Revised
Generation Interconnection
Facility Study Report

For

PJM Generation Interconnection Request
Queue Position AA1-123

Highland-Sammis 345kV

September 2017

General

East Ohio Energy, LLC, the Interconnection Customer (IC), has proposed a natural gas generating facility located in Columbiana County, OH. The installed facilities will have a total capability of 1,152 MW with 1,105 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is December 2019. **This study does not imply a American Transmission Systems, Inc. (ATSI) commitment to this in-service date.**

Revision from Facilities Study Report Issued September 26, 2017

The AA1-123 Facilities Study has been revised to reflect updates to permission assumptions.

Point of Interconnection

AA1-123 will interconnect with the ATSI transmission system along the Highland-Sammis 345kV line.

Cost Summary

The AA1-123 project will be responsible for the following costs:

Description	Total Cost	
Attachment Facilities	$	0
Direct Connection Network Upgrades	$	3,323,300
Non Direct Connection Network Upgrades	$	2,060,400
Allocation for New System Upgrades	$	6,788,600
Contribution for Previously Identified Upgrades	$	0
Total Costs	**$**	**12,172,300**

A. Transmission Owner Facilities Study Summary

1.Description of Project

East Ohio Energy LLC (hereinafter referred to as "Developer") has proposed the addition of 1152 MW of NATURAL GAS generation with 96% (1105 MW) capacity to the Highland-Sammis 345 kV circuit between Highland substation and Sammis substation, approximately 11 miles from Sammis substation. This project is located in eastern Ohio (Ref: "Figure 4").

The generation facility will be located within the AEP (Ohio Power) service territory, and the power would be injected into the **American Transmission Systems, Inc. (ATSI)** 345 kV transmission system at a new three-breaker ring bus-configured switching station (interconnection substation). ATSI is a subsidiary of FirstEnergy (FE) (hereinafter referred to as "Transmission Owner").

The project includes network upgrades/system reinforcements in **Monongahela Power Company**, a FirstEnergy Company (FE), service territory (an Affected Transmission Owner also hereinafter referred to as "Transmission Owner") territory.

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

- If this project plans to go in-service before the system reinforcements are completely built, an Interim Deliverability Study will have to be completed by PJM to assess if there will be any reduced deliverability during that interim period.
- Added line item in Non-Direct Connection (NDC) costs for "Adjust remote relaying settings."
- Added line item for fiber for SCADA communication and Direct Transfer Trip.
- Renamed n4696 due to Lordstown (Z2-028) being complete prior to AA1-123; therefore instead of Highland SS Non-Direct Connection (NDC) work assumed Lordstown (Z2-028) Interconnection Substation work will be needed.
- (Revision 1) Under System Reinforcements, REMOVED language related to Sammis 345kV breakers and Wylie Ridge 138 kV breakers to be replaced as a result of updated Short Circuit Impact results and overload contributions from AA1-123.
- (Revision 1) Under System Reinforcements, ADDED five (5) 345 kV over-duty breaker replacements at Bruce Mansfield Substation (Penn Power) as a result of updated Short Circuit Impact results and overload contributions from AA1-123.
- PJM retooled the Short Circuit Analysis and determined that the following Bruce Mansfield 345kV Breakers are overdutied by the AA1-123 project: B19, B8, B23, B12, B57, B72 (generation owned). The B57 breaker is scheduled to be replaced in 2017 through the existing baseline project B2780 and AA1-123 will be responsible for acceleration costs.
- (Revision 2) Developer has elected Option-to-Build (OTB) for AA1-123 interconnection substation.

3. Interconnection Customer's Submitted Milestone Schedule

Developer's requested Commercial Operation Date (COD) for the generation facility is **November 1, 2020**. Transmission Owner's proposed schedule does match Developer's requested Milestone Schedule. A Project Kickoff meeting must occur by **September 1, 2017** to meet Transmission Owner's Assumed Milestone Schedule listed below.

Developer's Requested Milestone Schedule:

09/15/2019 Initial Back-feed through Project Substation Date
11/01/2020 Project Commercial Operation Date

Transmission Owner's Assumed Milestone Schedule:

09/15/2019 Initial Back-feed through Project Substation Date
11/01/2020 Project Commercial Operation Date

Direct **Connection and Non-Direct Connection Schedule**: in order to meet the Back-feed Date, a proposed twenty-one (21)-month schedule is estimated, from the date of a fully executed Interconnection Construction Service Agreement and Construction Kick-Off Meeting (assumed 9/1/2017 start) to complete the engineering, construction and associated activities, as detailed in the "Direct Connection" and "Non-Direct Connection" sections below.

System Reinforcements Schedule: a proposed nineteen (19)-month schedule is estimated to complete the engineering, construction and associated activities, as detailed in the "System Reinforcements" section below, assuming an Interconnection Construction Service Agreement has been fully-executed, and a Construction Kick-Off Meeting has occurred.

4. Scope of Customer's Work

Direct Connection Facilities

Developer will construct facilities, including the NATURAL GAS generation system and generation step-up (GSU) transformer, and connect to the new 345 kV three-breaker ring bus, via an approximate 3.5 mile 345 kV generation attachment line. Since Developer chose the "Option to Build", it is also responsible for the design, procurement, and construction of the TO-owned, new three (3) breaker, 345 kV ring-bus substation, designated as AA1-123 Interconnection Substation.

Point of Interconnection (POI): the physical point of interconnection will be located within the interconnection substation. The Developer-owned dead-end insulators between Developer-provided generation attachment wire and the Transmission Owner dead-end structure will be defined as the POI (Ref: "Attachment 4").

Developer is required to own, install, and maintain a fully-rated, fault-interrupting circuit breaker on the high-side of each GSU transformer, and also a main breaker between the collector bus and the incoming line disconnect switch.

The direct connection facilities include 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.

Project Scope
It is proposed that the project be connected via a new 345 kV three-breaker ring bus. The new interconnection substation is to be constructed on the Highland-Sammis 345 kV circuit between Highland substation and Sammis substation, approximately 11 miles from Sammis substation. The loop would extend approximately 500 feet. Developer is responsible for constructing all of the facilities on its side of the POI, as shown in the attached one-line diagram, "Attachment 4". Since Developer has selected the "Option to Build," it is also responsible for the design, procurement, and construction of the new, TO-owned, 345 kV three (3)-breaker ring bus substation.

Generator Attachment Line (approximately 4 miles from POI to Project Site) – Developer owned
Assumptions / Notes:

- Recommend 345 kV Attachment Line including installation of OPGW to support fiber communication for transmission line protection between AA1-123 interconnection substation and generation substation.
- Developer will coordinate design and alignment of proposed 345 kV Attachment Line with the Transmission Owner for review of any clearance, right-of-way overlap, or right-of-way encroachment issues with any existing TO-owned transmission line facilities.

Description of Facilities Work Based on "Option to Build"
Transmission Owner Interconnection Substation (Direct Connection)
Developer will design, furnish and install the following for the new three-breaker 345 kV ring bus substation:

Transmission Owner Interconnection Substation – OPTION TO BUILD
[PJM Network Upgrade n**4694**]

Since Developer has chosen the "Option to Build," the interconnection substation shall be built by Developer.

