Generation Interconnection Facility Study Report

For

PJM Generation Interconnection Request Queue Position AD1-020

"Hunterstown-Lincoln 115 kV"

100 MW MFO, 53.6 MW Capacity

December 2019

General

This Facilities Study has been prepared in accordance with the PJM Open Access Transmission Tariff, Section 205, as well as the Facilities Study Agreement between Adams Solar LLC, the Interconnection Customer ("IC" or "Developer") and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is Mid-Atlantic Interstate Transmission, LLC (MAIT).

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 Interconnection Customer 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

Adams Solar LLC has proposed a new facility which is a combination of solar and battery installation located at in Straban Township, Adams County, Pennsylvania. The installed facilities will have a total capability of 100 MW (80 MW of solar and 20 MW of battery storage) with 53.6 MW of this output being recognized by PJM as capacity (53.6 MW (67% UCAP) of solar and 0 MW of battery). The Developer intends to charge the battery with excess generation produced by the solar farm.

AD1-020 consists of solar panels and battery storage units on a Point of Interconnection (POI) on the Hunterstown-Lincoln 115 kV line. AD1-020 will be connected to the POI via a 115-34.5 kV main collector transformer with a rating of 65/87/108 MVA. The facilities are proposed to connect to the Hunterstown-Lincoln 115 kV line. The proposed in-service date for this project is

December 31, 2021. **This study does not imply a Mid-Atlantic Interstate Transmission, LLC (MAIT) commitment to this in-service date.**

Generation	Energy	Capacity
Solar	**80 MW**	**53.6 MW (67% UCAP)**
Battery	**20 MW**	**0 MW**
Total	**100 MW**	**53.6 MW**

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 point of interconnection along the Hunterstown-Lincoln 115 kV line. The proposed interconnection substation location is to the south of the 115 kV line and the physical generation facilities are located on both the north and south side of the 115 kV line.

2. Point of Interconnection (POI)

The POI will be located within the new 115 kV ring bus interconnection where Developer-owned 115 kV attachment line conductor will terminate on the insulators on the dead-end structure and will be defined as the POI. (See Figure 1)

Developer is required to own, install, and maintain a fully-rated, fault-interrupting circuit breaker on the high-side of the GSU transformer with revenue metering equipment between the collector bus and the incoming generator lead line.

The direct connection facilities include a new line terminal equipment on Transmission Owner's side of the point of interconnection. This typically includes a dead-end structure and a three-phase, gang-operated disconnect switch. These facilities are considered radial equipment from the terminal to the point of interconnection.

3. Cost Summary

The AD1-020 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 645,400
Direct Connection Network Upgrades	$ 4,638,900
Non Direct Connection Network Upgrades	$ 985,100
Allocation for New System Upgrades	$ 0
Contribution for Previously Identified Upgrades	$ 0
Total Costs	**$ 6,269,400**

The costs provided above exclude the Contribution in Aid of Construction ("CIAC") Federal Income Tax Gross Up charge. If, at a future date, it is determined that the CIAC Federal Income

Tax Gross charge is required, the Transmission Owner shall be reimbursed by the Interconnection Customer for such taxes. See Section 7 of this report for the estimated tax if ever applicable.

4. Interconnection Customer's Submitted Milestone Schedule

Developer's Submitted Milestone Schedule

Developer's requested Commercial Operation Date (COD) for the generation facility is **December 31, 2021**. Transmission Owner's proposed schedule does not match the Developer's requested Milestone Schedule. A Project Kickoff meeting must occur by March 31, 2020 to meet Transmission Owner's Assumed Milestone Schedule listed below.

Interconnection Customer's Submitted Milestone Schedule

- Plan to break ground 4/16/20
- Turn over flat, graded site with 1 inch gravel to ITO for new switching station 9/16/20
- Permits – state level CPCN and county level Final Site Plan approval complete by 3/1/20
- Substantial site work completed 7/16/21
- Delivery of major electrical equipment 5/16/21
- Back Feed Power early to 10/15/21
- Commercial Operation 12/31/21

Transmission Owner's Assumed Milestone Schedule:

- 04/01/2022 Initial Back-feed through Project Substation Date
- 05/01/2022 Project Commercial Operation Date

(See Section 8 for Milestone Schedules for the ITO to complete the required interconnection facilities for accommodation of AD1-020.)

5. Scope of Customer's Work

IC must follow TO's Transmission Interconnection Design and Protection Requirements as specified in Attachment A to this Facilities Study.

Adams County, Pennsylvania. The installed facilities will have a total capability of 100 MW (80 MW of solar and 20 MW of battery storage) with 53.6 MW of this output being recognized by PJM as capacity (53.6 MW (67% UCAP) of solar and 0 MW of battery). The Developer intends to charge the battery with excess generation produced by the solar farm. The IC will construct and own facilities including one (1) 115/34.5 kV generation step up (GSU) transformers, 115 kV interconnection meter package, one (1) 115 kV breaker with associated relay/protection/controls, four (4) 35 kV circuit breakers with associated relay/protection/controls, and 115 kV conductor

up to the Point of Interconnection (POI). The POI will be where the 115 kV conductor from the IC meets the FE-owned dead-end insulator string connected to the deadend structure inside the new switchyard, as shown on the one-line diagram in Figure 1.

The AD1-020 project will be interconnected via generator lead line to a new three (3) breaker, 115 kV ring bus Interconnection Switchyard. The new yard will be built in close proximity to the Lincoln-Hunterstown 115 kV lines. IC is responsible for constructing all the facilities on its side of the POI, including the generation step-up (GSU) transformer and 115 kV generator lead line as shown in the attached single-line diagram (see Figure 1).

Developer is required to own, install, and maintain a fully-rated, fault-interrupting circuit breaker on the high-side of the GSU transformer with revenue metering equipment between the collector bus and the incoming generator lead line. IC shall coordinate with FE on the establishment of dedicated communication circuits for Supervisory Control and Data Acquisition (SCADA) monitoring to the FE Transmission System Control Center. Additionally, IC will be responsible for paying all expenses to meet the FE Protection Requirements due to direct connections and other upgrades required by this project.

IC will be responsible for acquiring all rights-of-way, easements, properties, vegetation clearing, environmental and municipal permits that may be required to construct all attachment facilities, up to the POI shown in the one-line diagram in Figure 1.

The Transmission Owner is responsible for the design, procurement, and construction of the new 3 breaker ring bus substation and loop feed from the Lincoln-Hunterstown 115 kV lines.

The Attachment Facilities include new line terminal equipment on Transmission Owner's side of the point of interconnection. This typically includes a dead-end structure and a three-phase, gang-operated disconnect switch. These facilities are considered radial equipment from the terminal to the point of interconnection.

Attachment Facilities (By IC)

Facilities Work to be constructed by IC:

- Construct generator lead line approximately 0.05-mile interconnection to AD1-020 from the new terminal (POI) at the ring bus interconnection substation.

