# *Revised*
# *Generation Interconnection*
# *Facility Study Report*

## *For*

## *PJM Generation Interconnection Request*
## *Queue Position AA2-161*

## *"Yukon-Robbins 138 kV"*

## *541 MW MFO, 513 MW Capacity*

**November 2019**

# 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.

# Changes from July 2019 Facilities Study Report:

This Facilities Study has been updated to reflect:

1) Allegheny Energy Center LLC is the new Interconnection Customer.
2) Network Upgrade Number n5033 is no longer needed.

# A. Transmission Owner Facilities Study Summary

## 1. Description of Project

Allegheny Energy Center LLC (hereinafter referred to as "Interconnection Customer (IC)") proposed a combined cycle natural gas generating facility located near the intersection of Henderson Road and Great Allegheny Passage North in Buena Vista, Allegheny County, Pennsylvania (Elizabeth Township). The installed facilities will have a total capability of **541 MW**. PJM recognizes **513 MW** of this output as Capacity Interconnection Rights. The proposed Commercial Operation Date for this project is **June 1, 2023**.

The AA2-161 project is impacting two Transmission Owners. The Interconnected Transmission Owner (ITO) is West Penn Power Company which is a FirstEnergy company ("FE") and the affected Transmission Owner is Duquesne Light Company ("DUQ").

## 2. Point of Interconnection (POI)

The generation facility will interconnect with the West Penn Power transmission system through a new to-be-constructed six breaker ring bus substation which loops the Yukon-Robins and the

Yukon-Springdale 138 kV transmission lines. Please refer to **Figure 1** for a one line diagram of system configuration. The Point of Interconnection ("POI") will be located at a new FE-owned deadend structure within the new interconnection yard. IC is responsible for installing the 0.8 miles long generator lead to the point of interconnection.

The specific Point of Interconnection will be defined as the point where the Interconnection Customer's attachment wire connects with FE's insulator string which is in turn connected to FE's deadend structure within the new 138 kV yard as shown in Figure 1.

## 3. Cost Summary

The AA2-161 project will be responsible for the following costs:

| Description | Total Cost |
|---|---|
| Attachment Facilities | $ 521,187 |
| Direct Connection Network Upgrades | $ 7,636,913 |
| Non Direct Connection Network Upgrades | $ 3,005,900 |
| Allocation for New System Upgrades | $ 4,200,900 |
| Contribution for Previously Identified Upgrades | $ 0 |
| **Total Costs** | **15,364,900** |

## 4. Interconnection Customer's Submitted Milestone Schedule

IC's requested Commercial Operation Date (COD) for the generation facility is **June 1, 2023**. A Project Kickoff meeting must occur by May 1, 2020 to meet Transmission Owner's Assumed Milestone Schedule listed below.

**Developer's Requested Milestone Schedule:**

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

06/01/2023 Project Commercial Operation Date

Note: An outage on the source line is unlikely to be granted from May 1 to October 1. Therefore, the engineering and construction for the Transmission Owner portion of the project must be targeted to be completed by 05/01/2022 in order to meet the requested Backfeed Date of 09/01/2022. If the outages are able to be granted between May 1 and October 1, the work to be completed by FirstEnergy will be targeted to be completed closer to the Backfeed Date in order to minimize potential impacts to the transmission system. The schedule is based on no issues with siting/permitting, right-of-way acquisition, or outage requirements.

## 5. Scope of Customer's Work

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

IC will install a 541 MW natural gas facility to be located in Allegheny County, Pennsylvania. The IC will construct and own facilities including the 1 X 1 combined cycle generating facilities, two (2) 25/138 kV generation step up (GSU) transformers, 138 kV interconnection meter package, one (1) 138 kV breaker with associated relay/protection/controls, two (2) 25 kV circuit breakers with associated relay/protection/controls, and 138 kV conductor up to the Point of Interconnection (POI). The POI will be where the 138 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 AA2-161 project will be interconnected via generator lead line to a new six (6) breaker, 138 kV ring bus Interconnection Switchyard (Buena Vista Substation). The new yard will be built in close proximity to the Yukon-Robbins and Springdale –Wycoff Jct. 138 kV lines. IC is responsible for constructing all the facilities on its side of the POI, including the generation step-up (GSU) transformer and 138 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 6 breaker ring bus substation and loop feed from the Yukon-Robbins 138 kV line and the Springdale-Wycoff Jct. 138 kV lines.

The Attachment Facilities include new line terminal equipment on Transmission Owner's side of the point of interconnection. This typically includes operational metering, 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 0.8-mile interconnection to AA2-161 from the new terminal (POI) at the ring bus interconnection substation.

**Assumptions / Notes:**

- Developer will coordinate design and alignment of proposed AA2-161, 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.
- Developer will coordinate design and construction of proposed AA2-161 138 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 138 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 AA2-161 138 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

### *Attachment Facilities Work (By ITO) –*

**New Line Terminal Equipment**
***PJM Network Upgrade Number n5027***

Install all necessary radial equipment from ring bus terminal to Point of Interconnection including revenue metering equipment.

**Fiber Installation**
***PJM Network Upgrade Number n5027***

Install approximately 0.38 miles of ADSS fiber from the new Interconnection Substation to fiber backbone to be used for SCADA communications backhaul from the Interconnection Substation. The nearest SCADA hops are assumed to be Mitchell or Jeannette substations.

### *Direct Connection Work (By ITO) –*

**Buena Vista Interconnection Substation (138 kV 6 breaker ring bus)**

***PJM Network Upgrade Number n5027***

Design, furnish and construct a new six (6) breaker ring bus Buena Vista interconnection substation.

## *Non-Direct Connection Work (by ITO) –*

### 1. Yukon-Robbins 138 kV Line Loop

***PJM Network Upgrade Number n5028***

Sectionalize the existing 138 kV Yukon-Robbins 138 kV line near towers #88 and #89 and install a loop to the proposed 6-breaker ring bus substation.

### *2.* Springdale-Wycoff Jct 138 kV Line Loop

***PJM Network Upgrade Number n5029***

Sectionalize the existing 138 kV Springdale-Yukon 138 kV line near towers #25 and #26 and install a loop to the proposed 6-breaker ring bus substation.

### 3. Yukon Substation

***PJM Network Upgrade n5030***

At Yukon Substation, install new line relaying and carrier panels on the Huntingdon and Springdale 138 kV Lines.

### 4. Springdale Substation

***PJM Network Upgrade n5031***

At Springdale Substation, install new line relaying and carrier panels on the Yukon 138 kV Line.

### 5. Huntingdon Substation

***PJM Network Upgrade n5032***

At Huntingdon Substation, install new relay panels and carrier equipment on the Yukon 138 kV line.

## *System Reinforcements and Network Upgrades*

**1. Yukon 500 kV Substation: Replace five (5) overdutied 138 kV circuit breakers with 80 kA symmetrical circuit breakers:[1] (ITO)**

- Replace 138 kV Y-1 circuit breaker
  PJM Network Upgrade Number N1364
- Replace 138 kV Y-3 circuit breaker
  PJM Network Upgrade Number N1365
- Replace 138 kV Y-7 circuit breaker
  PJM Network Upgrade Number N1373
- Replace 138 kV capacitor circuit breaker
  PJM Network Upgrade Number N1380
- Replace 138 kV Y-6 circuit breaker
  PJM Network Upgrade Number N1381

**2. Dravosburg Substation (Duquesne Light Company)**
***PJM Network Upgrade n5909***

At Dravosburg Substation, replace the Z-70 Elwyn 138 kV circuit breaker and associated equipment.