Developer will design, furnish and install the following for the new three-breaker 345 kV ring bus substation:

- Three (3) 345 kV, 3000 ampere, 63 kA interrupting power circuit breakers with a thirty (30)-year warranty (transferrable/assignable to Transmission Owner)
- Six (6) 345 kV, 3000 ampere, three-pole, manually-operated, group disconnect switches
- Three (3) 345 kV, 3000 ampere, three-pole, motor-operated, disconnect switches
- Nine (9) surge arresters for application on a 345 kV system
- Nine (9) 345 kV capacitor voltage transformers for relaying

- Station Service – primary and a backup station power supply with automatic transfer. This will consist of the following sources:
    - Primary: One (1) 345 kV power voltage transformer
    - Backup: Feed from the local utility company distribution feeder (cost & schedule not included herein)
- Three (3) 345 kV transmission line termination structures
- 345 kV bus and conductor with associated structures
- Prefabricated building with battery and charger, including all Transmission Owner relaying and controls per the Protection Requirements (provided as Attachment "A"). Dimensional size of control building to be determined by Transmission Owner.
- Relays, controls, SCADA RTU and wiring.
- Foundations for the equipment listed above.
- Substation fencing, cable trench & conduit system, ground grid and stoning.
- New facilities shall follow Transmission Owner security standards. Developer to contact Transmission Owner with preliminary substation component and fence design for security design and equipment details.

Assumptions / Notes:

- Developer will acquire adequate land size to accommodate the Transmission Owner interconnection substation, transmission line, and access road, including assigning easement access and/or property rights upon transfer of operation. Transmission Owner did not perform an evaluation to determine if Developer has secured an adequate amount of land for the interconnection substation.
- Developer chose the "Option to Build" and shall design and construct new interconnection substation to Transmission Owner specifications and follow Transmission Owner's *Approved Vendors and Contractors* document located on the PJM website.
- Developer will acquire all applicable environmental permits and install all storm water management measures per site development requirements.
- Developer is responsible to make all arrangements for backup station service for the interconnection substation from the local utility company.
- In order to meet the requested Back-feed Date of 09/15/2019, the exact substation site, pull-off structure locations, and structure details (for connection to the transmission line loops) are required from Developer, no later than 03/01/2018 (i.e. a minimum eighteen (18)-month lead-time from Back-feed Date). Delays in provision of substation site details will affect the schedule.
- Developer will coordinate with the Transmission Owner on the pre-energization checklist, which includes all equipment and relay function testing and commissioning requirements, at least 100-days prior to final (Back-feed) energization and transfer of operation.
- Due to system outage limitations during the months June through September, Developer should target 06/01/2019 for substantial completion of OTB interconnection substation and interconnection of the

345 kV loop line. At this point, transfer of operational control to Transmission Owner shall occur and allow OTB schedule to continue for three (3) months and allow final testing and commissioning of remaining elements within the AA1-123 Interconnection substation.

5. Description of Facilities Included in the Facilities Study

Project Scope

Direct Connection Facilities

1. Engineering Oversight & Commissioning for the "Option to Build" AA1-123 345kV three breaker ring bus substation (PJM Network Upgrade n4694)
2. Highland-Sammis 345kV Line Loop to three breaker ring bus substation. (PJM Network Upgrade Number n4695)

Non-Direct Connection Facilities

1. Protection changes at Sammis substation (PJM Network Upgrade Number n4697)
2. Protection changes at Lordstown (Z2-028) Interconnection Substation (PJM Network Upgrade Number n4696)
3. Adjust Remote Relay Settings at Bluebell, Bruce Mansfield, Evergreen, Glenwillow, GM Lordstown, Hanna, Highland, Hoytdale, Mahoningside, Newton Falls, Niles, Salt Springs, Shenango, Star, Toronto, and Lordstown (Z2-028) substations. (PJM Network Upgrade Number n5057)
4. Install 48 count OPGW fiber optic cable from Sammis substation to the AA1-123 interconnection substation, approximately 11 miles (PJM Network Upgrade Number n5056)
5. Replace the following 345 Circuit Breakers at Bruce Mansfield Substation: B19, B8, B23, B12, B57, B72 (generation owned)- (PJM Network Upgrade Number n4338.2, n4338.3, n4339.1, n4339.2, & n4340.1). The B57 breaker is scheduled to be replaced in 2017 through the existing baseline project B2780.

6. 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 2016 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 or not this project meets the eligibility requirements of IRS Notice 88-129.

Description	NUN	Estimated Cost	Tax (if applicable)
Direct Connection Facilities			
Project Management, Commissioning, Environmental, Forestry, Real Estate, ROW, SCADA, Metering, and Security for the 345kV three breaker ring bus substation for AA1-123 generation interconnection.	n4694	$ 552,100	$ 73,700
Highland-Sammis 345kV, Loop to 3-Bkr	n4695	$ 2,771,200	$ 369,200

Description	NUN	Estimated Cost	Tax (if applicable)
Ring Bus for PJM AA1-123. Install a loop, approx. 500' in length, to a new 345kV 3-breaker ring bus substation.			
Non-Direct Connection Facilities			
Sammis SS. Upgrade relaying on the 345kV AA1-123 Interconnect (former Highland) line.	n4697	$ 236,400	$ 31,500
Lordstown (Z2-028) Interconnect SS. Update line name due to AA1-123 Interconnect Substation on all drawings and nameplates.	n4696	$ 26,600	$ 3,600
Adjust Remote Relay Settings at Bluebell, Bruce Mansfield, Evergreen, Glenwillow, GM Lordstown, Hanna, Highland, Hoytdale, Mahoningside, Newton Falls, Niles, Salt Springs, Shenango, Star, Toronto, and Lordstown (Z2-028) substations.	n5057	$ 150,900	$ 19,200
Sammis - AA1-123 Interconnection SS. Construct a 48 count OPGW fiber optic cable from Sammis substation to the AA1-123 interconnection substation, approximately 11 miles. Extend underground ADSS fiber tail into both AA1-123 and Sammis substations.	n5056	$ 1,646,500	$ 219,400
Replace 345kV Circuit Breakers at Bruce Mansfield Substation and associated disconnect switches: Transmission Owned CB's: B19, B8, B23, B12, B57. Generation Owned CB: B72.	n4338.2, n4338.3, n4339.1, n4339.2, n4340.1	$ 6,788,600	$ 862,600
Total Estimated Costs		**$ 12,172,300**	**$ 1,579,100**

Transmission Lines ("LN") & Substations ("SS) – New/Upgraded

* Any cyber and/or physical security requirements that may be required for this project based on the latest compliance requirements have not yet been confirmed. Scope and cost estimates will be determined and provided as soon as they become available.

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

A proposed twenty-one (21)-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. Construction cannot begin until after all applicable permits and/or easements have been obtained.

Activity	Start Month	End Month
Preliminary Engineering	1	2
Permits & Real Estate	8	14
Detailed Engineering	3	17
Equipment Procurement - Delivery	12	17
Below Grade Construction	12	17
Above Grade Construction	15	21
Testing & Commissioning	18	21

System Reinforcements Schedule: A proposed nineteen (19)-month System Reinforcements schedule is estimated to complete all of the engineering, construction and associated activities, listed below, assuming an Interconnection Construction Service Agreement has been fully-executed, and a Construction Kick-Off Meeting has occurred. The schedule duration is due to the sequencing of line outages; some of the lines cannot be de-energized concurrently. 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. Construction cannot begin until after all applicable permits and/or easements have been obtained.

B. Transmission Owner Facilities Study Results

1.Transmission Lines – New

Description of Facilities Work:
Facilities Work to be constructed by Transmission Owner:

- **Direct Connection**
  Highland (Lordstown)-Sammis 345 Line Loop
  [PJM Network Upgrade n**4695**]

Transmission Owner will sectionalize the existing Highland (Lordstown)-Sammis 345 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 between Transmission Owner structures 40467 and 40469 on the Highland (Lordstown)-Sammis 345 kV line adjacent to the existing 345 kV line right-of-way (See "Figure 2") and the dead-end structures will each be within 500 ft. of the existing transmission line. 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.