Assumptions / Notes:

- Developer will coordinate design and alignment of proposed AD1-020, 115 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.
- Developer will coordinate design and construction of proposed AD1-020 115 kV Lead Line. For these areas, the Developer shall provide TO with proposed transmission plan & profile 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 115 kV terminal positions. As a minimum, Developer facilities should not encroach within 100 feet of TO centerline at blowout conditions. If 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 Developer, if final alignment of AD1-020 115 kV generator lead line causes encroachments, changes, or modifications to any existing or relocated TO facilities.

6. Description of Facilities included in the Facilities Study (Work by ITO)

Attachment Facilities Work (By ITO) –

1. New Line Terminal Equipment
PJM Network Upgrade Number n6253

Install all necessary radial equipment from ring bus terminal to Point of Interconnection including engineering oversight of specification and design of new customer owned revenue metering.

2. New Fiber Installation

PJM Network Upgrade Number n6254

Installation of ADSS fiber for SCADA communication. This will require the installation of approximately 1.1 miles of ADSS as well as some new structures to support the ADSS. The proposed path to the new interconnection substation does not have sufficient structures to complete the path to the newly proposed interconnection substation.

Direct Connection Work (By ITO) –

1. New Interconnection Substation (115 kV 3 breaker ring bus)

PJM Network Upgrade Number n6255

Design, furnish and construct a new three (3) breaker ring bus interconnection switchyard. Includes Project Management and Construction Management.

2. SCADA Communication

PJM Network Upgrade Number n6256

MPLS router at new interconnect substation to provide SCADA transport for new RTU. Estimated in-sub fiber run for connection from new interconnect substation to support relaying

and other communications between AD1-020 interconnection and AD1-020 Generation substation.

Non-Direct Connection Work (by ITO) –

1. Hunterstown-Lincoln 115 kV Line Loop

PJM Network Upgrade Number n6257

Sectionalize the existing 115 kV Hunterstown-Lincoln 115 kV line between towers #78/79 and #80/81 and install a loop to the proposed 3-breaker ring bus substation.

2. Lincoln Substation

PJM Network Upgrade n6258

At Lincoln Substation, upgrade line relaying for Hunterstown 115 kV line exit and rename for new AD1-020 interconnection yard.

3. Hunterstown Substation

PJM Network Upgrade n6259

At Hunterstown Substation, upgrade line relaying for Lincoln 115 kV line exit and rename for new AD1-020 interconnection yard.

7. Total Costs of Transmission Owner Facilities included in Facilities Study

The following table summarizes the total estimated costs according to FERC criteria. The estimated costs are in 2018 dollars. The taxes are a CIAC (Contribution in Aid of Construction) Federal Income Tax Gross Up charge. This tax may or may not be charged based on whether this project meets the eligibility requirements of IRS Notice 88-129. The IC will be responsible for the actual cost of all implementing all work identified in the table above.

Description	Total (w/o Tax)	Tax (if applicable)	Total Cost (with Tax)
New Line Terminal Equipment: Install radial equipment from ring bus terminal to the point of interconnection. PJM Upgrade #N6253	$ 408,000	$ 83,072	$ 491,073
Fiber- ADSS fiber installation to AD1-020 interconnection substation. PJM Upgrade #N6254	$ 235,400	$48,000	$ 283,400
Metering – FE engineering oversight of specification and design of new customer owned revenue metering. Part of PJM Upgrade #N6253	$ 2,000	$500	$2,500
Total Attachment Facilities (AF) Costs	**$645,400**	**$131,572**	**$776,973**
New AD1-020 Switchyard- Install 115 kV three breaker ring bus connector station for new customer generation addition. PJM Upgrade #N6255	$ 4,148,800	$ 844,728	$ 4,993,527
SCADA Communication- Estimated MPLS router at new AD1-020 Interconnection substation to support new RTU. PJM Upgrade #N6256	$ 150,200	$ 30,600	$ 180,800
Project Management, Construction Management, Commissioning, Meter, and SCADA. Part of PJM Upgrade #N6255	$ 339,900	$ 69,300	$ 409,200
Total Direct Connect (DC) Costs	**$4,638,900**	**$944,628**	**$5,583,527**

Hunterstown-Lincoln 115 kV Line Loop- Loop the Hunterstown-Lincoln 115 kV circuit into the proposed 3-breaker ring bus between structures #78/79 and #80/81. PJM Upgrade #N6257	$ 466,700	$ 95,100	$ 561,800
Lincoln Substation - Upgrade line relaying for Hunterstown 115 kV line exit and rename for new AD1-020 PJM station. PJM Upgrade #N6258	$ 259,200	$ 52,800	$ 312,000
Hunterstown Substation –Upgrade line relaying for Lincoln 115 kV line exit and rename for new AD1-020 PJM station. PJM Upgrade #N6259	$ 259,200	$ 52,800	$ 312,000
Total Non-Direct Connect (NDC) Costs	**$985,100**	**$200,700**	**$1,185,800**
Total AF + DC + NDC Costs	**$6,269,400**	**$1,276,900**	**$7,546,300**

8. Milestone Schedules for Completion of Work Included in Facilities Study:

A proposed **twenty-four** (24)-month **Direct Connection** and **Non-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 will occur as planned.

Direct Connection Schedule: In order to meet the Back-feed Date, a twenty-four (24) month schedule is estimated, from the date of a fully executed Interconnection Construction Service Agreement and Construction Kick-Off Meeting, to complete the engineering, construction and associated activities, as detailed in the "Direct Connection" section below.

This assumes that sufficient engineering details are available to evaluate the scope of work.

24 month Schedule (assume April 2020 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	22
Above Grade Construction – Substation	18	23
Above Grade Construction – T-Lines	22	23
Testing & Commissioning	24	24

Non-Direct Reinforcements Schedule: A proposed twelve (12) month schedule is estimated to complete the engineering, construction and associated activities, as detailed in the "Non-Direct Connection" section below, assuming an Interconnection Construction Service Agreement has been fully-executed, and a Construction Kick-Off Meeting has occurred. It is assumed these non-direct connection reinforcements are able to be constructed within the same time frame as the interconnection substation.

System Reinforcements Schedule: No system reinforcements were identified in this study.

Assumptions / Notes:

Construction cannot begin until after all applicable permits and/or easements have been obtained.

Engineering Assumptions

- Existing structures are assumed to need no modifications.

Siting and Right-of-Way Assumptions

- In PA, assume that project will receive local municipal approval with no public or municipal opposition.
- In PA, assume that project line work will require a CPCN.
- Assume all work occurs within an existing transmission line right-of-way with little or no modifications to existing structures; however, additional clearing rights from property owners may be required where additional vegetation clearing is needed.
- All work will occur within existing FE right-of-way. Some off-ROW access will likely be required from adjacent property owners. These additional costs are NOT included as part of the estimate.
- Temporary land rental may be required for contractor material with material/equipment staging areas, depending upon size of property provided for interconnection substation.
- Schedule assumes no property owner, governmental, or municipal opposition to the overall AD1-020 project.
- Assumes new poles required for installation of ADSS will not encounter any opposition.
- ADSS installation assumes approximately 500 feet of underground in order to get to the site location.
- Assumes ADSS installation requires 1 railroad crossing permit.
- It is assumed that Developer will acquire any necessary rights for installation of new poles for ADSS.

