow SS

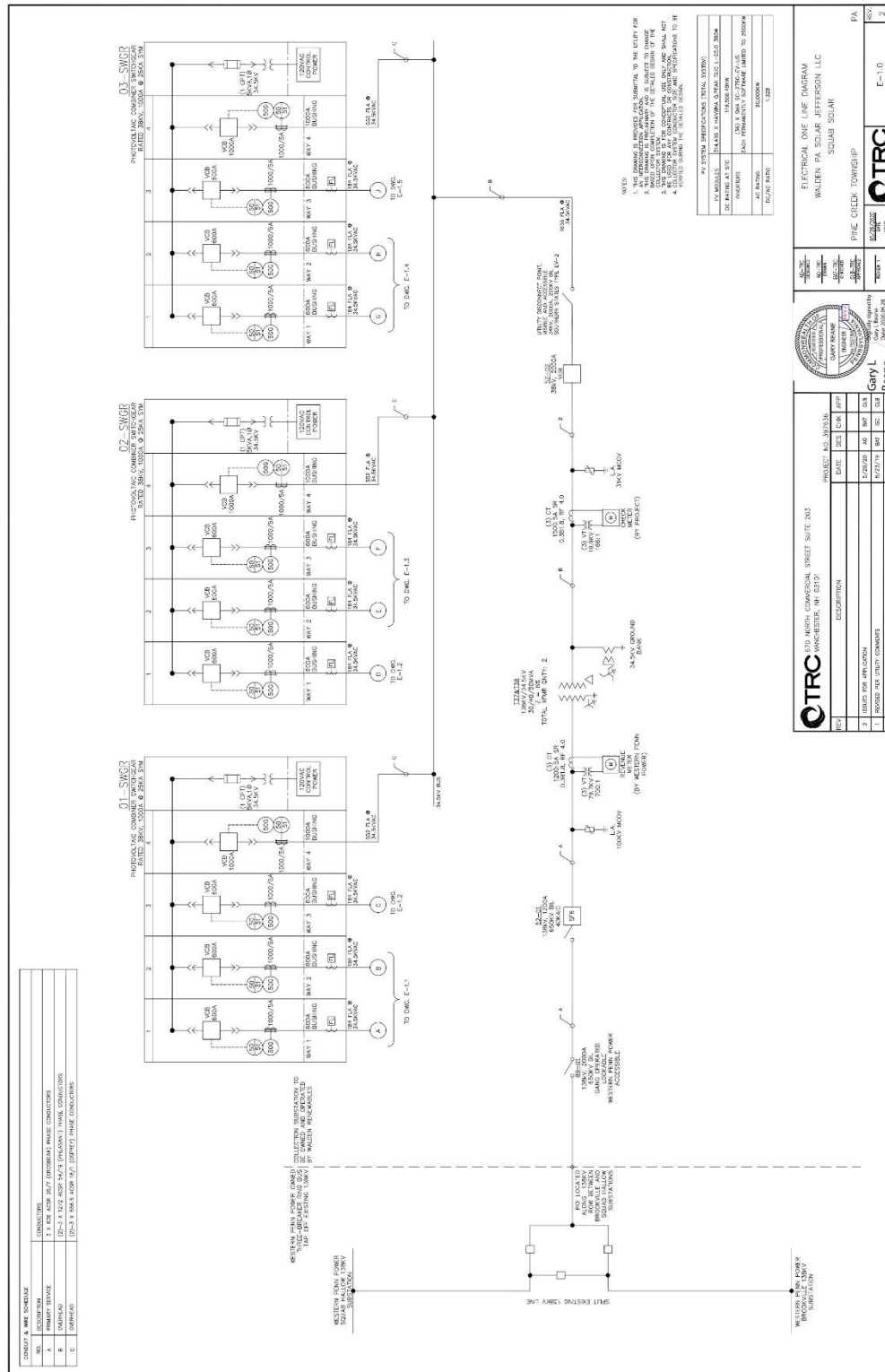
- Reuse existing Brookville SEL-421 primary line relay and SEL-411L backup line relay for primary DCB and backup step distance protection to the new 3 breaker ring bus substation
- Reuse existing Brookville terminal line trap and line tuner for DCB carrier and anti-islanding breaker status communication to the new 3 breaker ring bus substation
- Install RFL-9780 RSK Tx/Rx to transmit breaker status for anti-islanding to the new 3 breaker ring bus substation