[1] Interconnection Customer, Interconnected Transmission Owner and Transmission Provider acknowledge that in the event that baseline project b3006 (Yukon substation upgrade) is completed prior to the Customer Facility achieving commercial operation as described in Section 6.3 of the ISA, Network Upgrades N1364, N1365, N1373, N1380 and N1381 may no longer be required for the interconnection of the Customer Facility.

If the listed Network Upgrades are no longer required, Transmission Provider shall initiate a scope change process in accordance with PJM Manual 14C and upon completion of the scope change process, Interconnection Customer will be relieved of any cost responsibility for such Network Upgrades, and Security will be adjusted in accordance with section 11.2.1 of Appendix 2 to the ISA.

## 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/Tax) | Tax (if applicable) | Total Cost |
|---|---|---|---|
| | Allocation to AA2-161 | | |
| New Line Terminal Equipment: Install radial equipment from ring bus terminal to the point of interconnection. PJM Upgrade #N5027 | $ 498,043 | $ 75,256 | $ 422,787 |
| Fiber: Install approximately 0.38 miles of ADSS fiber to backbone to support SCADA transport. PJM Upgrade #N5027 | $ 116,000 | $ 17,600 | $ 98,400 |
| **Total Attachment Facilities (AF) Costs** | **$614,043** | **$92,856** | **$521,187** |
| Buena Vista Interconnection Substation: Install 138kV six breaker ring bus interconnection station for new customer generation addition. PJM Upgrade #N5027 | $ 7,806,857 | $ 1,179,644 | $ 6,627,213 |
| Project Management, Construction Management, Commissioning, Meter, and SCADA. PJM Upgrade #N5027 | $ 1,189,500 | $ 179,800 | $ 1,009,700 |
| **Total Direct Connect (DC) Costs** | **$8,996,357** | **$1,359,444** | **$7,636,913** |
| Loop the Huntingdon-Yukon 138kV circuit into the proposed 6-breaker ring bus near towers #88 and 89. PJM Upgrade #N5028 | $ 774,800 | $ 117,100 | $ 657,700 |
| Loop the Springdale-Yukon 138kV circuit into the proposed 6-breaker ring bus near Structures #25 and #26. PJM | $ 774,800 | $ 117,000 | $ 657,700 |

| | | | |
|---|---|---|---|
| Upgrade #N5029 | | | |
| Yukon Substation – Install new line relaying and carrier panels on the Huntingdon 138 kV Line. PJM Upgrade #N5030. | $ 480,950 | $ 72,700 | $ 408,250 |
| Yukon Substation – Install new line relaying and carrier panels on the Springdale 138 kV Line. PJM Upgrade #N5030. | $ 480,950 | $ 72,700 | $ 408,250 |
| Springdale Substation – Install new line relaying and carrier panels on the Yukon 138 kV Line. PJM Upgrade #N5031. | $ 319,500 | $ 48,300 | $ 271,200 |
| Huntingdon Substation – Install new line relaying and carrier panels on the Yukon 138 kV Line. PJM Upgrade #N5032. | $ 710,100 | $ 107,000 | $ 602,800 |
| Yukon 138 kV Breaker Replacements – Replace 5 138 kV overdutied breakers with 3000 A, 80 kA breakers. Breaker IDs are CAP, Y-1, Y-6, Y-3 and Y-7. Replace breaker foundations and control cable. Replace 9 138 kV breaker disconnect switches with V-type switches. Reinforce 138 kV bus structures, ground grid and other equipment as required to meet new fault duty requirements. PJM Upgrades #N1380, #N1364, #N1381, #N1365 and #N1373[1] | $ 4,048,600 | $ 611,800 | $ 3,436,800 |
| Dravosburg Substation: Replace Z-70 Elwyn 138 kV CB. PJM Upgrade #N5909 (Duquesne Light Company) | $900,000 | $135,900 | $764,100 |
| **Total Non-Direct Connect (NDC) Costs** | **$8,489,700** | **$1,282,500** | **$9,379,500** |
| **Total AF + DC + NDC Costs** | **$18,100,100** | **$2,734,800** | **$15,364,900** |

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

A proposed twenty-four (24)-month **Direct Connection/Attachment Facility** and a proposed eighteen (18) month **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.

**Direct Connection/Attachment Facility 24 month Schedule (assume May 2020 start)**

| Activity | Start Month | End Month |
|---|---|---|
| | | |
| Preliminary Engineering | 1 | 2 |
| Siting, Permits & Real Estate | 3 | 12 |
| Detailed Engineering | 3 | 12 |
| Equipment Delivery | 12 | 16 |
| Below Grade Construction – Substation | 14 | 16 |
| Below Grade Construction – T-Lines | | |
| Above Grade Construction – Substation | 17 | 20 |
| Above Grade Construction – T-Lines | 21 | 24 |
| Testing & Commissioning | 24 | 24 |

**Non-Direct Connection Schedule**: A proposed eighteen (18) month schedule (assumed October 2020 start) 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 system reinforcements are able to be constructed within the same time frame as the interconnection substation.

**System Reinforcements Schedule**[2]: It is assumed that the system reinforcements are able to be constructed within the same time frame as the interconnection substation. Engineering work has already begun on the Yukon 50 kV project (RTEP B3006) in order to facilitate a request for FE to accelerate this project from the original date that was provided for it to be in service.[1]

**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 to support the new ADSS conductor.

**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 Letter of Notification (LON).
- 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 AA2-161 project.

**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.
- 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

[2] Duquesne Light Company indicates a 12 month schedule after the signing of the ICSA to complete n5909. It is assumed that this work can be done concurrently with the other interconnection work identified.

permits that will be transferred to FirstEnergy.

**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 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, WPP, will be necessary to serve the customer load supplied from the AA2-161 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 n5027***

Install operational metering, dead-end structure, three-phase, gang-operated disconnect switch for the new generator lead line termination into the new Buena Vista Interconnection Substation.

B. **Fiber Installation**
***PJM Network Upgrade Number n5027***
Estimated approximately 0.38 miles of ADSS fiber from the proposed ring bus to fiber backbone to be used for SCADA communications backhaul from the proposed ring bus. The nearest SCADA hops are assumed to be Mitchell or Jeannette substations.

**Engineering Assumptions:**

1. Assumed that structures are suitable and capable for installation of ADSS. If structures are unable to accommodate additional loading, then estimate will need to be re-evaluated for another alternative route or additional costs to replace structures.
2. Assumed fiber backbone to have available fibers.
3. No forestry work is anticipated.
4. Existing structures are assumed to need no modifications to support the new ADSS conductor.