Environmental Assumptions

- Environmental permits from PA will be required.
- Environmental studies will be required to develop E&S Control Plans and required measures. Costs include development and submittal of E&S Plan, periodic monitoring of E&S measures including post construction removal and rehabilitation.

Forestry/Vegetation Management Assumptions

- Additional vegetation clearing may be required for access road installation and within existing right-of-way where additional conductor clearance is required.
- No special conditions for vegetation clearing. Vegetation removal may be constrained due to seasonal restrictions due to T&E's (10/1 - 3/31) for potential native bat habitat. This should be included and verified as part of project environmental studies.

Back-up Service Agreement

The execution of a back-up retail service agreement with the local Load Serving Entity, Meted, will be necessary to serve the customer load supplied from the AD1-020 interconnection point when the units are out-of-service. This assumes the intent of the IC is to net the generation with the load.

B. Transmission Owner Facilities Study Results

1. Transmission Lines- New

A. **New Line Terminal Equipment**
PJM Network Upgrade Number n6253

Install a dead-end structure and a three-phase, gang-operated disconnect switch for the new generator lead line termination into the new 3 breaker ring Interconnection Switchyard.

B. **Fiber Installation for SCADA Communication**
PJM Network Upgrade Number n6254

Installation of ADSS fiber for SCADA communication. This will require the installation of approximately 1.1 miles of ADSS as well as some new structures to support the ADSS. The proposed path to the new interconnection substation does not have sufficient structures to complete the path to the newly proposed interconnection substation.

2. Transmission Line – Upgrades

Hunterstown-Lincoln 115 kV Line Loop

PJM Network Upgrade Number n6256

Transmission Owner will sectionalize the existing 115 kV transmission line at the new Transmission Owner interconnection substation, at a site to be selected by Developer with agreement from Transmission Owner.

The station is to be located at the following GPS coordinates:
39.860000 Lat: -77.181781 Long

This is located approximately located between structures #78/79 and #80/81 on the Hunterstown-Lincoln 115 kV line.

This study assumes the interconnection substation will be located adjacent to the Transmission Owner 115 kV line right-of-way (See "Figure 2") and the dead-end structures will each be within one to two (1-2) spans of the line (approximately 100-300 feet). The estimated costs shown in this study are typical for this type of design. The actual costs will be determined by the final substation and line loop locations.

Transmission Owner will install a loop, approximately 100-300 feet in length, from the Hunterstown-Lincoln 115 kV line to the proposed 3-breaker ring bus substation.

The schedule is based on assuming project kick-off occurs no later than **March 31, 2020** (i.e. minimum **twenty-four** (24) months prior to Backfeed Date), and the Pennsylvania Public Utility Commission will grant a waiver to a full application. The 'exact' substation location and details are required from Developer prior to the start of engineering (i.e. no later than **04/01/2020**). Delays in provision of substation site details will affect the schedule.

Note: An outage on the source line is unlikely to be granted from May 1 to October 1. The schedule is based on no issues with siting/permitting, right-of-way acquisition, or outage requirements.

Assumptions:

Engineering Assumptions:

1. It is assumed that the AD1-020 substation will be constructed mid-span on the line and the line will be terminated inside the substation in an in/out configuration. Assume the existing conductors and shieldwires are in good condition and will be reused.
2. Assume existing structures #78/79 and #80/81 are in good condition and have adequate capacity for the new loading arrangement.
3. Install two wood deadend structures for the loop. Install an additional guyed wood monopole deadend on each leg of the loop to route the loop into the substation bays.
4. Substation is adjacent to the existing line with the substation being approx. 100-300' in length (1-2 span lengths) off the transmission corridor.
5. Assume that the loop will tie into existing circuit between structures #78/79 and #80/81.
6. Access will be provided through the substation area and substation access roads.
7. No forestry work is anticipated.
8. It is assumed that no existing structures will need to be removed.

Siting Assumptions:

1. An application to the Pennsylvania Public Utility Commission (PaPUC) is one of the issues in determining what will be needed for property acquisition. It is expected that Developer will acquire all of the necessary property and transfer it to Transmission Owner.
2. The estimate assumes a Certificate of Public Convenience and Necessity (CPCN)) is required for Pennsylvania Public Utility Commission approval. If a full siting application is required, significant external legal involvement and environmental studies will be required which would greatly increase costs and schedule (not included herein).
3. It is expected that the Erosion & Sedimentation Control Plan will be combined with the substation work and be the responsibility of the Transmission Owner.

Right-of-Way Assumptions:

1. Right-of-way is required from Developer only. The project is entirely on Developer's property and the property will be transferred to Transmission Owner at no cost.
2. Right-of-way acquisition must occur prior to Pennsylvania Public Utility Commission review of the submittal.
3. Title completed by Developer and provided to Transmission Owner upon request.

4. FirstEnergy would require the interconnection substation site either in fee or with a perpetual easement. It would be up to the developer to acquire the property (in a manner acceptable to FE) and transfer it to FirstEnergy. If they are unable to get the land in fee or with a perpetual easement, FirstEnergy will not accept the transfer of ownership.

3. New Substation/Switchyard Facilities

A. Interconnection Substation (115 kV 3 breaker ring bus)

PJM Network Upgrade Number n6255

Transmission Owner will design, furnish and construct the new 115 kV line terminal for the Developer as part of the new 3-breaker ring bus interconnection substation, including the following:

- Three (3) 115 kV, 3000 ampere, 40 kA interrupting power circuit breakers
- Six (6) 115 kV, three-pole, manually-operated, group disconnect switches
- Three (3) 115 kV, three-pole, motor-operated, disconnect switch
- Nine (9) surge arresters for application on a 115 kV system
- Nine (9) 115 kV capacitor voltage transformers for relaying
- Station Service – Transmission Owner requires a primary and a backup station power supply with automatic transfer. This consists of the following sources:
    - Primary: One (1) 115 kV power voltage transformer
    - Backup: Feed from a local distribution feeder
- Three (3) 115 kV transmission line termination structures
- 115 kV bus (with damper wire) and conductor with associated structures
- Prefabricated building with battery and charger
- Transmission Owner relaying and controls per the Protection Requirements (provided as Attachment "A").
- SCADA RTU/Communications circuit – Contact Transmission Owner for specifics
- Foundations for the equipment listed above.
- Substation fencing, cable trench & conduit system, ground grid and stoning.
- Compliance with Transmission Owner security standards. Developer to contact Transmission Owner for design / equipment details

Assumptions / Notes:

- A rough-graded, level site and access road is to be provided by Developer.
- It is assumed that the Developer will be able to provide this graded, level and geotechnically adequate site that is suitable for substation construction.
- Developer stated that substation access road is likely to come from Riley Road.