Armstrong SS

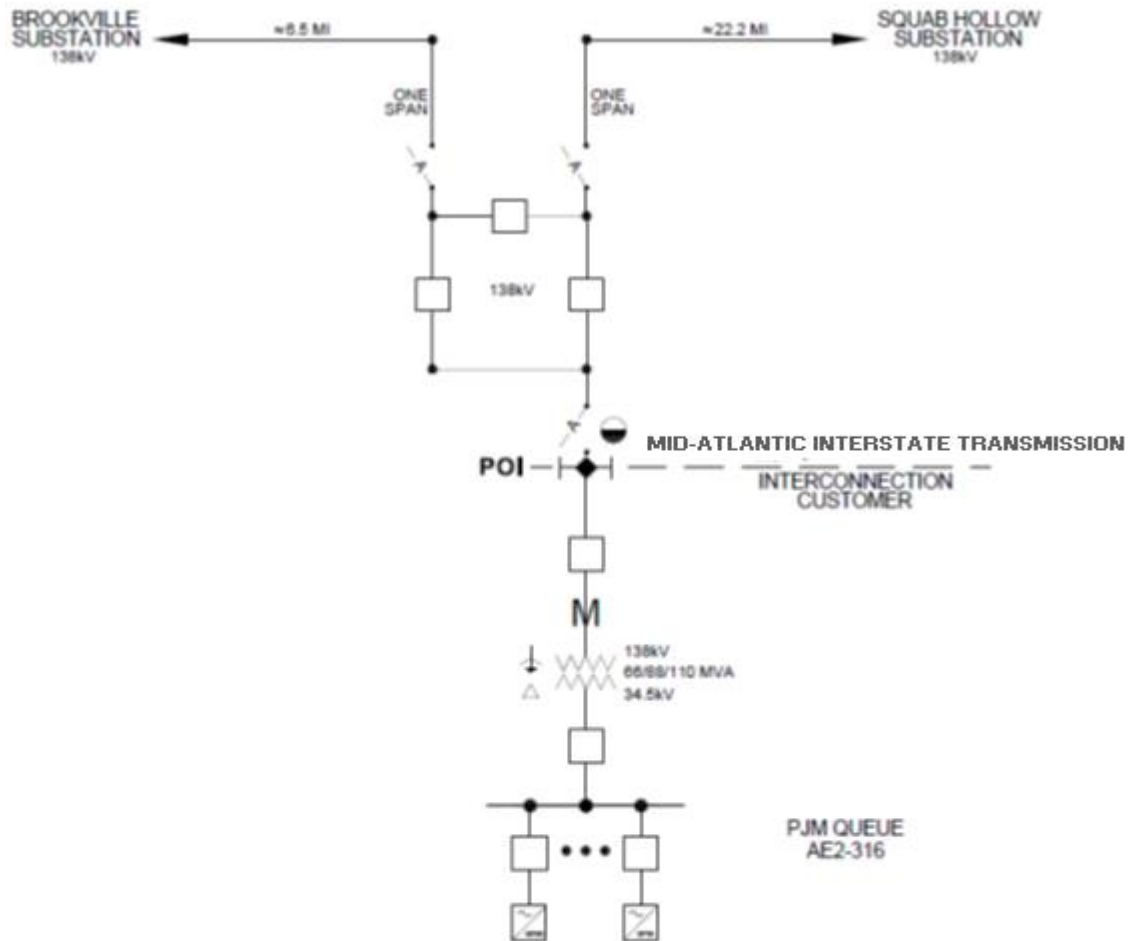
- Install RFL-9780 FSK Tx/Rx to transmit breaker status for anti-islanding to Brookville SS. A handoff scheme at Brookville shall forward this signal to the new 3 breaker ring bus.

Attachment #2: One-Line Diagrams

IC One-Line
(NOT APPROVED FOR CONSTRUCTION)