## 2. Transmission Line – Upgrades

### A. Yukon-Robbins 138 kV Line Loop

***PJM Network Upgrade Number n5028***

Transmission Owner will sectionalize the existing 138 kV transmission line at the new Transmission Owner interconnection substation, at a site to be selected by Developer with agreement from Transmission Owner. This study assumes that the interconnection new substation will be located adjacent to the Transmission Owner 138 kV line right-of-way (See "Figure 2") and the dead-end structures will each be within one (1) span of the line (approximately 300 feet). Transmission Owner will install a loop, approximately 300 feet in length, from the Yukon-Robbins 138kV line to the proposed 6-breaker ring bus substation. 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.

The schedule is based on assuming project kick-off occurs no later than **04/01/2020** (i.e. minimum **twenty-five** (25) months prior to Backfeed Date), and the Pennsylvania PUC 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 **03/01/2020**). 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. Therefore, the engineering and construction for the project must be targeted to be completed by 05/01/2022 in order to meet the requested Backfeed Date of 09/01/2022. If the outages are able to be granted between May 1 and October 1, the work to be completed by FirstEnergy will be targeted to be completed closer to the Backfeed Date in order to minimize potential impacts to the transmission system. The schedule is based on no issues with siting/permitting, right-of-way acquisition, or outage requirements.

**Assumptions:**

**Engineering Assumptions:**

1. Install two guyed 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.
2. Install a hold-back structure on the Yukon-Robbins 138 kV circuit.
3. Substation is adjacent to the existing line with the substation being approx. 300' in length (2 span lengths) off the transmission corridor.
4. Assume that the loop will tie into existing circuit between structures #25 and #26.
5. Access will be provided through the substation area and substation access roads.
6. No forestry work is anticipated.
7. It is assumed that no existing structures will need to be removed.

**Siting Assumptions:**

1. An application to the Pennsylvania Public Utilities Commission (PaPUC). One of the issues in determining what will be needed is 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 Letter of Notification is required for PaPUC 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 PaPUC review of the submittal.
3. Title completed by Developer and provided to Transmission Owner upon request.

## *B.* Springdale-Wycoff Jct 138 kV Line Loop

***PJM Network Upgrade Number n5029***

Transmission Owner will sectionalize the existing 138 kV transmission line at the new Transmission Owner interconnection substation, at a site to be selected by Developer with agreement from Transmission Owner. This study assumes that the interconnection new substation will be located adjacent to the Transmission Owner 138 kV line right-of-way (See "Figure 2") and the dead-end structures will each be within two (2) spans of the line (approximately 300 feet). Transmission Owner will install a loop, approximately 300 feet in length, from the Yukon-Robbins 138kV line to the proposed 6-breaker ring bus substation. 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.

The schedule is based on assuming project kick-off occurs no later than **04/01/2020** (i.e. minimum **twenty-five** (25) months prior to Backfeed Date), and the Pennsylvania PUC 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. Therefore, the engineering and construction for the project must be completed by 05/01/2022 in order to meet the requested Backfeed Date. The schedule is based on no issues with siting/permitting, right-of-way acquisition, or outage requirements.

**Assumptions:**

**Engineering Assumptions:**

1. Install two guyed 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.
2. Install a hold-back structure on the Springdale-Wycoff Jct 138 kV circuit.
3. Substation is adjacent to the existing line with the substation being approx. 300' in length (2 span lengths) off the transmission corridor.
4. Assume that the loop will tie into existing circuit between structures #25 and #26.
5. Access will be provided through the substation area and substation access roads.
6. No forestry work is anticipated.
7. It is assumed that no existing structures will need to be removed.

**Siting Assumptions:**

1. An application to the PaPUC. One of the issues in determining what will be needed is 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 Letter of Notification (LON) is required for PaPUC 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 PUC review of the submittal.
3. Title completed by Developer and provided to Transmission Owner upon request.

## 3. New Substation/Switchyard Facilities

### A. Interconnection Substation (138 kV 6 breaker ring bus)

***PJM Network Upgrade Number n5027***

Transmission Owner will design, furnish and construct the new 138 kV six (6) breaker ring bus interconnection substation, including the following:

- Six (6) 138 kV, 3000 ampere, 40 kA interrupting power circuit breakers
- Twelve (12) 138 kV, three-pole, manually-operated, group disconnect switches
- Five (1) 138 kV, three-pole, motor-operated, disconnect switch
- Fifteen (15) surge arresters for application on a 138 kV system
- Fifteen (15) 138 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) 138 kV power voltage transformer
    - Backup: Feed from a local distribution feeder
- Two (2) 138 kV transmission line termination structures
- One (1) 138 kV transmission line termination structure (for generator position)
- 138 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.
- **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 fiber backbone. Also includes, SCADA work at new interconnect substation to support new RTU. Estimate also includes SCADA work at Springdale, Huntingdon and Yukon substations to support line relay replacements and SCADA work.

- **Project Management, Construction Management, Commissioning, Meter and SCADA**
  Work related to performing or provision of support for construction management, commissioning, metering and SCADA.

Assumptions / Notes:

- A rough-graded, level site and access road is to be provided by Developer.
- In order to meet the Backfeed Date of **09//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-five** 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 and the terrain. 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 substation layout to determine if the land size is adequate.

## 4. Upgrades to Substation / Switchyard Facilities

### A. Yukon Substation

***PJM Network Upgrade n5030***

At Yukon Substation, install new line relaying and carrier panels on the Huntingdon and Springdale 138 kV Lines.

### B. Springdale Substation

***PJM Network Upgrade n5031***

At Springdale Substation, install new line relaying and carrier panels on the Yukon 138 kV Line.

**C. Huntingdon Substation**

***PJM Network Upgrade n5032***

At Huntingdon Substation, install new relay panels and carrier equipment on the Yukon 138 kV line.

**D. Yukon Substation**

**At Yukon 500 kV Substation, replace five (5) overdutied 138 kV circuit breakers with 80 kA symmetrical circuit breakers:[1]**

- Replace 138 kV Y-1 circuit breaker
  ***PJM Network Upgrade Number N1364***
- Replace 138 kV Y-3 circuit breaker
  ***PJM Network Upgrade Number N1365***
- Replace 138 kV Y-7 circuit breaker
  ***PJM Network Upgrade Number N1373***
- Replace 138 kV capacitor circuit breaker
  ***PJM Network Upgrade Number N1380***
- Replace 138 kV Y-6 circuit breaker
  ***PJM Network Upgrade Number N1381***

**E. Dravosburg Substation**

***PJM Network Upgrade n5909***

Replace the Z-70 Elwyn 138 kV circuit breaker and associated equipment at Dravosburg Substation.

## 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 Sections 24.1 and 24.2.

IC will be responsible for designing, furnishing and installing Supervisory Control and Data Acquisition (SCADA) RTU equipment in its generation substation, and for obtaining the telecommunication circuits and data transfer from the RTU to the Transmission Owner Data Center.

## Transmission Owner Requirements

See Attachment A.

## 6. Environmental, Real Estate and Permitting Issues

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

- Environmental permitting, Real Estate acquisition, and Public Utilities Commission of Pennsylvania (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.
- 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
- 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 Public Utilities Commission of Pennsylvania (PaPUC) notification/approval.