Assumptions:

General Assumptions:

- Install a loop, approx. 500' in length, to a new 345kV 3-breaker ring bus substation.
- It is assumed that the substation dead-end structures will be located approx. 500 ft. east of the existing 345kV circuit between structures 40467 and 40469. This estimate assumes that the 345kV circuit will cross over the adjacent 138kV circuit. See "Engineering Assumptions" for a list of assumptions.
- Schedule is based on no outage issues or siting/permitting issues.
- In order to meet an **09/15/2019** Back-feed Date, transmission line loop engineering must begin no later than **03/01/2018**. At that time, Transmission Owner Engineering will require the exact substation location and layout details.

Engineering Assumptions:

1. It is assumed that the loop point is located between structures 40467 and 40469.
2. Install two (2) single-circuit, single-pole tangent steel dead-end structures with concrete foundations for lowering the adjacent double-circuit 138kV line. Shield wire will be dead-ended on these structures and no shield wire will be installed between the two to allow a reduced height for the 345kV crossing. The weight spans on the adjacent towers were compared with the tower loading diagrams and it appears that the towers will be adequate to support the increased weight spans.
3. Install two (2), three (3)-pole steel dead-end structures with concrete foundations for the 345kV loop to the proposed substation. Install strain plates on structures 40467 and 40468 (or 40469) to mitigate insulator swing.
4. Install two (2) single-circuit steel H-Frame structures with concrete foundations for the approximately 500 ft. 345kV loop.

5. The phasing at the substation will allow for the horizontal 345kV circuit configuration to enter the substation without any rolling of the phases.
6. The above scenario was modeled in PLS-CADD with assumed steel pole structures. The steel pole optimization tool was utilized in PLS-Pole and adjusted for a maximum usage of 80% to determine approximate structure weights as a starting point for structure costs. The three-pole 345kV structures are approx. 130 ft. tall with total weights of 110,000 lbs. The 345kV H-frame tangent H-Frames are approx. 90 ft. tall with total weights of 15,000 lbs. This low weight is due to the short span lengths (250 ft. on either side) and reduced tensions (5000 lbs. Cond/2500 lbs. SW). The 138kV dead-end structures are approx. 60 ft. tall with total weights of 16,000 lbs.
7. Foundation costs were assumed and can vary greatly depending on rock depth and soil conditions.

Siting Assumptions:

1. A letter of notification (LON) is required to the OPSB.
2. No significant ecological impacts in the area of the project. Transmission Owner is assuming that it will have no significant field or office ecological work or review.
3. All work occurs within an existing transmission line right-of-way or on the substation 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.
4. No property owner or elected official opposition to the project.

Right-of-Way Assumptions:

1. Developer will acquire all necessary right-of-way and transfer to Transmission Owner.
2. Right-of-way costs are for review of documentation transferring rights to Transmission Owner.

Vegetation Management/Forestry Assumptions:

1. Seasonal USFW clearing restrictions may exist, and could impact costs and schedule.

2.**Transmission Line – Upgrades**

➢ Non-Direct Connection

Fiber Communications

[PJM Network Upgrade n5056]

Per the attached Protection Requirements, Transmission Owner will design, furnish, install and maintain fiber- optic communications between the new **interconnection** substation and the **Sammis** substation to be used for line protection, direct transfer trip (DTT), SCADA and other communications. This will require the installation of approximately eleven (11) miles of new fiber-optic cable on existing transmission facilities. Transmission Owner will construct a 48-count OPGW fiber optic cable from Sammis Substation to the new interconnection substation, extend underground ADSS fiber-tails into both substations, terminate and test. (Ref: "Fiber-Optic Communication Channels" section below)

Assumptions:

- OPGW will use AFL DNO-11095 cable which should be light weight enough not to require any Transmission Line improvements.

3.New Substation/Switchyard Facilities

➢ Direct Connection

Engineering Oversight and Commissioning for Transmission Owner Interconnection Substation

[PJM Network Upgrade n**4694**]

AA1-123 requested Option-to-Build for the three-breaker 345 kV ring bus substation. Ownership will transfer to ATSI (First Energy) prior to connecting ATSI's 345 kV transmission lines into the switchyard. This 345 kV switchyard will be built by AA1-123, and owned and operated by ATSI (First Energy).

4.Upgrades to Substation / Switchyard Facilities

➢ Non-Direct Connection

Sammis Substation

[PJM Network Upgrade n**4697**]

Per the attached Protection Requirements, Transmission Owner will perform the following:

Upgrade relaying on the 345kV AA1-123 Interconnect (former Highland) line. The new line protection communications scheme will be fiber-optic based.

Assumptions:

- Estimate includes fiber costs inside substation fence only.
- Estimate assumes new relay panel will be installed in existing control building.
- Estimate assumes existing SCADA RTU is adequate.
- Estimate assumes existing AC/DC system is adequate for required additions.
- Estimate assumes that existing wave trap, LTU and carrier relaying will be removed (and replaced by new fiber-optic based relaying).
- Estimate assumes all control cables out to the yard will be re-used and that all relaying modifications will take place inside the control building.

➢ Non-Direct Connection

Adjust Remote Relay Settings at Bluebell, Bruce Mansfield, Evergreen, Glenwillow, GM Lordstown, Hanna, Highland, Hoytdale, Mahoningside, Newton Falls, Niles, Salt Springs, Shenango, Star, Toronto and Lordstown (Z2-028) substations.
[PJM Network Upgrade n5057]

Assumptions:

- Remote relay settings may need adjusted at Bluebell, Bruce Mansfield, Evergreen, Glenwillow, GM Lordstown, Hanna, Highland, Hoytdale, Mahoningside, Newton Falls, Niles, Salt Springs, Shenango, Star, Toronto, and Lordstown (Z2-028) substations but not necessarily limited to these substations.

➢ Non-Direct Connection

Lordstown (Z2-028) Interconnection Substation
[PJM Network Upgrade n4696]

Transmission Owner will update line name due to AA1-123 Interconnect Substation on all drawings and nameplates.

Assumptions:

- Assumed Project Lordstown (Z2-028) interconnection substation has been built.

Detailed Protection Requirements are provided as "Attachment 2."

System Reinforcements:

➢ Non-Direct Connection

Bruce Mansfield Substation – replace six (6) 345 kV circuit breakers and associated ten (10) 345 kV disconnect switches.
[PJM Network Upgrades n4338.2, n4338.3, n4339.1, n4339.2, & n4340.1]

A proposed ninteen (19)-month **System Reinforcements** schedule is estimated to complete all of the engineering, construction and associated activities, listed below, assuming an Interconnection Construction Service Agreement has been fully-executed, and a Construction Kick-Off Meeting has occurred. The schedule duration is due to the sequencing of line outages; some of the lines cannot be de-energized concurrently. 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. Construction cannot begin until after all applicable permits and/or easements have been obtained.

Transmission Owner will replace five (5) 345 kV, 63 kA-rated circuit breakers with 80 kA-rated circuit breakers, and associated ten (10) 345 kV GOAB disconnect switches. The B57 breaker is scheduled to be replaced in 2017 through the existing baseline project B2780.

Generation Owner will replace one (1) 345 kV, 63 kA-rated circuit breaker with an 80 kA-rated circuit breaker and one associated 345 kV Disconnect Switch.