- In order to meet the Backfeed Date of **04/01/2022**, the exact substation site, pull-off structure location, and structure details (for connection to the transmission line loop) are required from Developer no later than **04/01/2020** (i.e. minimum **twenty-four** (24) months lead-time from Backfeed Date). Delays in provision of substation site details will affect the schedule.
- Developer will acquire adequate land size to accommodate the Transmission Owner interconnection substation. Transmission Owner did not perform an evaluation to determine if Developer has secured an adequate amount of land for the interconnection substation. The proposed land for the interconnection substation has not yet been finalized. Schedule may be affected based upon size of the property, terrain and geotechnical evaluation. The property should be large enough to contain the fenced area, graded slopes, and any storm water management for the Transmission Owner interconnection substation. Transmission Owner would need to review Developer's proposed substation location to determine if the land size is adequate.
- **Fiber installation within interconnection substation**
  MPLS router at new interconnect substation to provide SCADA transport for new RTU. Estimated in-sub fiber run for connection from new interconnect substation to support relaying and other communications between AD1-020 interconnection and AD1-020 Generation substation.
- **Project Management, Construction Management, Commissioning, Meter and SCADA**
  Work related to performing or provision of support for construction management, commissioning, metering and SCADA.

4. Upgrades to Substation / Switchyard Facilities

A. Hunterstown Substation

PJM Network Upgrade n6259

At Hunterstown Substation, upgrade line relaying for Lincoln 115 kV line exit and rename for new AD1-020 interconnection yard.

The existing SCADA transport at Hunterstown substation is sufficient for additional SCADA telemetry.

B. Lincoln Substation

PJM Network Upgrade n6258

At Lincoln Substation, upgrade line relaying for Hunterstown 115 kV line exit and rename for new AD1-020 interconnection yard.

The existing SCADA transport at Lincoln substation is sufficient for additional SCADA telemetry.

5. Metering & Communications

PJM Requirements

The IC will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for the IC's generating resource. Reference PJM Manuals M-01 and M-14D, and PJM Tariff Section 8 of Attachment O.

FirstEnergy Requirements

Developer shall install, own, operate, test and maintain the necessary revenue metering equipment. Developer shall provide Transmission Owner with dial-up communication to the revenue meter.

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 Developer to PJM. Transmission Owner will work with PJM and Developer to ensure the generation data provided to PJM meets Transmission Owner's requirements.

Transmission Owner would prefer to a Schneider Electric ION 8650 revenue meter.

Communications for transmission line protection between the new **interconnection** substation, and Developer's **generation** (collector) substation, will be via fiber optics (see "Fiber Optic Communication Channels" section below).

6. Fiber Optic Communication Channels

Developer will design, provide, install, own and maintain a fiber-optic communications cable between the new **interconnection** substation, and 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. These channels will reside in the separate cables and be completely redundant protection for system stability reasons. The primary and backup relay fiber-optic communication channels must be in separately-routed cable paths.

The Developer 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 interconnection substation control house. Developer is responsible for obtaining and maintaining all associated Rights-of-Way (ROW), Easements, and Permits for its fiber cable.

7. Environmental, Real Estate and Permitting Issues

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 Developer to purchase the property, a Phase 1 Environmental Assessment should be conducted for the entire site to avoid assumption of environmental liabilities by Developer or Transmission Owner.
- The Transmission Owner interconnection substation may involve environmental surveys, permits, approvals and plans with federal, state, and/or local agencies.
- Assumed Developer 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 Developer, twelve (12)-to-eighteen (18)- months should be added to the Project Schedule to secure necessary permits, and additional costs would apply.
- Developer will provide copies of all of the relative environmental permits and other necessary approvals to Transmission Owner before Transmission Owner accepts the interconnection facilities.
- Developer 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. Developer is responsible to maintain access road and ensure unimpeded access for Transmission Owner at all times.

- Developer is responsible for all property acquisition (including easements/rights-of-way (ROW)) for transmission, distribution and communication facilities needed for the generator interconnection.
- If Developer 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. Developer is responsible for all costs, including but not limited to subdivision, associated with the property transfer.
- If Developer leases the project property, the Developer 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 the Pennsylvania Public Utilities Commission (PaPUC) notification/approval.

8. General Assumptions/Qualifiers

The accomplishment of the work on the Transmission Owner system to support the estimated costs and proposed schedule is dependent on the following:

The accomplishment of the work on the Transmission Owner system to support the estimated costs and proposed schedule is dependent on the following:

- Obtaining the necessary line outages. Transmission line outages are typically not granted from June to September and are discouraged during extreme winter conditions.
- No equipment delivery, environmental, permitting, regulatory or real estate delays.
- No extreme weather.
- No force majeure.
- Estimates assume no significant rock encountered during construction, and suitable soil conditions exist to accommodate a standard ground-grid and foundation installation.
- It is assumed that the new interconnection substation will be located on the south side of the Hunterstown-Lincoln 115 kV transmission corridor (see "Figure 2") and the loop will avoid crossing other Transmission Owner transmission lines.
- All work occurs within an existing transmission line right-of-way or on 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.
- Right-of-way is required from Developer only. The project is entirely on Developer's property.
- FirstEnergy would require the interconnection substation site either in fee or with a perpetual easement. It would be up to the developer to acquire the property (in a manner

acceptable to FE) and transfer it to FirstEnergy after the substation is constructed and ready for energization. If they are unable to get the land in fee or with a perpetual easement, FirstEnergy will not accept the transfer of ownership.

- 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.
- If the developer is obtaining permits that can or will be transferred to FirstEnergy, the requirement in the permits will need to be approved by FE prior to taking ownership. Coordination and collaboration is required to make sure the Developer is not permitting items such as storm requirements and maintenance that in the future FE cannot meet. If FirstEnergy should be informed and have the opportunity to review and approve those permits that will be transferred to FirstEnergy.
- Local permitting will be required form storm water pollution permits.
- Developer will obtain all necessary permits.
- Developer will develop all necessary access roads for project sites.
- Developer will conduct all necessary wetlands and waterways studies and permits. Wetlands delineation will be required as part of the permitting process.
- Developer will conduct all necessary historical and archaeological studies.
- Assumed the interconnection substation and generation (collector) substation are not adjacent (i.e. share a common fence). The 115 kV connection between the substations will be via a 115 kV transmission line.
- In order to meet the Backfeed Date of **04/01/2022**, the exact substation site, pull-off structure location, and structure details (for connection to the transmission line loop) are required from Developer **no later than 04/01/2020** (i.e. minimum **twenty four** (**24**) months lead-time from Backfeed Date). Delays in provision of substation site details will affect the schedule.
- Developer is responsible to make all arrangements for electric distribution service (if required) for its generation station. No costs or schedule included herein.
- Developer's generation step-up (GSU) transformer winding configuration shall have a wye-grounded winding on the high-side (transmission system) and have a delta connected winding on the low side.
- If the Developer were to choose the "Option to Build" for the interconnection substation, it must utilize an approved Transmission Owner A/E & Construction Contractor. A listing of Transmission Owner Approved Vendors and Contractors is located at the following PJM site:

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

- Developer shall maintain adequate clearances for its 115 kV generation attachment line from Transmission Owner's electric lines and structures. Developer shall submit final engineering design of its generation attachment line to Transmission Owner for approval prior to proceeding with the construction of the attachment line.
- If the 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

9. Detailed Protection Requirements

- See Attachment A.