## 7. Information Required for Interconnection Service Agreement

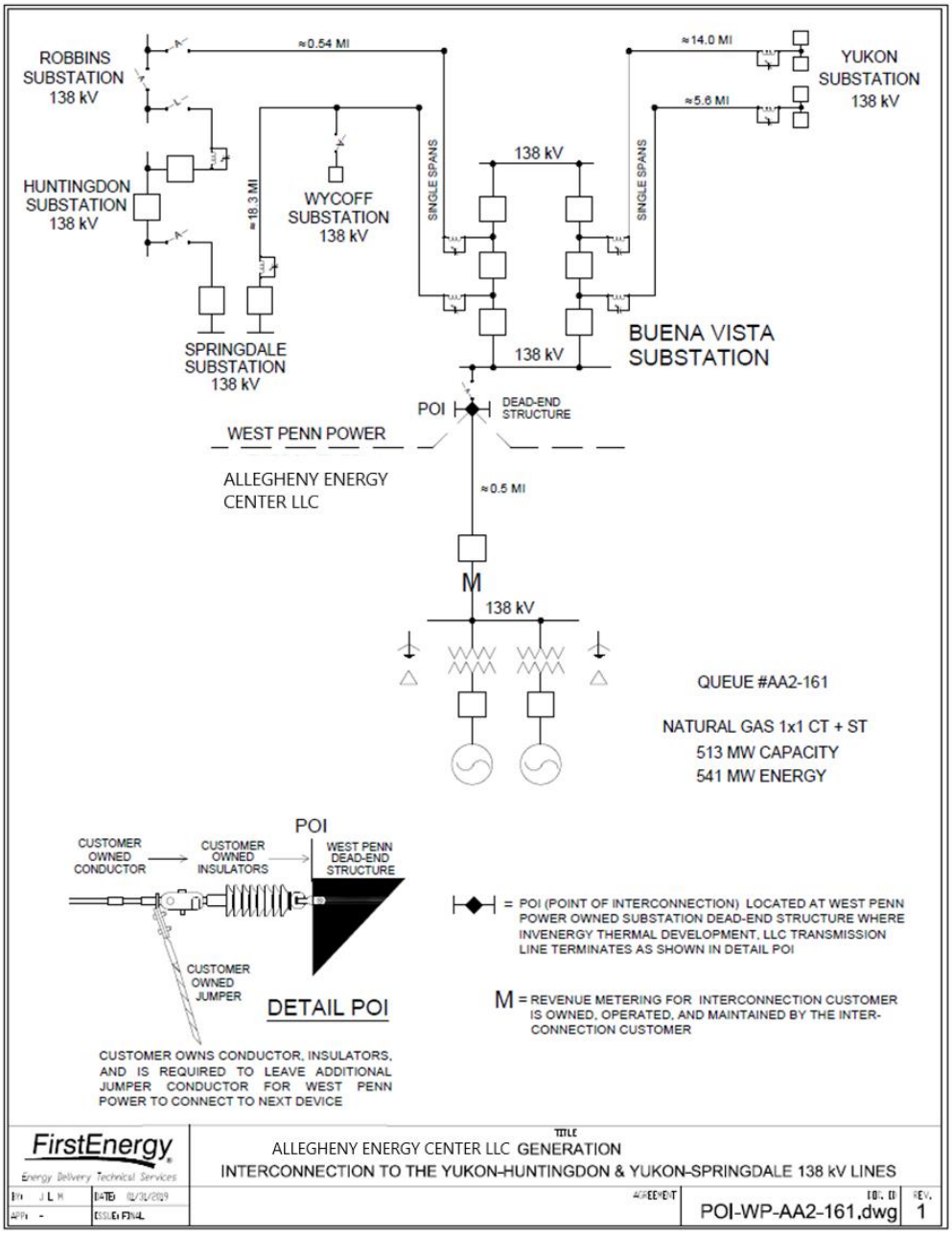
The following table summarizes the total estimated costs according to FERC criteria.

| Work Description | Direct | | Indirect | | Total Cost |
|---|---|---|---|---|---|
| | Labor | Material | Labor | Material | |
| Radial equipment from ring bus terminal to the point of interconnection. *Part of PJM Upgrade #N5027* | $ 190,254 | $147,975 | $42,279 | $42,279 | $ 422,787 |
| Fiber – Install approximately 0.38 miles of ADSS fiber to backbone to support SCADA transport. *PJM Upgrade #N5027* | $44,280 | $34,440 | $9,840 | $9,840 | $98,400 |
| **Total Attachment Facilities Cost** | $ 234,534 | $ 182,415 | $ 52,119 | $ 52,119 | $ 521,187 |
| Install 138kV six breaker ring bus interconnection station for new customer generation addition. *PJM Upgrade #N5027* | $2,982,246 | $2,319,525 | $ 662,721 | $ 662,721 | $ 6,627,213 |
| Project Management, Construction Management, Commissioning, Meter, and SCADA. *PJM Upgrade #N5027* | $ 454,365 | $ 353,395 | $ 100,970 | $ 100,970 | $ 1,009,700 |
| **Total Direct Connection Cost** | $ 3,436,611 | $ 2,672,920 | $ 763,691 | $ 763,691 | $ 7,636,913 |

| | | | | | |
|---|---|---|---|---|---|
| Loop the Huntingdon-Yukon 138kV circuit into the proposed 6-breaker ring bus near towers #88 and 89. PJM Upgrade #N5028 | $ 295,965 | $ 230,195 | $65,770 | $ 65,770 | $ 657,700 |
| Loop the Springdale-Yukon 138kV circuit into the proposed 6-breaker ring bus near Structures #25 and #26. *PJM Upgrade #N5029* | $ 295,965 | $ 230,195 | $ 65,770 | $ 65,770 | $ 657,700 |
| Yukon Substation – Install new line relaying and carrier panels on the Huntingdon 138 kV Line. *PJM Upgrade #N5030.* | $ 183,713 | $ 142,888 | $ 40,825 | $ 40,825 | $ 408,250 |
| Yukon Substation – Install new line relaying and carrier panels on the Springdale 138 kV Line. *PJM Upgrade #N5030.* | $ 183,713 | $142,888 | $ 40,825 | $ 40,825 | $ 408,250 |
| Springdale Substation – Install new line relaying and carrier panels on the Yukon 138 kV Line. *PJM Upgrade #N5031.* | $ 122,040 | $ 94,920 | $ 27,120 | $ 27,120 | $ 271,200 |
| Huntingdon Substation – Install new line relaying and carrier panels on the Yukon 138 kV Line. *PJM Upgrade #N5032.* | $ 271,260 | $ 210,980 | $ 60,280 | $ 60,280 | $ 602,800 |
| | | | | | |
| Yukon 138 kV Breaker Replacements – Replace 5 138 kV overdutied breakers with 3000 A, 80 kA breakers. | $ 1,546,560 | $ 1,202,880 | $343,680 | $ 343,680 | $ 3,436,800 |

| | | | | | |
|---|---|---|---|---|---|
| Breaker IDs are CAP, Y-1, Y-6, Y-3 and Y-7. Replace breaker foundations and control cable. Replace 9 138 kV breaker disconnect switches with V-type switches. Reinforce 138 kV bus structures, ground grid and other equipment as required to meet new fault duty requirements. PJM Upgrades #N1380, #N1364, #N1381, #N1365 and #N1373[1] | | | | | |
| Dravosburg Substation: Replace Z-70 Elwyn 138 kV CB. PJM Upgrade #N5909 (Duquesne Light Company) | $ 343,845 | $ 267,435 | $ 76,410 | $ 76,410 | $764,100 |
| **Total Non-Direct Connection Network Upgrades** | $ 3,243,060 | $ 2,522,380 | $720,680 | $ 720,680 | $ 7,206,800 |
| **Total Project Costs** | $6,914,205 | $ 5,377,715 | $1,536,490 | 1,536,490 | $15,364,900 |