Total Estimated Costs of Transmission Owner Facilities for System Reinforcements:

#	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost	AA1-123 Allocation
1	B.MNSFLD 345.kV GEN NO 2(B19)	Replace with an 80kV rated circuit breaker.	N4338.2	**$ 1,357,720**	**$ 1,357,720**
2	B.MNSFLD 345.kV GEN NO 3-(B8)	Replace with an 80kV rated circuit breaker.	N4338.3	**$ 1,357,720**	**$ 1,357,720**
3	B.MNSFLD 345.kV GEN2-HAN(B23)	Replace with an 80kV rated circuit breaker.	N4339.1	**$ 1,357,720**	**$ 1,357,720**
4	B.MNSFLD 345.kV GEN3-S. (B12)	Replace with an 80kV rated circuit breaker.	N4339.2	**$ 1,357,720**	**$ 1,357,720**
5	B.MNSFLD 345.kV GLEN-N.B(B57)	Replace with an 80kV rated circuit breaker. This breaker will be replaced in 2017 through a baseline project B2780	B2780	**$ 1,357,720**	**$ 0**
6	B.MNSFLD 345.kV GenOwned(B72)	Replace with an 80kV rated circuit breaker.	N4340.1	**$ 1,357,720**	**$ 1,357,720**
				Total New Network Upgrades	**$6,788,600**

Schedule:

A proposed twenty-one (21) month schedule is estimated to complete the engineering, construction and the associated activities, assuming an Interconnection Construction Service Agreement has been fully-executed, and a Construction Kick-Off Meeting has occurred. 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. Construction cannot begin until after all applicable permits and/or easements have been obtained.

- Start Date: **05/01/2017**
- Projected ISD: 1**2/01/2018**

Assumptions:

- Site visit was conducted, new breaker foundations are required.
- Estimate assumes existing conduit and cable will be reused via junction box.
- Estimate assumes existing breaker relaying will be reused.
- Estimate assumes new AC/DC systems are required for additions.
- Estimate assumes new foundations and steel are needed for switches.
- Estimate assumes a new ground grid will be needed throughout entire substation.
- Estimate assumes a most likely scenario pending a fault study analysis. All equipment that does not meet the criteria of analysis will be replaced.

5.**Metering & Communications**

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.

Assumed SCADA work needed at three substations: interconnection, Highland (or Lordstown), and Sammis.

Note that fiber-optic communications are required for SCADA transport. Network transport for SCADA will be accomplished via MPLS over fiber-optic cable. MPLS connectivity will be direct to Sammis substation. It is assumed that the fiber-optic cable installed for protective relaying (Ref: "Fiber-Optic Communication Channels" section below) will also be used for SCADA transport, and that no additional cables will be required.

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 the **Lordstown (Z2-028) interconnection** (or Highland substation) will be via Power Line Carrier (PLC).

Communications for transmission line protection between the new interconnection substation, and the **Sammis** substation will be via fiber-optics (Ref: "Fiber-Optic Communication Channels" section below).

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

Fiber-Optic Communication Channels

Transmission Owner responsibilities:

> Per the attached Protection Requirements (Ref: Attachment 2), Transmission Owner will design, provide, install, own and maintain a fiber-optic communications cable between the new **interconnection** substation, and **Sammis** substation. A minimum twelve (12) fiber-optic strands required for primary relaying, and a minimum of twelve (12) fiber-optic strands for backup relaying, for protection schemes to obtain high-speed tripping capability for any fault within the zone of protection. Additional fiber-optic strands in the cable will be used for SCADA transport. Transmission Owner will construct a 48-count OPGW fiber-optic cable from **Sammis** Substation to the new **interconnection** Substation, extend underground ADSS fiber-optic tails into both **Sammis** and new **interconnection** substations, terminate and test. Work includes two railroad crossings and various waterway crossings including the Yellow Creek.

Developer responsibilities:

Per the attached Protection Requirements (Ref: Attachment 2), Developer will design, provide, install, own and maintain dual fiber-optic communications cables, on separate paths, between the new **interconnection** substation and the **generation** (collector) substation. Minimum of twelve (12) fiber strands per cable, separate primary and backup fiber cables required. Developer is responsible for obtaining and maintaining all associated Rights-of-Way (ROW), Easements, and Permits for its fiber-optic cables.

As part of OTB, Developer will install two (2) short sections of TO-owned fiber-optic cable, from Developer's fiber-optic demarcation structure at the interconnection substation to the control house, and Transmission Owner will make the associated fiber-optic cable terminations.

6.Environmental, Real Estate and Permitting Issues

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

- Environmental permitting, Real Estate acquisition, and Ohio Power Siting Board (OPSB) notification durations vary, some up to twelve (12) months after preliminary engineering is completed to provide the required information.
- 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 Developer will be responsible for The all environmental surveys, permits, approvals and plans with federal, state, and/or local agencies.
- Since Developer chose the "Option to Build," Developer will provide copies of all relative environmental permits and other necessary approvals to Transmission Owner before Transmission Owner accepts the interconnection substation facilities.

- Developer 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.
- 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.
- If Developer owns the project property, in fee title, Transmission Owner MAY consider acceptance of an exclusive perpetual substation easement, together with permanent access rights to and from the substation, as well as a perpetual easement for any transmission lines to the substation.
- If Developer leases the project property, Transmission Owner MAY consider acceptance of an exclusive perpetual substation easement, 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 for AA1-123 interconnection substation and 345 kV transmission line loop 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 may involve Ohio Power Siting Board (OPSB) 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:

- 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 eastern-side of the transmission corridor (see "Figure 3").
- 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.
- 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.
- Developer is responsible to design, build, own, and maintain the 345 kV generation attachment line between the new generation substation and Transmission Owner's designated substation dead-end structure at the interconnection substation (ref: Figure 1).
- Developer is responsible to obtain and maintain all associated Rights-of-Way (ROW), Easements, and Permits for its overhead 345 KV generation attachment line between the new generation substation and Transmission Owner's designated substation dead-end structure at the interconnection substation (ref: Figure 1).
- Developer shall maintain adequate clearances for its 345 kV generation attachment line from Transmission Owner's transmission lines. It is assumed Developer's 345 kV generation attachment line will not cross Transmission Owner transmission lines. If Developer's line route changes, causing it to cross Transmission Owner transmission lines, 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 it's determined that Transmission Owner needs to alter its lines to facilitate adequate clearances from Developer's line, Developer would be responsible for the associated costs and schedule delay (not included herein).
- Transmission Owner will make the terminations of Developer's generation attachment line to the designated substation dead-end structure inside the interconnection substation fence. Developer will provide the line termination materials.
- Based on the site plan submitted by Developer, it is assumed Developer will cross under Transmission Owner's Boardman-Toronto 138 kV line, between the generation plant and the proposed equipment/material laydown yard, for construction purposes. Transmission Owner assumes no impact and that all required clearances will be maintained. Developer

shall submit crossing plan details, and Transmission Owner must approve same, prior to Developer's construction activities.

- Assumed PJM Project Lordstown (Z2-028) will be in-service before AA1-123. Based on that assumption, changes would not be required at Highland Substation. Specified Lordstown (Z2-028) relaying and transfer trip equipment would already match what would be required for AA1-123. If Lordstown (Z2-028) does not go in-service before AA1-123, relaying and transfer trip equipment would need to be updated at Highland Substation, as detailed in the attached Protection Requirements (Attachment 2). Costs and schedule not included herein.
- Developer is responsible to make all arrangements for electric distribution service from the local utility company (if required) for its generation station. No costs or schedule included herein.

Since Developer chose 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

Transmission Owner will act in an oversight capacity reviewing all OTB design information & site construction. Developer will coordinate with the Transmission Owner on the pre-energization checklist for the OTB interconnection substation, which includes all equipment, relay function testing and commissioning requirements, **at least 100-days prior** to final energization and transfer of operation. Transmission Owner will then coordinate all end-to-end testing between the Interconnection Substation and all remote terminal substations.

7.Summary of Results of Study

The following table summarizes the total estimated costs according to FERC criteria. The estimated costs are in 2016 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 or not this project meets the eligibility requirements of IRS Notice 88-129.