FirstEnergy One-Line



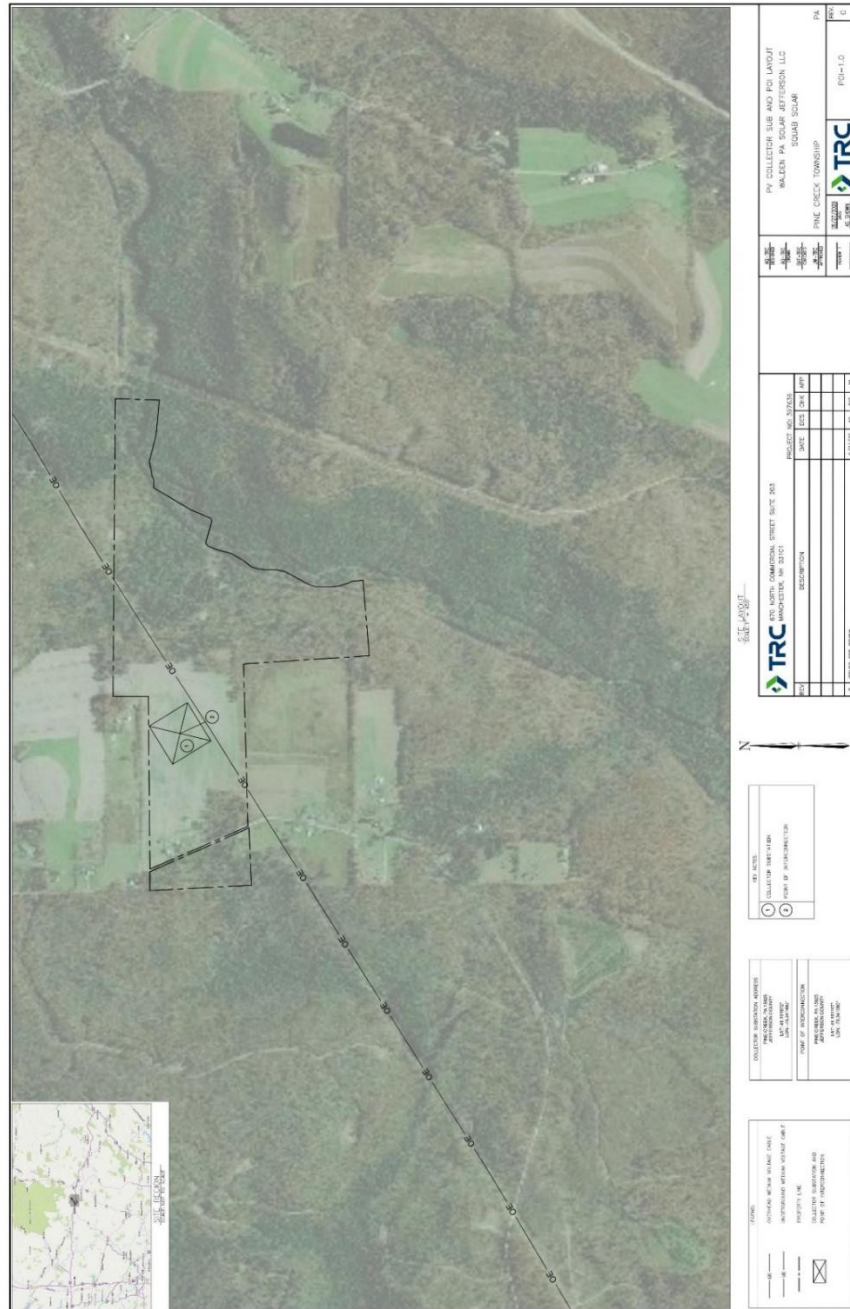
—◆— = POI (POINT OF INTERCONNECTION)

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

◐ = SCADA CONTROL

Attachment #3: IC Site Plan and Substation Attachment Facilities

IC Site Plan (NOT APPROVED FOR CONSTRUCTION)



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

Any different reactive power requirements that FE and/or PJM determines to be appropriate for wind-powered or other non-synchronous generation facilities will be stated in the applicable interconnection agreement(s).

Induction generators and other generators with no inherent VAR (reactive power) control capability, or those that have a restricted VAR capability less than the defined requirements, must provide dynamic supplementary reactive support located at the generation facility with electrical characteristics equivalent to that provided by a similar-sized synchronous generator.

Design Requirements

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

Transmission Design Requirements

Design Criteria

Facilities owned and operated by Transmission Owner shall comply with the applicable Transmission Owner technical requirements and standards posted on the PJM website per the PJM Tariff, and the following criteria. Where there are different requirements for the same criterion, the more restrictive shall apply. IC must abide by any PJM, RFC or NERC criteria imposed that is more restrictive than those of Transmission Owner.

General Design Requirements

• System phasing (counter clockwise)	X-Y-Z
• System frequency:	60 hertz
• Elevation, AMSL:	Less than 1000 meters
• Isokeraunic level:	40
• Maximum ambient temperature:	40 degrees C
• Minimum ambient temperature:	-40 degrees C
• Maximum conductor operating temperature:	Contact Transmission Owner
• Wind Loading (round shapes):	Per ASCE 7-98, per Fig. 6-1 depending on location
• Ice loading – Substations (no wind):	25 mm
• Seismic zone:	Per ASCE 7-98, per Fig. 9.4.1.1(a) and (b). Equipment qualification per IEEE 693-97

Voltage and Current Ratings

• Nominal phase-to-phase:	138 kV
• Maximum phase-to-phase:	145 kV
• Basic impulse level (BIL):	650 kV
• Maximum continuous current carrying capacity:	2000 A
• Design fault current:	40 kA
• Single Contingency (breaker failure) clearing time:	60 cycles

Clearances and Spacing

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