# FIGURE 1
# Queue #AA2-161: Planning Single-Line Diagram*

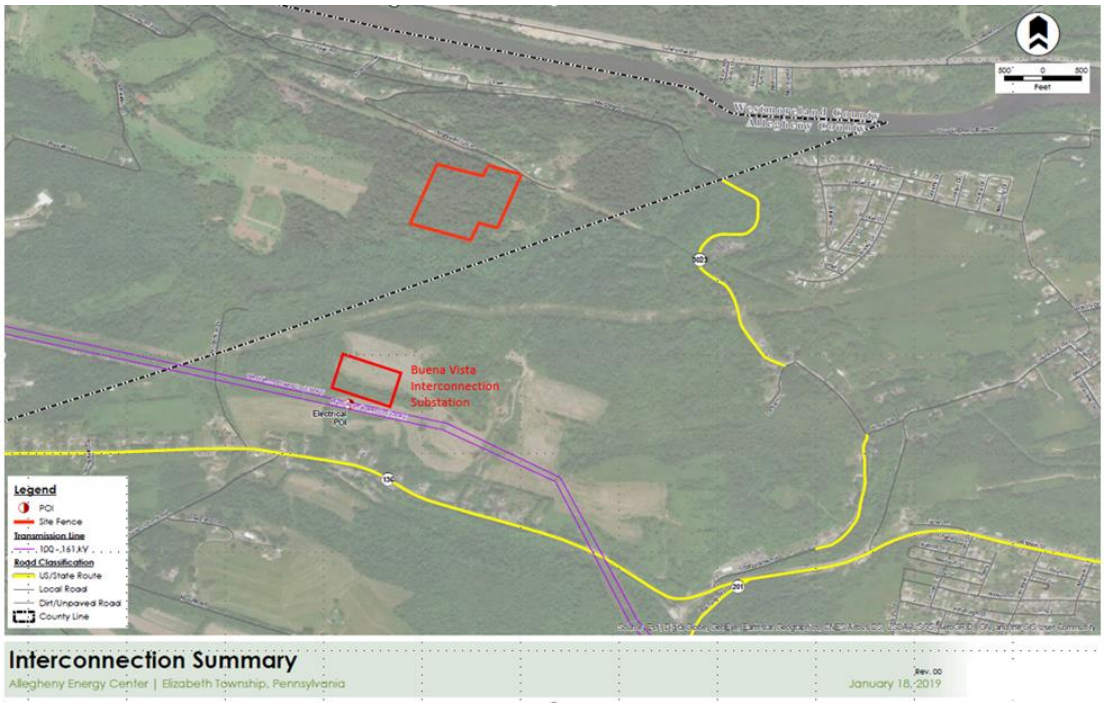


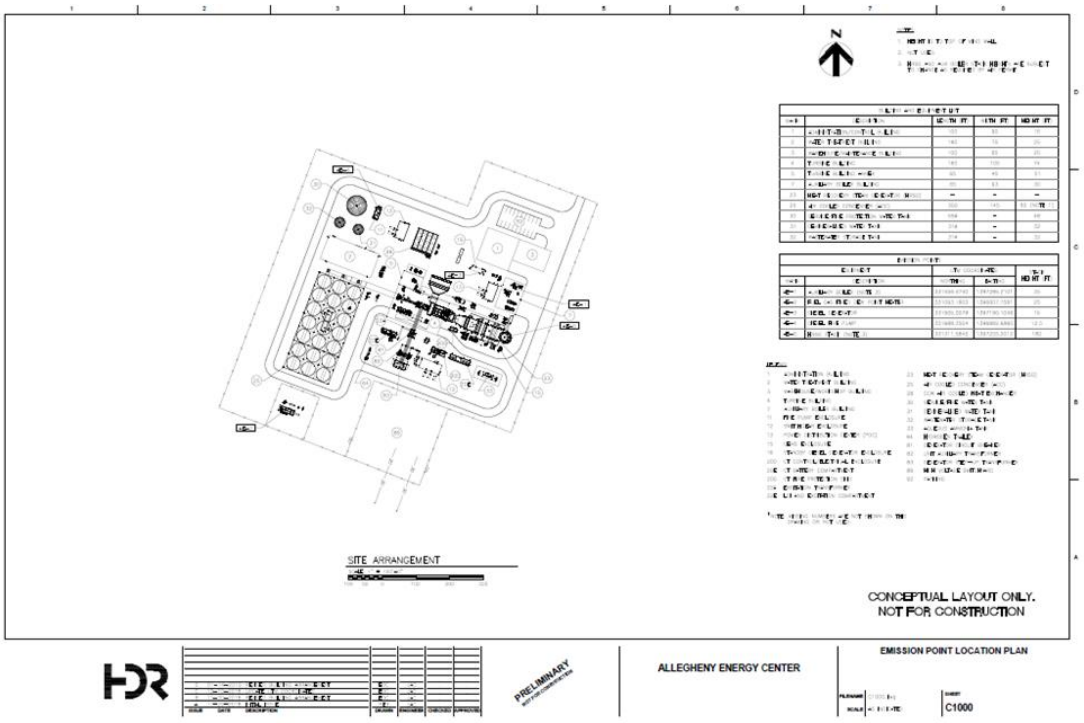

* Note: Diagram does not represent a physical layout. Not to be used for construction.