Description	Direct Labor	Direct Material	Indirect Labor	Indirect Materials
Direct Connection Facilities				
Project Management,	$ 435,400	$ 45,400	$ 69,800	$ 1,500

Description	Direct Labor	Direct Material	Indirect Labor	Indirect Materials
Commissioning, Environmental, Forestry, Real Estate, ROW, SCADA, Metering, and Security for the 345kV three breaker ring bus substation for AA1-123 generation interconnection.				
Highland-Sammis 345kV, Loop to 3-Bkr Ring Bus for PJM AA1-123. Install a loop, approx. 500' in length, to a new 345kV 3-breaker ring bus substation.	$ 1,778,100	$ 685,300	$ 285,100	$ 22,700
Non-Direct Connection Facilities				
Sammis SS. Upgrade relaying on the 345kV AA1-123 Interconnect (former Highland) line.	$ 164,700	$ 43,900	$ 26,400	$ 1,400
Lordstown (Z2-028) Interconnect SS. Update line name due to AA1-123 Interconnect Substation on all drawings and nameplates.	$ 22,900	$ 0	$ 3,700	$ 0
Adjust Remote Relay Settings at Bluebell, Bruce Mansfield, Evergreen, Glenwillow, GM Lordstown, Hanna, Highland, Hoytdale, Mahoningside, Newton Falls, Niles, Salt Springs, Shenango, Star, Toronto, and Lordstown (Z2-028) substations.	$ 140,000	$ 0	$ 10,900	$ 0
Sammis - AA1-123 Interconnection SS. Construct a 48 count OPGW fiber optic cable from Sammis substation to the AA1-123 interconnection substation, approximately 11 miles. Extend underground ADSS fiber tail into both AA1-123 and Sammis substations.	$ 1,336,400	$ 92,800	$ 214,200	$ 3,100
Replace 345kV Circuit Breakers and associated disconnect switches at Bruce Mansfield Substation: Transmission Owned: B19, B8, B23, B12, B57. Generation Owned: B72	$ 3,121,300	$ 3,191,700	$ 238,500	$ 237,100
Total	**$ 6,998,800**	**$ 4,059,100**	**$ 848,600**	**$ 265,800**

A proposed twenty-one (21)-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. Construction cannot begin until after all applicable permits and/or easements have been obtained.

Activity	Start Month	End Month
Preliminary Engineering	1	2
Permits & Real Estate	8	14
Detailed Engineering	3	17
Equipment Procurement - Delivery	12	17
Below Grade Construction	12	17
Above Grade Construction	15	21
Testing & Commissioning	18	21

Attachment 1. Generation Connection Requirements

The proposed interconnection facilities must be designed in accordance with the Transmission Owner's *Requirements for Transmission Connected Facilities* document located at either of the following links:

www.firstenergycorp.com/feconnect

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

Since Developer chose the "Option to Build," Developer will also be responsible for following Transmission Owner's Approved Vendors and Contractors document located at the PJM site (second link above).

The following is an excerpt taken from Transmission Owner's *Requirements for Transmission Connected Facilities* document:

> *The generation facility's minimum requirement shall be the provision of a reactive power capability sufficient to maintain a composite power delivery at continuous rated power output for the facility at either the POI or generator terminals as specified in the table below. The power factors range between 0.95 leading (absorbing VARs) and 0.90 lagging (producing VARs) as defined by the table. 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.*
>
> *If the connection studies show the need for a wind-powered or other nonsynchronous generating facility to provide reactive support to the transmission system, the minimum requirement shall be the provision of a reactive power capability sufficient to maintain a composite power delivery at continuous rated power output for the facility at the POI at a power factor as defined in the table. 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 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 Terminals
Synchronous	Increase	<= 20 MW	1.0 (Unity) to 0.90 lagging	Point of Interconnection
Wind or Non-Synchronous	Increase	ALL	1.0 (Unity) to 0.95 lagging	Point of Interconnection

> *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:	1210 feet
• Isokeraunic level:	40
• Maximum ambient temperature:	40 degrees C
• Minimum ambient temperature:	-40 degrees C
• Maximum conductor operating temperature:	Contact Transmission Owner
• Wind Loading (round shapes):	Per ASCE 7-98, per Fig. 6-1 depending on location
• Ice loading – Substations (no wind):	25 mm
• Seismic zone:	Per ASCE 7-98, per Fig. 9.4.1.1(a) and (b). Equipment qualification per IEEE 693-97

Voltage and Current Ratings

• Nominal phase-to-phase:	345 kV
• Maximum phase-to-phase:	362 kV
• Basic impulse level (BIL):	1300 kV
• Maximum continuous current carrying capacity:	3000 A
• Design fault current:	63 kA
• Single Contingency (breaker failure) clearing time:	30 cycles

Clearances and Spacing

- Recommended rigid bus center-to-center phase spacing: 174”
- Minimum phase-to-phase, metal-to-metal distance: 119”
- Recommended phase-to-ground: 106”
- Minimum phase-to-ground: 104”
- Low bus height above top of foundations (match existing): 20’-0”
- High bus height above top of foundations (match existing): 34’-0”
- Minimum vertical clearance from live parts to grade: 17’-2”
- Minimum horizontal clearance from live parts: 11’-8”
- Minimum conductor clearance above roads in switchyard: 30’-0”
- Minimum bottom of insulator to top of foundation: 8’-6”

Attachment 2. Detailed Protection Requirements

Not to be used for construction

Short Circuit Analysis

Short Circuit Values

The preliminary 345kV fault values for the AA1-123 Ring Bus (3 breaker) interconnection location with all new generation in service are:

Three phase = 43.5kA
Single line to ground = 42.1kA
Z1= (0.067 + j 0.379)%
Z0= (0.050 + j 0.424)%

The 345kV fault values for the AA1-123 Ring Bus interconnection location with all new generation out of service are:

Three phase = 36.0kA
Single line to ground = 29.1kA
Z1= (0.034 + j 0.463)%
Z0= (0.157 + j 0.785)%

Protection Requirements

AA1-123 345kV Interconnecting Substation

345kV Transmission Line Protection

- Highland/ Lordstown (Z2-028) line exit
  - Primary relay: SEL-421-5 directional comparison blocking line relaying operating over power line carrier (PLC) communications
    - Ametek/Pulsar UPLC on/off carrier set for use with directional comparison blocking line relaying.
    - CCVTs with carrier accessories in one phase and at least two secondary windings, line tuner, and wavetrap for use with PLC relaying and direct transfer trip
  - Backup relay: SEL-421-5 non-pilot direct tripping backup relay
  - Transfer trip: Dual Ametek/Pulsar UPLC FSK TX/RX carrier sets for use with direct transfer trip

- Sammis line exit
  - Primary relay: SEL-411L relay with line current differential protection over fiber
  - Backup relay: SEL-411L relay with line current differential protection over fiber
  - Fiber-optic cable(s), with dedicated fibers, for use with the SEL-411L primary and backup relaying

        - Minimum of twelve (12) dedicated fibers **each** for primary and backup relays (total 24)
    - Separate cables and routing not required

- AA1-123 Plant line exit
    - Primary relay: SEL-411L relay with line current differential protection over fiber
    - Backup relay: SEL-411L relay with line current differential protection over fiber
    - Dual, independent fiber-optic cable paths, with dedicated fibers, for use with the SEL-411L primary and backup relaying
        - Minimum of twelve (12) fibers (each cable), separate primary and backup fiber cables

345kV Breaker Failure to Trip Protection

- AA1-123 345kV Breaker Failure to Trip Relaying
  New SEL-501 breaker failure to trip relaying (1 on each of three 345kV breakers). The breaker failure to trip relaying on each Highland/ Lordstown (Z2-028) line exit breaker shall initiate direct transfer trip to Highland/Lordstown (Z2-028) 028 over power line carrier (UPLC). The breaker failure to trip relaying on each Sammis line exit breaker shall initiate direct transfer trip to Sammis via the SEL-411L primary and backup line relays (fiber). The breaker failure to trip relaying on each AA1-123 Plant line exit breaker shall initiate direct transfer trip to AA1-123 Plant via the SEL-411L primary and backup line relays (fiber).