10. 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.*

Generation	New /	Size	Power Factor Requirement	Measurement Location

Type	Increase			
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-Synchronous	New	All	0.95 leading to 0.95 lagging	Point of Interconnection
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-Synchronous	Increase	All	0.95 leading to 0.95 lagging	Generator's Terminals

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

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

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. 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) 1-2-3
- 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 10, per Fig. 250-2B depending on location

  Per ASCE 7-98, per Fig. 6-1 depending on location
- Ice loading – Substations (no wind): 25 mm
- Seismic zone: Per ASCE Manual 113 Substation Structure Design Manual. Equipment qualification per IEEE 693-2005 and IEE 1527-2006

  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: 115 kV
- Maximum phase-to-phase: 121 kV
- Basic impulse level (BIL): 550 kV
- Maximum continuous current carrying capacity: 2000 A
- Design fault current: 40 kA
- Single Contingency (breaker failure) clearing time: 30 cycles

Clearances and Spacing

- Recommended rigid bus center-to-center phase spacing: 84”
- Minimum phase-to-phase, metal-to-metal distance: 53”
- Recommended phase-to-ground: 45”

- Minimum phase-to-ground: 42”
- Low bus height above top of foundations (match existing): 15’-1”
- **High bus height above top of foundations (match existing):** 21’-1”
- Minimum vertical clearance from live parts to grade: 11’-7”
- Minimum horizontal clearance from live parts: 6’-1”
- Minimum conductor clearance above roads in switchyard: 20’-2”
- Minimum bottom of insulator to top of foundation: 8’-6”

11. Information Required for Interconnection Service Agreement

The following table summarizes the total estimated costs according to FERC criteria.

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
New Line Terminal Equipment: Install radial equipment from ring bus terminal to the point of interconnection. *PJM Upgrade #N6253*	$ 183,600	$ 142,800	$ 40,800	$ 40,800	$ 408,000
Fiber – ADSS fiber installation to AD1-020 interconnection substation. *PJM Upgrade #N6254*	$ 105,930	$ 82,390	$ 23,540	$ 23,540	$ 235,400
Metering – FE engineering oversight of specification and design of new customer owned revenue metering. *Part of PJM Upgrade #N6253*	$ 900	$ 700	$ 200	$ 200	$ 2,000
Total Attachment Facilities Cost	**$ 290,430**	**$ 225,890**	**$ 64,540**	**$ 64,540**	**$ 645,400**
New AD1-020 Switchyard-Install 115kV six breaker ring bus interconnection station for new customer generation addition. *PJM Upgrade #N6255*	$ 1,866,960	$ 1,452,080	$ 414,880	$ 414,880	$ 4,148,800
SCADA Communication-Estimated MPLS router at new AD1-020 Interconnection substation to support new RTU. *PJM Upgrade #N6256*	$ 152,955	$ 118,965	$ 33,990	$ 33,990	$ 339,900
Project Management, Construction Management, Commissioning, Meter, and SCADA. *Part of PJM Upgrade #N6255*	$ 67,590	$ 52,570	$ 15,020	$ 15,020	$ 150,200
Total Direct Connection Cost	**$ 2,087,505**	**$ 1,623,615**	**$ 463,890**	**$ 463,890**	**$ 4,638,900**

Hunterstown-Lincoln Line Loop- Loop the Hunterstown-Lincoln 115 kV circuit into the proposed 3-breaker ring bus between structures #78/79 and #80/81. *PJM Upgrade #N6257*	$ 210,015	$ 163,345	$ 46,670	$ 46,670	$ 466,700
Lincoln Substation - Upgrade line relaying for Hunterstown 115 kV line exit and rename for new AD1-020 PJM station. *PJM Upgrade #N6258*	$ 116,640	$ 90,720	$ 25,920	$ 25,920	$ 259,200
Hunterstown Substation – Upgrade line relaying for Lincoln 115 kV line exit and rename for new AD1-020 PJM station. *PJM Upgrade #N6259*	$ 116,640	$ 90,720	$ 25,920	$ 25,920	$ 259,200
Total Non-Direct Connection Network Upgrades	**$ 443,295**	**$ 334,785**	**$ 98,510**	**$ 98,510**	**$ 985,100**
Total Project Costs	**$ 2,821,230**	**$ 2,194,290**	**$ 626,940**	**$ 626,940**	**$ 6,269,400**

ATTACHMENT A
Queue #AD1-020

Detailed Protection Requirements

PROTECTION SCOPE

115 kV AD1-020 PJM SOLAR INTERCONNECT PROTECTION REQUIREMENTS

SHORT CIRCUIT ANALYSIS

Short Circuit values @ Lincoln 115 kV:
- Positive sequence Impedance (Ω) = 0.60695 + j3.73259
- Zero sequence Impedance (Ω) = 1.38951 + j5.10782
- Single Line to Ground Fault (S-L-G) = 15522 A
- 3 Phase Fault (3PH) = 17558 A

Short Circuit values @ Hunterstown 115 kV:
- Positive sequence Impedance (Ω) = 0.29888 + j2.87936
- Zero sequence Impedance (Ω) = 0.21234 + j2.10525
- Single Line to Ground Fault (S-L-G) = 25219 A
- 3 Phase Fault (3PH) = 22936 A

GENERAL REQUIREMENTS

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

RELAY COMMUNICATION CHANNELS

Two independent fiber optic communications channels are required between the FirstEnergy owned AD1-020 substation and the AD1-020 Generation facility to be used for relay communication based high speed tripping.

GENERATION 115 kV SUBSTATION CONNECTION REQUIREMENTS
PROTECTION REQUIREMENTS

Faults within any 115 kV piece of equipment must be detected by two independent high-speed zones of protection. GSU (Generator Step Up) Transformer protection shall consist of a primary current differential scheme and a backup Overcurrent scheme, preferably differential, utilizing separate current transformers and an independent transformer neutral overcurrent relay.

Backup protection shall be completely independent from the primary protection; including separate current transformers, potential transformer windings (wherever applicable) and DC control circuits.

A separate tripping path energizing separate breaker trip coils is required for primary and backup relaying.

A breaker failure relay (such as SEL-501 or SEL-352) shall be utilized on all 115 kV circuit breakers. Any protective relay trip of a 115 kV breaker shall initiate the failure to trip scheme for that breaker. The re-trip feature for the BFT scheme shall be utilized and trip the 115 kV circuit breaker. The 115 kV breaker failure scheme shall operate a hand reset lockout relay which shall trip and block close all electrically adjacent circuit breakers. Tripping of the breakers shall be accomplished via the fiber optic cables and the tie line protective relays (DTT).