# FIGURE 2

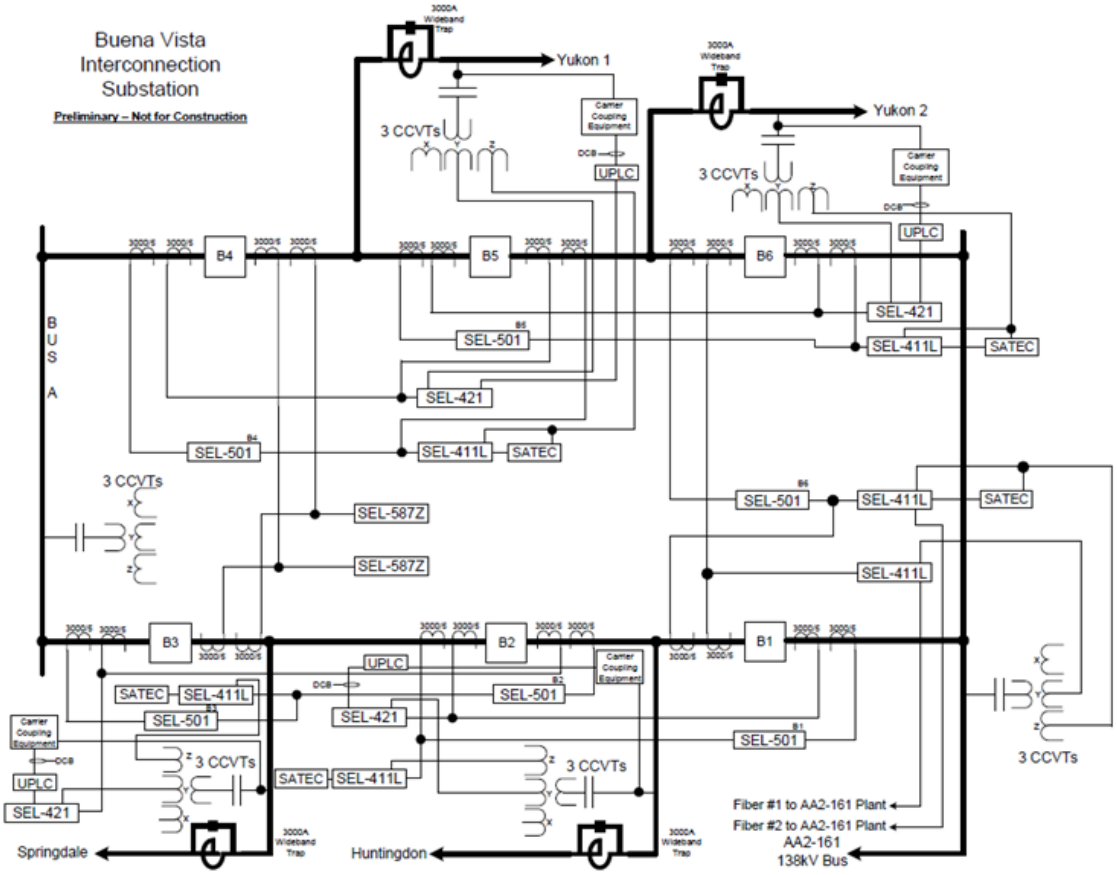
## Queue #AA2-161

# Proposed Project Location




SITE ARRANGEMENT
CONCEPTUAL LAYOUT ONLY.
NOT FOR CONSTRUCTION
PRELIMINARY
ALLEGHENY ENERGY CENTER
EMISSION POINT LOCATION PLAN
C1000

# Figure 3
# Buena Vista Interconnection Substation Elementary Diagram



# ATTACHMENT A.
# PJM Queue #AA2-161: Detailed Protection Requirements

## Detailed Protection Requirements

### WP-15-150526-073613 –

### Buena Vista 138kV (AA2-161): Install 6 breaker Ring Bus

Below are the protection requirements for this project. Buena Vista is the interconnection substation, Springdale, Huntingdon, and Yukon are the remote stations requiring relay and equipment upgrades. See attached relay sketch.

## Non-Direct Connect Protection Requirements

## Springdale Substation

Transmission Owner will replace existing carrier equipment, replace relays, prepare new relay settings, and test and commission protection schemes on the line exit to the new Buena Vista AA2-161 Interconnection. In addition, an area coordination study of the new protective relay settings for equipment at Springdale and adjacent substations, including Federal Street, Harwick, Huntingdon, Murrycrest, Shaffers Corners, Pittsburgh Mills, and AE 1&2 will be performed to determine if relay settings are affected by the change in short circuit current due to the addition of the AA2-161 natural gas generation.

## Huntingdon Substation

Transmission Owner will replace existing carrier equipment, replace relays, prepare new relay settings, and test and commission protection schemes on the line exit to the new Buena Vista AA2-161 Interconnection. In addition, an area coordination study of the new protective relay settings for equipment at Huntingdon and adjacent substations, including Springdale will be performed to determine if relay settings are affected by the change in short circuit current due to the addition of the AA2-161 natural gas generation

## Yukon Substation (2 exits)

Transmission Owner will replace existing carrier equipment, replace relays, prepare new relay settings, and test and commission protection schemes on both line exits to the new Buena Vista AA2-161 Interconnection. In addition, an area coordination study of the new protective relay settings for equipment at Yukon and adjacent substations, including Bethelboro, Smithton, Westraver, Youngwood, Waltz Mill, and Wycoff will be performed to determine if relay settings are affected by the change in short circuit current due to the addition of the AA2-161 natural gas generation.

## Direct Connect Protection Requirements

**Short Circuit Values (Existing Conditions)**

Fault values for the Buena Vista (AA2-161) Interconnection Substation location:

Three phase = 18,652 A

Single line to ground = 11,312 A

Zl= 0.00261 + j0.02228 p.u.

Z0= 0.01687 + j0.06423 p.u.

Note: These fault values were obtained using the FirstEnergy short circuit model without AA2-161 generators in the fault case.

Impedances are given on 100 MVA and 138kV bases. The faults provided are bolted, symmetrical values for normal system conditions with a flat 1.0 p.u. voltage profile. Future increases in fault currents are possible and it is Developer's responsibility to upgrade its equipment and/or protective equipment coordination when necessary.

## Buena Vista AA2-161 138kV Interconnection Substation Protection Requirements

The attached relay sketch provides protection details of the new AA2-161 138kV Interconnection Substation. Six new 145kV rated, 3000A minimum continuous, 40kA or higher interrupting, nominal 138kV breakers are required for construction of a ring bus splitting the line from Yukon to Huntingdon and Yukon to Springdale. Each of the (6)138kV breakers will be equipped with four sets 3000:5 A multi-ratio C800 relay accuracy CTs with a thermal rating factor of 2.0.

One set of (3) CCVTs, one per phase, are required for installation on each node of the 138kV ring bus. The CCVTs shall have dual secondary windings with each winding capable of being connected at either a 1200:1 or a 700:1 ratio.

**Springdale Line Protection**

The zone of protection for this scheme consists of the protected line between the CTs supplying the relays at the new Buena Vista (AA2-161) Interconnection Substation and the CTs supplying the relays at Springdale Substation. The primary line protection shall be an SEL-421 relay utilizing phase distance and directional ground overcurrent elements in a directional comparison blocking (DCB) scheme over a power line carrier channel (On/Off channel frequency to be determined at time of protection specification issue) on Phase Z. The backup line protection shall be an SEL-411L relay with phase distance and directional ground overcurrent direct tripping elements for a non-pilot scheme. Redundancy for primary and backup line protection schemes is required including independent DC supply on separate breakers from a DC panelboard, separate tripping paths energizing separate trip coils in the breakers, independent current transformers, and independent secondary windings of the same voltage transformer for primary and backup relaying. Should

additional PJM studies indicate that stability issues exist, therefore requiring dual high-speed tripping schemes, a backup power line carrier communication channel must be established for the backup line protection scheme on a separate phase of the line. Reclosing will be performed by the backup line protection relay for one line breaker on the terminal.

**Huntingdon Line Protection**

The zone of protection for this scheme consists of the protected line between the CTs supplying the relays at the new Buena Vista (AA2-161) Interconnection Substation and the CTs supplying the relays at Huntingdon Substation. The primary line protection shall be an SEL-421 relay utilizing phase distance and directional ground overcurrent elements in a directional comparison blocking (DCB) scheme over a power line carrier channel (On/Off channel frequency to be determined at time of protection specification issue) on Phase Y. The backup line protection shall be an SEL-411L relay with phase distance and directional ground overcurrent direct tripping elements for a non-pilot scheme. Redundancy for primary and backup line protection schemes is required including independent DC supply on separate breakers from a DC panelboard, separate tripping paths energizing separate trip coils in the breakers, independent current transformers, and independent secondary windings of the same voltage transformer for primary and backup relaying. Should additional PJM studies indicate that stability issues exist, therefore requiring dual high-speed tripping schemes, a backup power line carrier communication channel must be established for the backup line protection scheme on a separate phase of the line. Reclosing will be performed by the backup line protection relay for one line breaker on the terminal.