AA1-123 Plant 345kV

345kV Transmission Line Protection

- AA1-123 Interconnecting Station line exit
    - Primary relay: SEL-411L relay with line current differential protection over fiber
    - Backup relay: SEL-411L relay with line current differential protection over fiber
    - Synch check for manual/SCADA close on the interconnecting line to be done at AA1-123 Generating Station

345kV Breaker Failure to Trip Protection

- 345kV Breaker Failure to Trip Relaying
    - SEL-352-2 breaker failure to trip relaying on each of four 345kV breakers. The breaker failure to trip relaying on the AA1-123 Interconnecting Station line exit breakers shall initiate direct transfer trip via the SEL-411L primary and backup line relays (fiber).

345kV Bus Protection

- 345kV Bus Differential Relaying
    - Dual bus differential protection shall be required between the AA1-123 line exit breaker and the CTG/bus breakers.

345kV GSU Transformer Protection @ AA1-123 Generating Station (minimum protection to meet Transmission Owner requirements)

- Dual, independent transformer differential protection schemes (Transformer and Overall)
- Transformer neutral time overcurrent relay

Developer shall provide utility-grade relays for protection of the Transmission Owner Transmission System. Transmission Owner shall approve all relays specified for the protection of the Transmission Owner Transmission System, including time delay and auxiliary relays. Relay operation for any of the listed functions that are required shall initiate immediate separation of the parallel generation from the Transmission Owner Transmission System:

Relay	**Function**
Frequency	To detect underfrequency and overfrequency operation.
Overvoltage	To detect overvoltage operation.
Undervoltage	To detect undervoltage operation.
Ground Fault Detector	To detect a circuit ground on the Transmission Owner Transmission System.
Phase Fault Detector	To detect phase to phase faults on the Transmission Owner Transmission System.
Transfer Trip Receiver	To provide tripping logic to the generation owner for isolation of the generation upon opening of the Transmission Owner supply circuits.
Directional Power	To detect, under all system conditions, a loss of Transmission Owner primary source. The relay shall be sensitive enough to detect transformer magnetizing current supplied by the generation.

The Interconnection Customer will be required to comply with all Transmission Owner Generation Protection Requirements for Generation Interconnection Customers. The Generation Protection Requirements may be found within Transmission Owner's"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

Transmission Owner System Modifications:

Highland Substation

Note: this report assumes PJM Project Lordstown (Z2-028) will be in-service before AA1-123. Based on that assumption, changes would not be required at Highland Substation. Specified Lordstown (Z2-028) relaying and transfer trip equipment would already match what would be required for AA1-123. If Lordstown (Z2-028) does not go in-service before AA1-123, relaying and transfer trip equipment would need to be updated at Highland Substation, as follows:

345kV Transmission Line Protection

- Primary relay: SEL-421-5 directional comparison blocking line relaying operating over power line carrier (PLC) communications
  - Ametek/Pulsar UPLC on/off carrier set for use with directional comparison blocking line relaying.
  - CCVTs with carrier accessories in one phase and at least two secondary windings, line tuner, and wavetrap for use with PLC relaying and direct transfer trip
- Backup relay: SEL-421-5 non-pilot direct tripping backup relay
- Transfer trip: Dual Ametek/Pulsar UPLC FSK TX/RX carrier sets for use with direct transfer trip

345kV Breaker Failure to Trip Protection

- AA1-123 345kV Breaker Failure to Trip Relaying
  New SEL-501 breaker failure to trip relaying (1 for each 345kV breaker on the AA1-123 Ring Bus line exit). The breaker failure to trip relaying shall initiate direct transfer trip to AA1-123 Ring Bus over power line carrier (UPLC).

Sammis Substation

345kV Transmission Line Protection

- Primary relay: SEL-411L relay with line current differential protection over fiber
- Backup relay: SEL-411L relay with line current differential protection over fiber

345kV Breaker Failure to Trip Protection

- AA1-123 345kV Breaker Failure to Trip Relaying
  Maintain SEL-352 breaker failure to trip relaying. The breaker failure to trip relaying on each AA1-123 Ring Bus line exit breaker shall be modified to initiate direct transfer trip to AA1-123 Ring Bus via the SEL-411L primary and backup line relays (fiber).