All primary relaying is required to be connected CTs on the inner bushing looking through the breaker in to the protected zone. All backup relaying is required to be connected CTs on the outer bushing looking through the breaker in to the protected zone. The protection should trip the associated breakers, initiate breaker failure-to-trip schemes and reclosing schemes where applicable.

The relaying system shall have a reliable source of DC power independent from the AC system or immune to AC system disturbance or loss (for example - DC battery and charger) to assure proper operation of the protection scheme.

All relays, relay schemes and relay settings that include 115 kV voltages or currents or trip any 115 kV circuit breakers shall require the review and approval of FirstEnergy.

FirstEnergy will complete detailed relay coordination studies to identify off-site relay setting changes required due to this generation interconnection. This may result in additional individual relay replacements being required. These relay replacements will be done at the cost of the developer.

NOTE: The customer is solely responsible for protecting their own equipment in such a manner that electrical faults or other disturbances on the FE system do not damage its equipment.

AD1-020 CUSTOMER GENERATION SUBSTATION to FE AD1-020 115 kV Substation

PROTECTION REQUIREMENTS

The protection for the 115kV line from the AD1-020 generation substation to AD1-020 FE substation shall consist of:

- SEL-411L with fiber optic interface (Primary)
- SEL-411L with fiber optic interface (Backup)

- DTT sent through primary and backup SEL-411L

Additionally, each breaker shall utilize a SEL-501 relay and associated hand reset lockout relay for breaker failure to trip protection.

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.

FE AD1-020 FE SUBSTATION TO AD1-020 CUSTOMER GENERATION 115 kV Substation

PROTECTION REQUIREMENTS

The protection for the 115 kV line to the AD1-020 generation substation shall consist of:

- SEL-411L with fiber optic interface (Primary)
- SEL-411L with fiber optic interface (Backup)
- DTT sent through primary and backup SEL-411L

Additionally, each breaker shall utilize a SEL-501 relay and associated hand reset lockout relay for breaker failure to trip protection. Intertie functionality will be included in the backup SEL-411L at AD1-020 FE substation due to the system configuration surrounding the substation.

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.

FE AD1-020 SUBSTATION TO LINCOLN 115 kV LINE

PROTECTION REQUIREMENTS

The protection for the 115 kV line to the Lincoln substation shall consist of:

- SEL-421 with fiber optic interface (Primary)
- SEL-411L with fiber optic interface (Backup)
- DTT sent through primary and backup relays

Additionally, each breaker shall utilize a SEL-501 relay and associated hand reset lockout relay for breaker failure to trip protection.

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.

FE AD1-020 SUBSTATION TO HUNTERSTOWN 115 kV LINE

PROTECTION REQUIREMENTS

The protection for the 115 kV line to the Hunterstown substation shall consist of:

- SEL-421 with fiber optic interface (Primary)
- SEL-411L with fiber optic interface (Backup)
- DTT sent through primary and backup relays

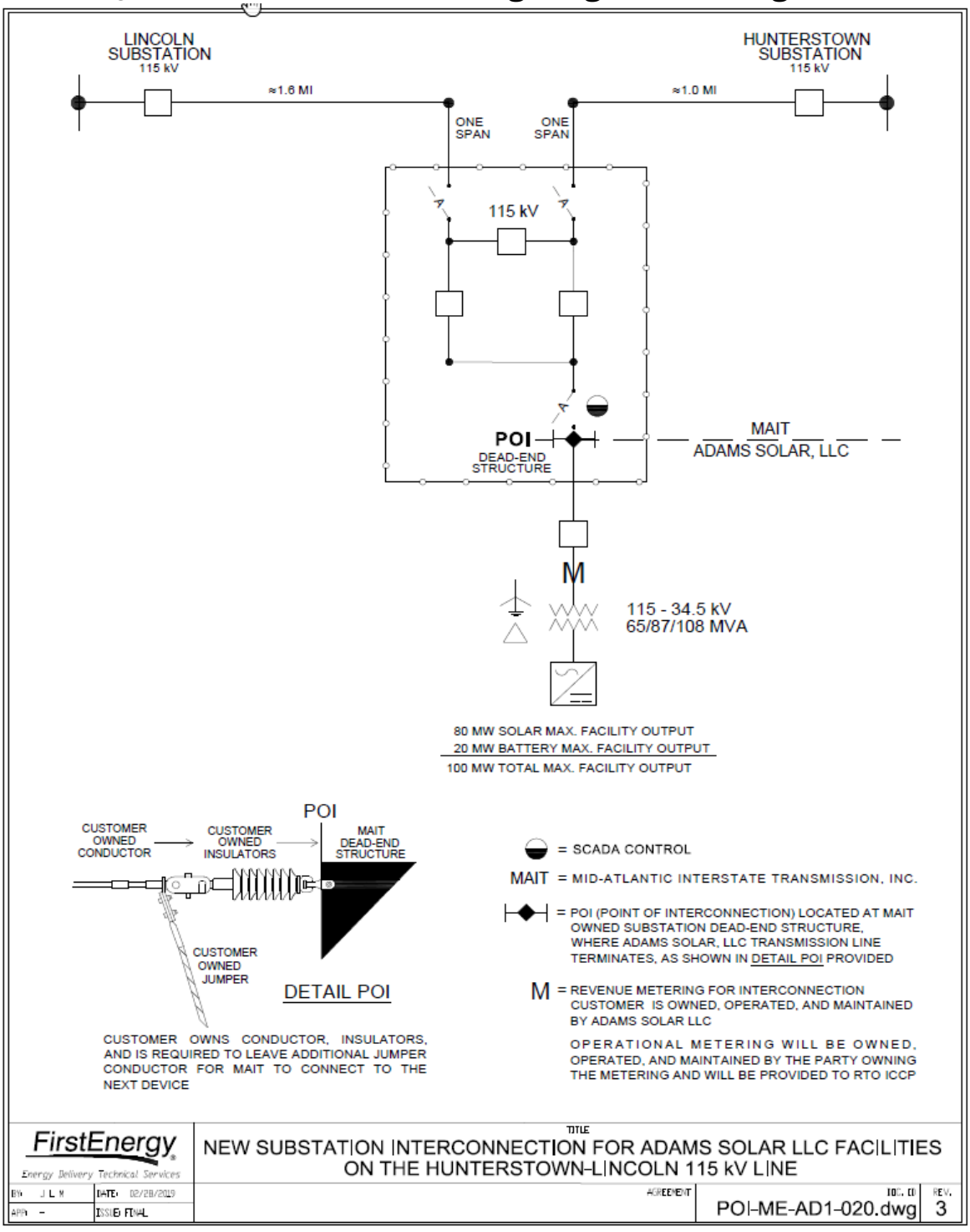
Additionally, each breaker shall utilize a SEL-501 relay and associated hand reset lockout relay for breaker failure to trip protection.

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.

FIGURE 1

Queue #AD1-020: Planning Single-Line Diagram*



* Note: Diagram does not represent a physical layout. Not to be used for construction.