**Yukon 1 Line Protection**

The zone of protection for this scheme consists of the protected line between the CTs supplying the relays at the new Buena Vista (AA2-161) Interconnection Substation and the CTs supplying the relays at Yukon Substation. The primary line protection shall be an SEL-421 relay utilizing phase distance and directional ground overcurrent elements in a directional comparison blocking (DCB) scheme over a power line carrier channel (On/Off channel frequency to be determined at time of protection specification issue) on Phase Y . The backup line protection shall be an SEL-411L relay with phase distance and directional ground overcurrent direct tripping elements for a non-pilot scheme. Redundancy for primary and backup line protection schemes is required including independent DC supply on separate breakers from a DC panelboard, separate tripping paths energizing separate trip coils in the breakers, independent current transformers, and independent secondary windings of the same voltage transformer for primary and backup relaying. Should additional PJM studies indicate that stability issues exist, therefore requiring dual high-speed tripping schemes, a backup power line carrier communication channel must be established for the backup line protection scheme on a separate phase of the line. Reclosing will be performed by the backup line protection relay for one line breaker on the terminal

**Yukon 2 Line Protection**

The zone of protection for this scheme consists of the protected line between the CTs supplying the relays at the new Buena Vista (AA2-161) Interconnection Substation and the CTs supplying the relays at Yukon Substation. The primary line protection shall be an SEL-421 relay utilizing phase distance and directional ground overcurrent elements in a directional comparison blocking (DCB)

scheme over a power line carrier channel (On/Off channel frequency to be determined at time of protection specification issue) on Phase Z . The backup line protection shall be an SEL-411L relay with phase distance and directional ground overcurrent direct tripping elements for a non-pilot scheme. Redundancy for primary and backup line protection schemes is required including independent DC supply on separate breakers from a DC panelboard, separate tripping paths energizing separate trip coils in the breakers, independent current transformers, and independent secondary windings of the same voltage transformer for primary and backup relaying. Should additional PJM studies indicate that stability issues exist, therefore requiring dual high-speed tripping schemes, a backup power line carrier communication channel must be established for the backup line protection scheme on a separate phase of the line. Reclosing will be performed by the backup line protection relay for one line breaker on the terminal

**(AA2-161) Generation Direct Connect Tie Line Protection**

The zone of protection for this scheme consists of the direct connect tie line between the CTs supplying the relays at Buena Vista (AA2-161) Interconnection Substation and the CTs on the tie line circuit breaker at the AA2-161 Generation substation. The line protection system will consist of dual, high speed clearing pilot protection schemes. The Buena Vista (AA2-161) direct connect tie line primary protection shall be an SEL-411L current differential scheme communicating over a dedicated fiber-optic channel via a direct, relay to relay fiber cable, with direct tripping, non-pilot step distance and directional ground overcurrent backup elements. The AA2-161 direct connect tie line backup protection shall be an SEL-411L current differential scheme utilizing a second dedicated fiber-optic channel over a direct, relay-to-relay fiber cable, with direct tripping, non-pilot, step distance and directional ground overcurrent backup elements. Direct Transfer Trip (DTT) for breaker failure to trip will also utilize both SEL-411L relays and their respective fiber optic communication channels between the Buena Vista (AA2-161) Interconnection Substation and the AA2-161 Generation Substation. Redundancy for primary and backup line protection schemes is required including independent DC supply on separate breakers from a DC panelboard, separate tripping paths energizing separate trip coils in the breakers, independent current transformers, and independent secondary windings of the same voltage transformer for primary and backup relaying. Should additional PJM studies indicate that stability issues exist, therefore requiring dual high-speed tripping schemes, the primary and backup relay fiber optic communication channels must be in separately routed cable paths. No automatic reclosing will be applied at the AA2-161 interconnection Substation for faults on the 138kV direct connect tie line.

**Bus A Protection**

The zone of protection for this scheme consists of the protected Bus A between the CTs on the Yukon 1 line exit side of B4 and the CTs on the Springdale line exit side of B3. The bus protection system will consist of dual high impedance current differential relays. Both Primary and Backup protection shall utilize a SEL-587Z relay.

**Breaker Failure Relaying**

A breaker failure relay (SEL-501) shall be utilized on each of the 138kV circuit breakers B1 – B6. The source for the breaker failure relay shall be CTs on either side of the 138kV circuit breakers. Any protective trip of this breaker shall initiate the breaker failure to trip scheme. The re-trip feature of each SEL-501 breaker failure relay shall be utilized to re-trip the associated 138kV circuit breaker.

DC supplied to power the breaker failure schemes shall be independent DC breakers from either the primary or backup relaying scheme DC.

The 138kV breaker failure scheme for Breaker B1 shall trip and block closing of the 138kV Breakers B1, B2, B6 at the AA2-161 Interconnection Substation. Tripping shall be done via a hand-reset LOR lockout relay. Breaker 1 breaker failure should key DTT to the AA2-161 Generation substation.

The 138kV breaker failure scheme for Breaker 2 shall trip and block closing of the 138kV Breakers B1, B2 and B3 at the AA2-161 Interconnection Substation. Tripping shall be done via a hand-reset LOR lockout relay.

The 138kV breaker failure scheme for Breaker 3 shall trip and block closing of the 138kV Breakers B2, B3 and B4 at the AA2-161 Interconnection Substation. Tripping shall be done via a hand-reset LOR lockout relay.

The 138kV breaker failure scheme for Breaker 4 shall trip and block closing of the 138kV Breakers B3, B4 and B5 at the AA2-161 Interconnection Substation. Tripping shall be done via a hand-reset LOR lockout relay.

The 138kV breaker failure scheme for Breaker 5 shall trip and block closing of the 138kV Breakers B4, B5 and B6 at the AA2-161 Interconnection Substation. Tripping shall be done via a hand-reset LOR lockout relay.

The 138kV breaker failure scheme for Breaker 6 shall trip and block closing of the 138kV Breakers B1, B5 and B6 at the AA2-161 Interconnection Substation. Tripping shall be done via a hand-reset LOR lockout relay. Breaker 6 breaker failure should also key DTT to the AA2-161 Generation substation.

**DC Power**

The relaying system shall have a reliable source of DC power independent from the AC system that is immune to AC system disturbance or loss (for example - DC battery and charger) to assure proper operation of the protection scheme. Primary and backup relaying schemes shall be powered from different DC distribution panel circuit breakers.