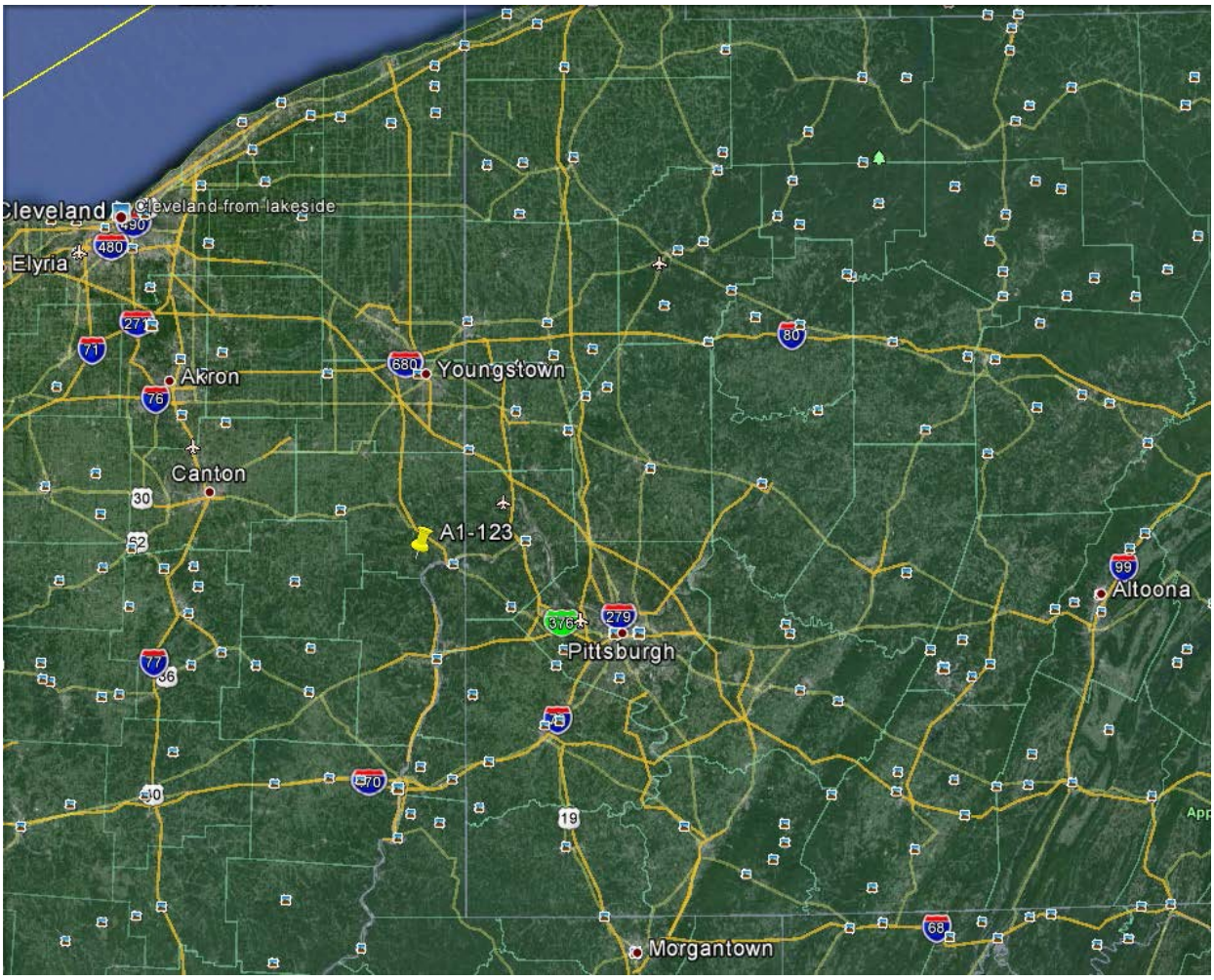
345kV Circuit Breaker Adequacy

- (15) 345kV circuit breakers have been identified by PJM as overdutied with the addition of AA1-123. This would necessitate replacing the existing 63kA breakers with 80kA breakers. Additional design work may be identified as necessary at Sammis (e.g. buswork, ground grid, etc.) due to exceeding 63kA of available short circuit current.

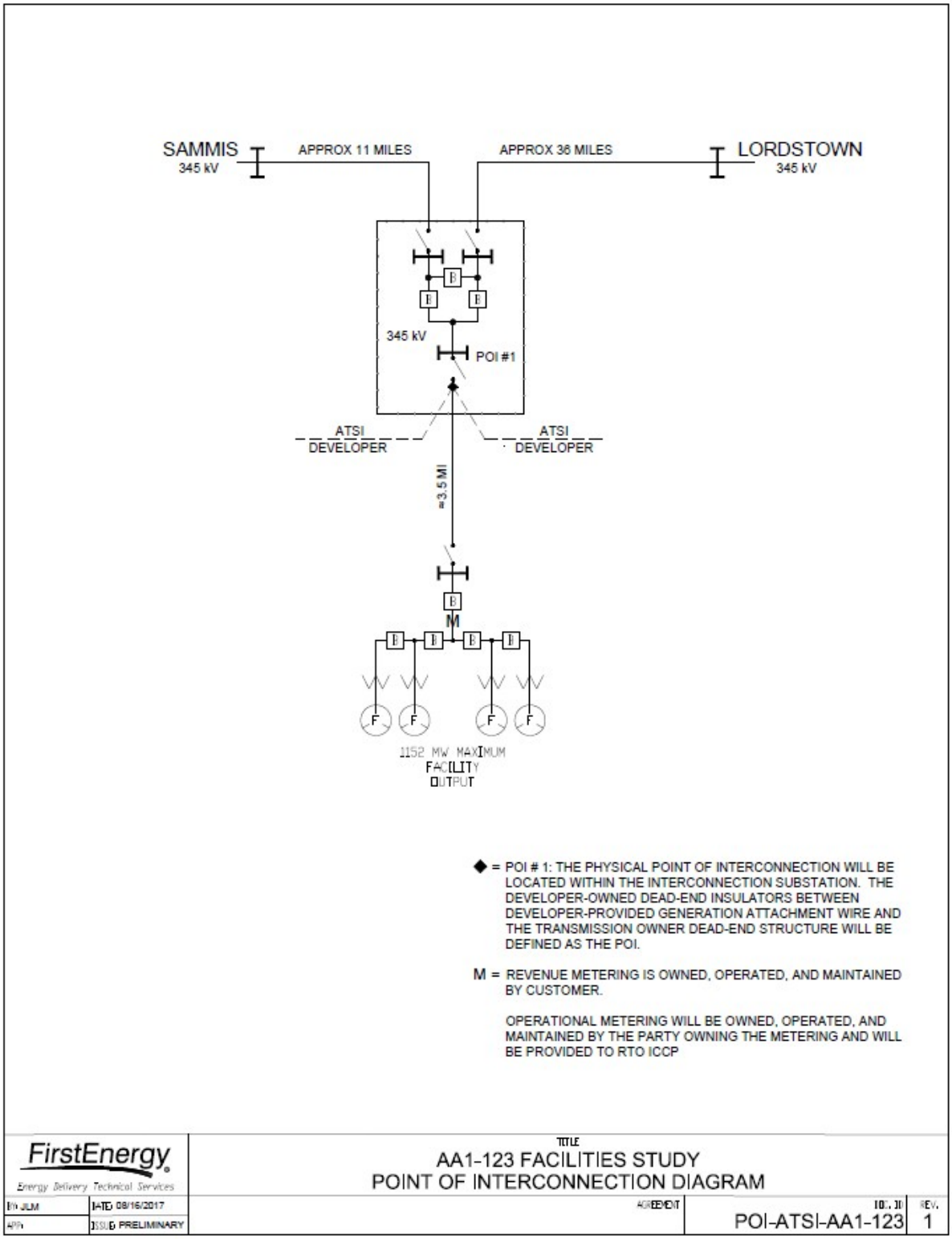
Settings Changes

- Settings changes are possible at, but not limited to, the following Transmission Owner stations:
  - Bluebell
  - Bruce Mansfield
  - Evergreen
  - Glenwillow
  - GM Lordstown
  - Hanna
  - Highland
  - Hoytdale
  - Mahoningside
  - Newton Falls
  - Niles
  - Salt Springs
  - Sammis
  - Shenango
  - Star
  - Toronto
  - Lordstown (Z2-028) Interconnection Substation