FIGURE 2
Single Line Diagram (provided by the Developer)

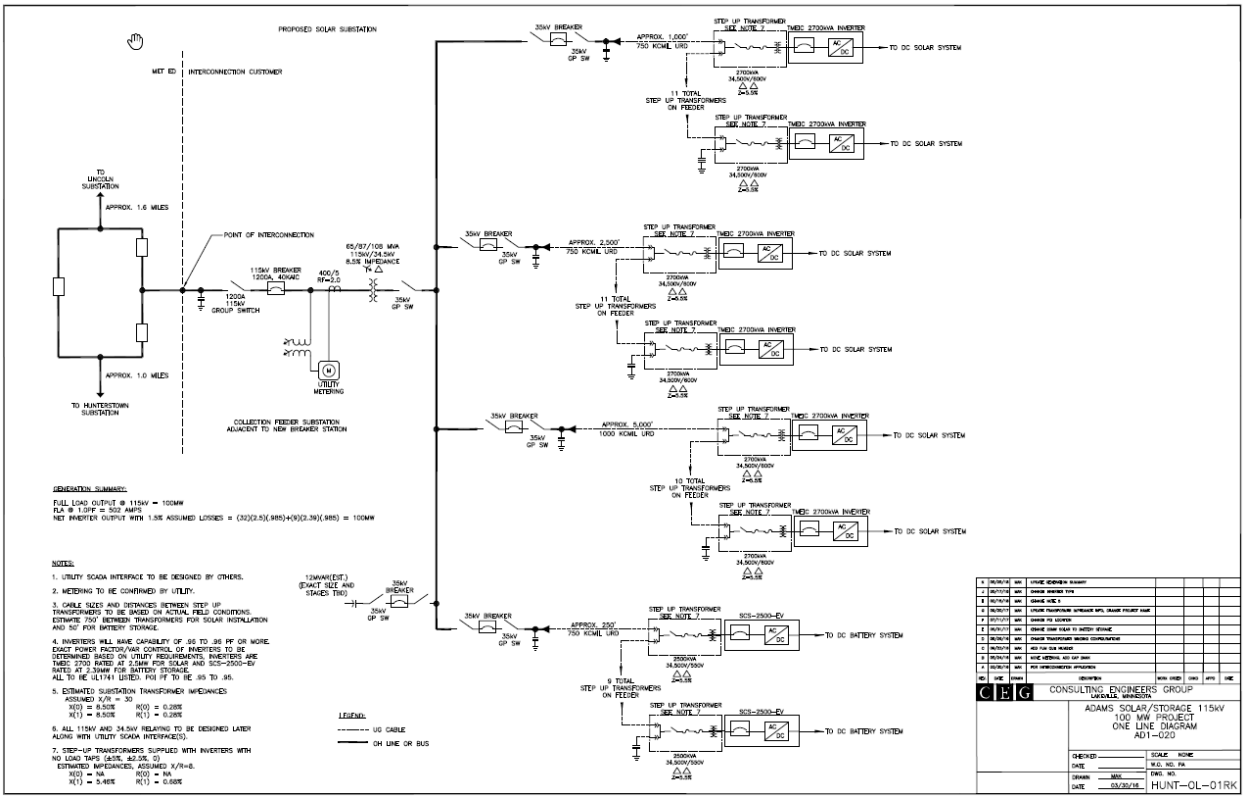


FIGURE 3

Queue #AD1-020

Proposed Project Location

(Provided by Developer)

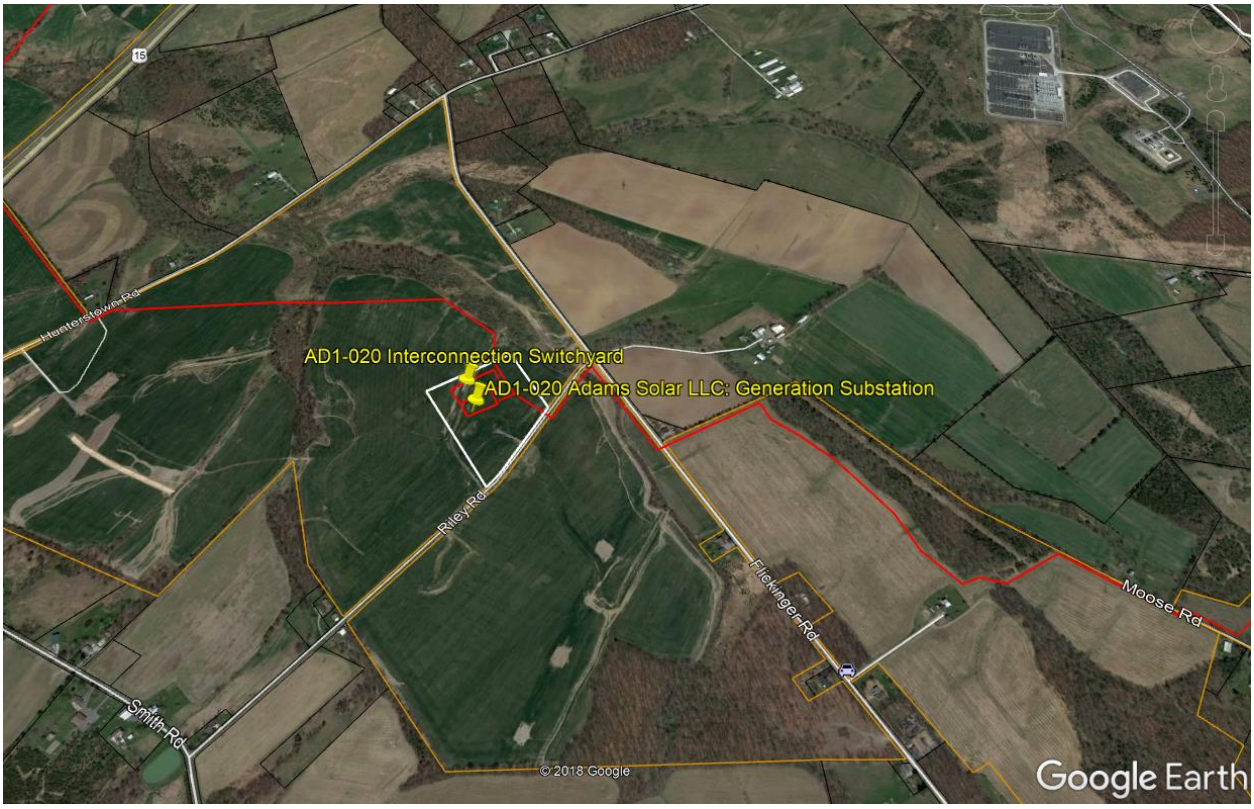


Figure 4
Adams Solar LLC (AD1-020 Site Overview)

(Provided by Developer)