## AA2-161 Generation Substation Protection Requirements

I

t is the responsibility of the Developer to assure protection, coordination and equipment adequacy within its facility for conditions including but not limited to:

- Single phasing of supply
- System faults
- Equipment failures

• Deviations from nominal voltage or frequency

• Lightning and switching surges

• Harmonic voltages

• Negative sequence voltages

• Separation from FE supply

• Synchronizing generation

• Synchronizing facilities between independent transmission system and FE

• Transmission System

Developer is to design its protective system to clear any faults within their zones of protection with one or more of their local circuit breakers. Each zone of protection covering the 138kV portion of the interconnection system, including the GSU transformers, is to be protected by two independent relay schemes that each provide high speed fault clearing. The terminal breaker at the generation end of the direct connect tie line is to be included in the 138kV over-lapping zones of protection. The CTs used for the zones of protection covering the 138kV portion of the system shall use C800 relay accuracy CTs and the CTs should not saturate for the maximum through-fault current that can be experienced by the relay system for the tap ratio in use. Each 138kV breaker is to have breaker failure to trip protection. The AA2-161 Generation substation will contain at least one 138kV direct connect tie line circuit breaker, and a high side and low side transformer circuit breaker for each GSU transformer. The transformer windings shall be wye ground–delta (HV-LV). The 138kV interconnection line circuit breaker(s) shall be purchased with four sets (12 total) of 3000:5 A MR C800. A 138kV three phase potential source (CCVT or equivalent) is required for line terminal relaying.

The AA2-161 Generation Substation shall not close into the direct connect tie line if it is dead, so that all synchronizing is performed at the AA2-161 Generation Substation. All communications between AA2-161 Interconnection Substation and the AA2-161 Generation Substation, including relay trip signals, shall utilize fiber optic communications paths so that no copper cables shall be run between these substations for the purpose of carrying currents, trip signals, or communications of any sort. No automatic reclosing will be applied at the AA2-161 interconnection Substation for faults on the 138kV direct connect tie line.

**Buena Vista AA2-161 Direct Connect Tie Line Protection**

Two SEL-411L relays with separate fiber optic communication channels shall be used for the interconnection tie line protection to match the line relays schemes as described for Buena Vista AA2-161 Interconnection Substation. Two fiber optic channels are required for these schemes to obtain high-speed tripping capability for any fault within the tie line zone of protection. Should additional PJM studies indicate that stability issues exist, therefore requiring dual high-speed tripping schemes for stability, the two fiber optic channels must be in separately routed paths. At least one of the two current differential protective relays shall also provide direct tripping non-pilot phase distance and ground time overcurrent protection to cover for a loss of communication. The use of any other relays for interconnection tie line protection will require written approval from FirstEnergy.

The 138kV interconnection tie line protection circuit breaker CTs shall be 3000:5 A MR C800 current transformers. A 138kV three phase potential source (CVT or equivalent) is required for line terminal relaying.

**Breaker Failure Relaying**

Each breaker on the high side portion of the AA2-161 Generation Substation is to have breaker failure to trip protection. The breaker failure to trip protection must include current sensing Or'd with the breaker status to identify a closed breaker. The breaker failure to trip protection shall trip all breakers electrically adjacent to the failed breaker at the AA2-161 Generation substation and the breaker failure to trip protection on the direct connect tie line breaker shall send DTT through both fiber channels to the Transmission Owner AA2-161 Interconnection Substation.

**Inter-tie Relaying**

In addition to the two fully independent high-speed relay schemes for the 138kV portion of the AA2-161 Generation Substation, an inter-tie relay is also required. The inter-tie relay shall be an SEL-351 or equivalent, including 27, 59, 81, 67V and 67N elements. The current source for the intertie relay shall be CTs on the direct connect tie line breaker and the protection elements listed shall trip the 138kV interconnection line breaker.

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.

**Developer is solely responsible for protecting its own equipment in such a manner that electrical faults or other disturbances on the Transmission Owner system do not damage its equipment.**

**Approvals**

All relays, relay schemes and relay settings that include 138kV voltages or currents, or trip any 138kV circuit breakers, shall require the review and approval of Transmission Owner. Transmission Owner 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. The cost of these relay replacements will be borne by Developer.

## Metering Requirements

A revenue metering installation is required for this installation. Requirements are outlined in FirstEnergy's "Requirements for Transmission Connected Facilities" document.

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

***METERING-DESIGN NOTE***

FirstEnergy Corporation is required to meet RFC requirement TOP-006 as defined in PJM Manual 01 for tie line metering accuracy (SCC SCADA operational metering). The XXXXXXXXX line is designated as a tie line. Higher accuracy (SCADA) operational metering/transducers must be used, including metering accuracy instrument transformers (CCVTs, PT, CTs) which feed this operational metering. Accordingly, at least 0.3Z (200VA) burden accuracy for CCVTs, Bitronics metering and metering class CTs are required for all (SCADA) operational metering on this tie line. Any operational metering must meet the following accuracy guideline as defined in PJM Manual 01, Section 5.7:

For all new metering installed since December 1, 1997, the following primary transducer accuracy guidelines are followed:

| Primary Transducer | Accuracy Guideline |
|---|---|
| Frequency Transducers | 0.001 Hz |
| Potential Transformers | 0.30% of Full Scale |
| Current Transformers | 0.50% of Full Scale |
| MW/MVAR/Voltage Transducers | 0.25% of Full Scale |
| Remote Terminal Units (A/D) | 0.25%of Full Scale |

This accuracy guideline results in an overall metering accuracy better than 2% and satisfies the NERC BAL standards. Billing accurate telemeter data values should be supplied whenever possible.

Substation design must contact the metering department for revenue metering equipment details and associated revenue metering instrument transformers.

These requirements are in addition to any metering required by PJM.

# ATTACHMENT B.
# Generator 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 Type | New / Increase | Size | Power Factor Requirement | Measurement Location |
|---|---|---|---|---|
| Synchronous | New | > 20 MW | 0.95 leading to 0.90 lagging | Generator's Terminals |
| Synchronous | New | <= 20 MW | 0.95 leading to 0.90 lagging | Point of Interconnection |
| Wind or Non-Synchronous | New | All | 0.95 leading to 0.95 lagging | Generator's Terminals[3] |
| Synchronous | Increase | > 20 MW | 1.0 (unity) to 0.90 lagging | Generator's Terminals |

[3] For projects that entered PJM's New Service Queue prior to May 1, 2015, the power factor requirement will be measured at the Point of Interconnection.

| | | | | |
|---|---|---|---|---|
| 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[4] | 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) 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

[4] For projects that entered PJM's New Service Queue prior to May 1, 2015, the power factor requirement is 1.0 (unity) to 0.95 lagging.

- 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”

## Metering, SCADA and Communications

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.

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).

## 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 may reside in the same cable, provided that this line does not require completely redundant protection for system stability reasons. 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 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.

**Environmental, Real Estate and Permitting Issues**

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

- Environmental permitting, Real Estate acquisition, and Public Utilities Commission of Pennsylvania (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.
- 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
- 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 Public Utilities Commission of Pennsylvania (PaPUC) notification/approval.

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 southern-side of the 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.
- 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
- 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.
- 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 138 kV connection between the substations will be via a 138 kV transmission line.
- An outage on the source line is unlikely to be granted from May 1 to October 1. Therefore, the engineering and construction for the Transmission Owner portion of the project must be targeted to be completed by 05/01/2022 in order to meet the requested Backfeed Date of 09/01/2022. If the outages are able to be granted between May 1 and October 1, the work to be completed by FirstEnergy will be targeted to be completed closer to the Backfeed Date in order to minimize potential impacts to the transmission system.
- In order to meet the Backfeed Date of **09/01/2022**, 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-five (25)** 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 138 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