Attachment 3. Project Location

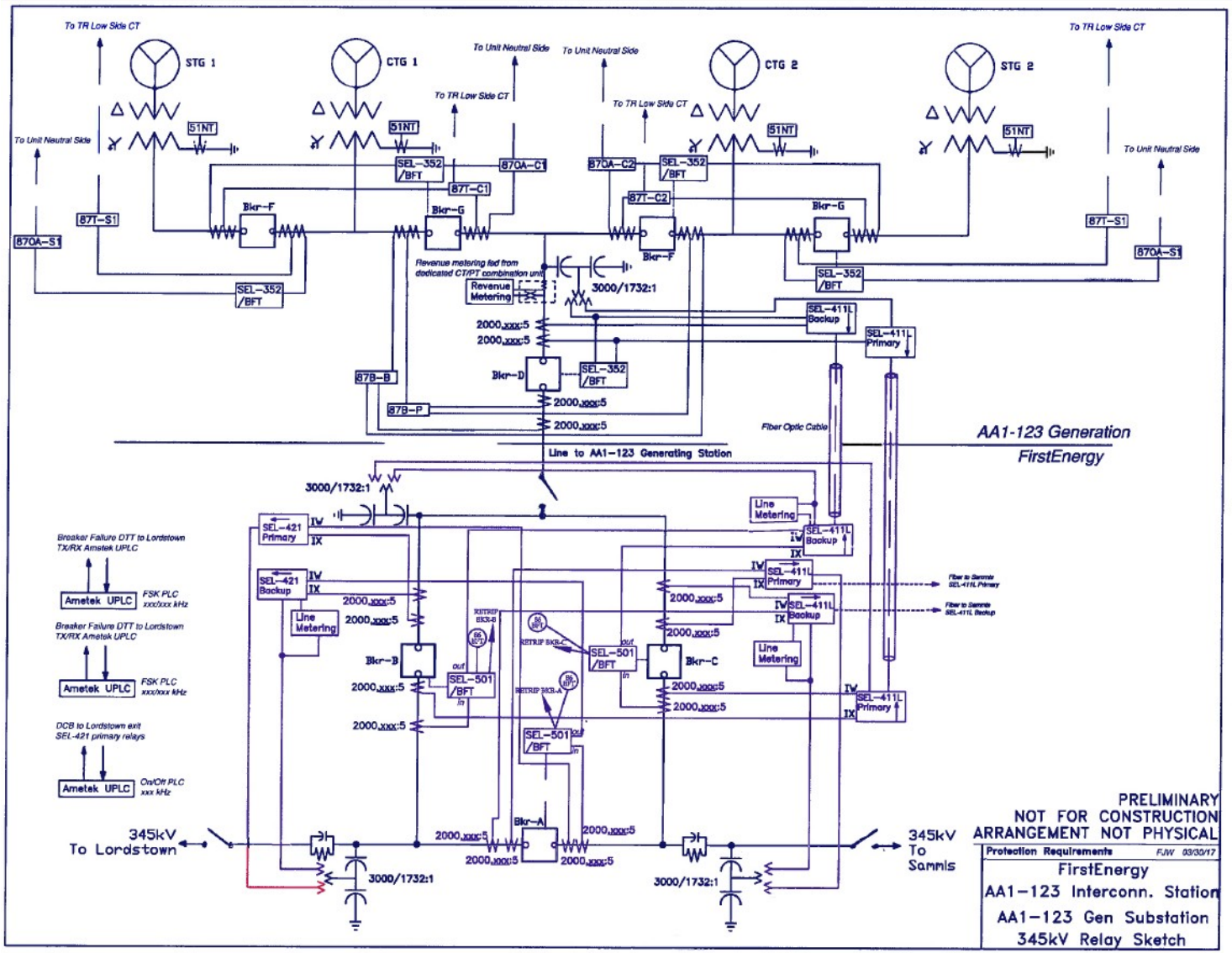


Attachment 4. Single Line Diagram

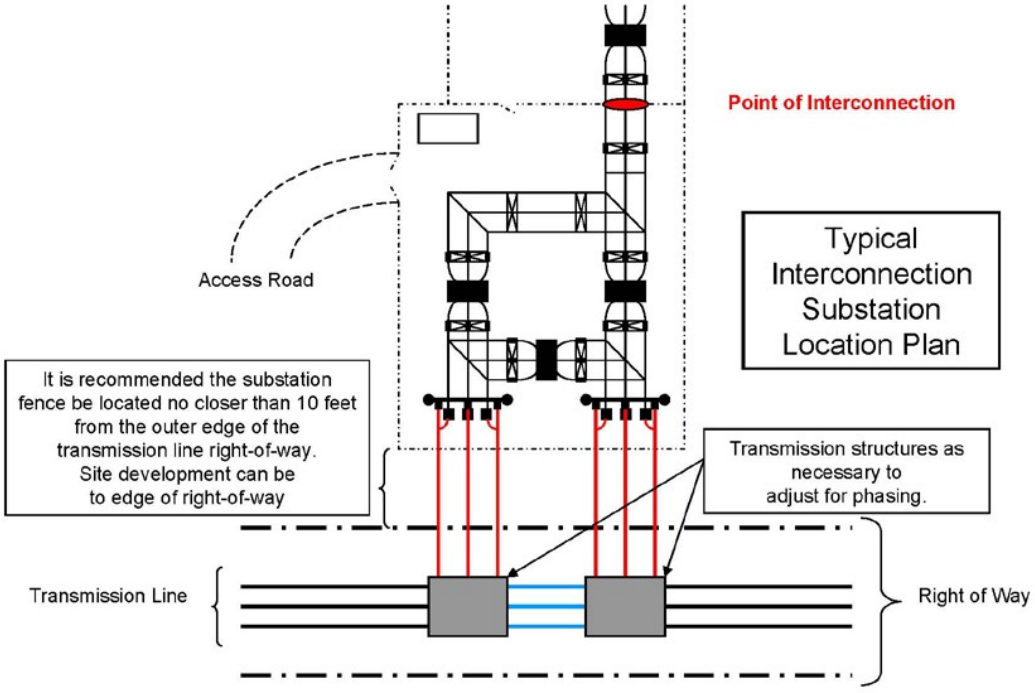


* Note: Diagram does not represent a physical layout. Not to be used for construction.

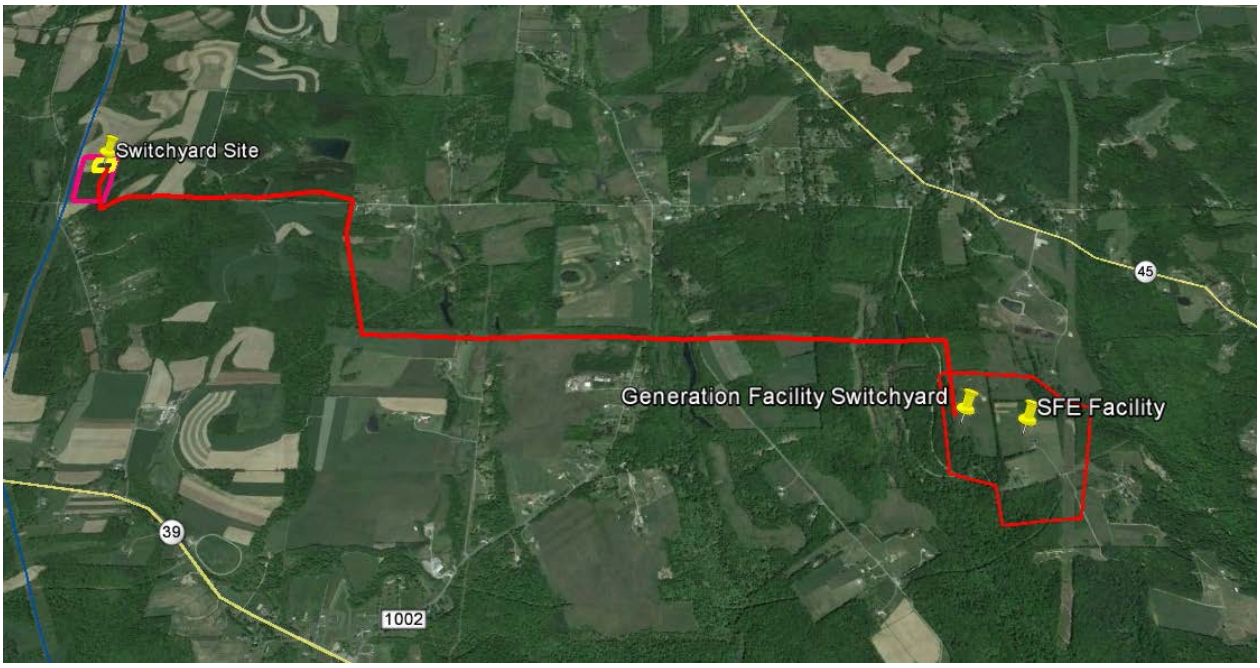
Attachment 5. Relaying One Line Diagram



Attachment 6. Typical Interconnection Substation Location Plan



Attachment 7. Conceptual Site Plan By Developer
With Transmission Owner Notes*



Notes:

- GPS Coordinates: Generation Facility: 40.636008, -80.678315
- AA1-123 Interconnection Substation: 40.652794, -80.733917
- This report assumes that the new interconnection substation will be located adjacent to the Transmission Owner 345 kV line right-of-way and the dead-end structures will each be within one (1) span of the line.
- 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.
- It is assumed Developer will cross under Transmission Owner's Sammis-Pidgeon 138 kV line, between the generation plant and the proposed equipment/material laydown yard, for construction purposes. Transmission Owner assumes no impact and that all required clearances will be maintained. Developer shall submit crossing plan details, and Transmission Owner must approve same, prior to Developer's construction activities.