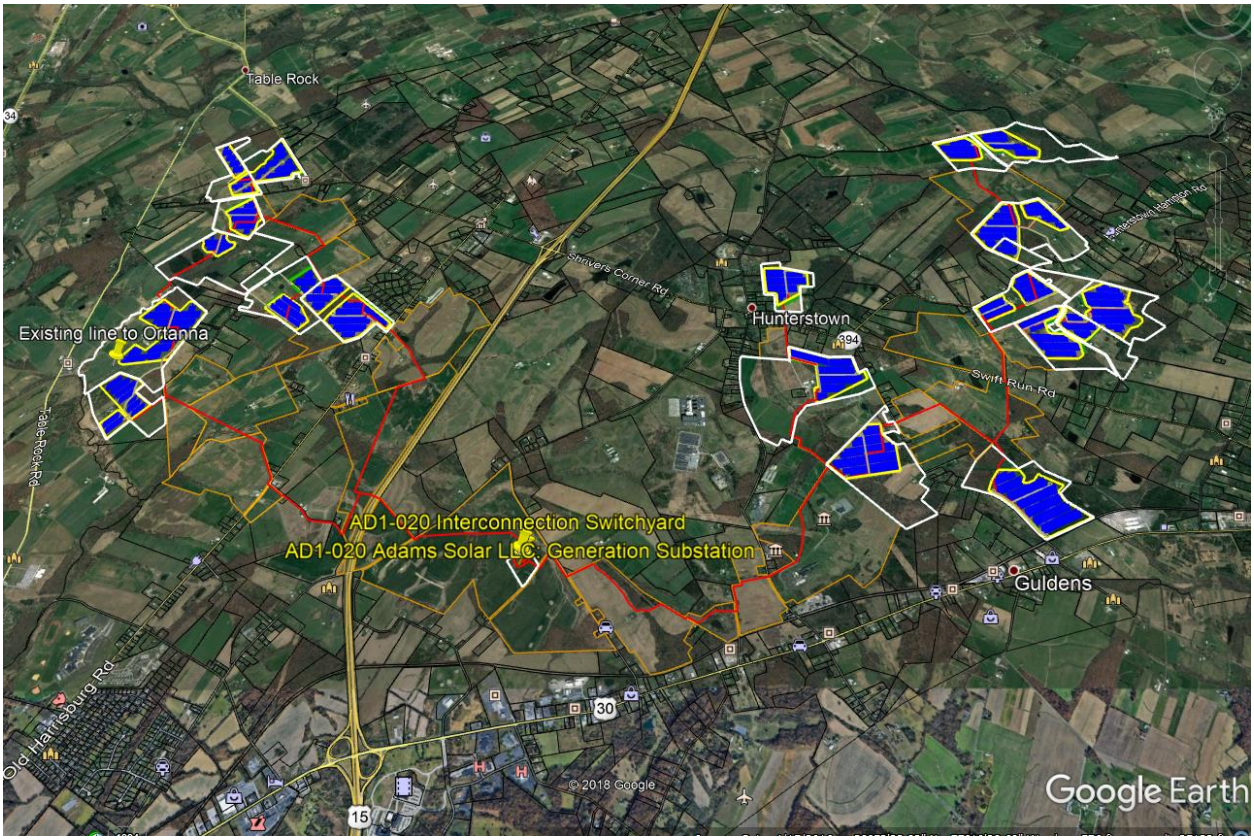


Figure 5
Hunterstown-Lincoln 115 kV – Structure Numbers

(Provided by FirstEnergy)

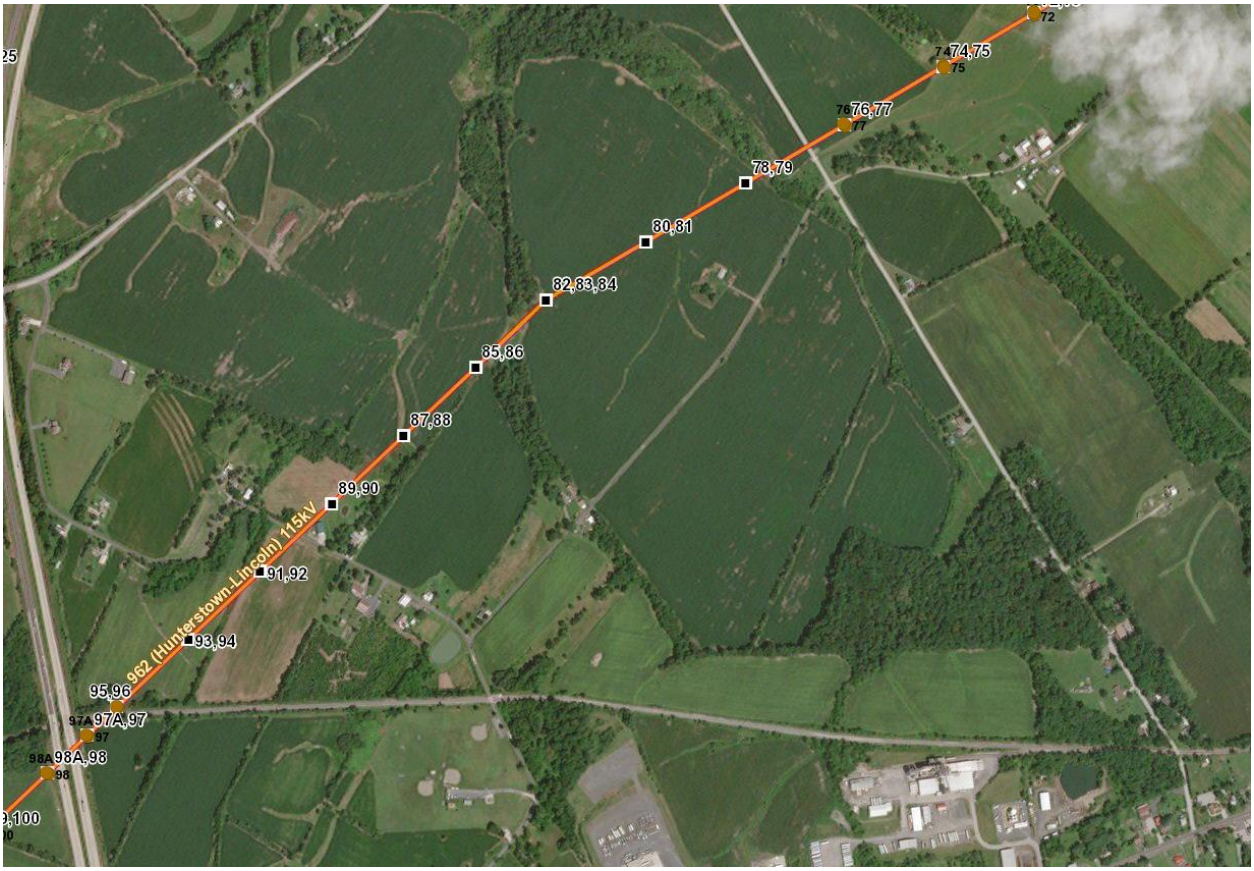


Figure 6
Preliminary Proposed ADSS Fiber Route

(Provided by FirstEnergy)