Generator Interconnection Facilities Study Report

For

PJM Generation Interconnection Request Queue Position AE1-105

"North Longview 500 kV"

August 2022

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Preface

The intent of the Facility Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

In some instances, an Interconnection Customer may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection or merchant transmission upgrade, may also contribute to the need for the same network reinforcement.

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

A. Transmission Owner Facilities Study Summary

1. Description of Project

Mountain State Clean Energy, LLC, (hereinafter referred to as "IC") has proposed a natural gas generating facility located in Monongalia County, West Virginia. The installed facilities for AE1-105 will have a total capability of 1270 MW with 1235 MW of this output being recognized by PJM as capacity. The generation facility will interconnect with West Penn Power, a First Energy Company (FE), hereinafter referred to as "Transmission Owner" (TO), at the existing North Longview substation by installing a new 500 kV breaker to create a four breaker ring bus.

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

The System Impact Study report was updated to remove all required system network upgrades that were in the original report that was posted on the PJM website dated December 2019.

3. Interconnection Customer's Milestone Schedule

IC's requested Commercial Operation Date (COD) for the generation facility is **July 1, 2026**.

Milestone Schedule:

April 1, 2026	Initial Back-feed through Project Substation Date
July 1, 2026	Project Commercial Operation Date

4. Customer's Scope of Work

IC is responsible for all design and construction related to activities on their side of the Point of Interconnection (POI). This includes, but is not limited to, the generation step-up (GSU) transformer, 500 kV (AE1-105) generator lead line and connection to the new 4 breaker ring bus interconnection at North Longview substation.

Point of Interconnection (POI): The POI will be located within the existing North Longview 500 kV substation at a newly built 4 breaker ring bus, where IC-owned 500 kV attachment line conductor will terminate on the insulators on the dead-end takeoff structure and will be defined as the POI.

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

Route selection, line design, and right-of-way acquisition for the IC's facilities are not included in this report and are the responsibility of the IC.

Assumptions / Notes:

- IC will coordinate design and alignment of proposed 500 kV generator lead line with the Transmission Owner for review of any clearance, right-of-way or right-of-way encroachment issues with TO owned facilities.
- IC will coordinate design and construction of proposed 500 kV Lead Line. For these areas, the IC shall provide TO with proposed drawings prior to construction and as-built drawings, confirmed by as-built survey data post-construction.
- Transmission Owner's preference would be to limit interference and avoid transmission line crossings with new 500 kV terminal positions. As a minimum, IC facilities should not encroach within 100 feet of TO centerline at blowout conditions. If IC's line design does not comply with this requirement TO would need to review this area as a special exception.
- Additional costs will be incurred by the IC, if final alignment of the 500 kV generator lead line causes encroachments, changes, or modifications to any existing or relocated TO facilities.
- IC is responsible to make all arrangements for electric distribution service (if required) for its generation station. No costs or schedule are included herein.

5. Description of Facilities Included in the Facilities Study

Attachment Facilities

Transmission Owner will design, furnish and construct the new 500 kV line terminal and take off structure. This work will include, but not be limited to, installation of a 500 kV line exit take-off structure, foundations, disconnect switch and associated equipment to accommodate the termination of the 500 kV generator lead line.

Direct Connection

North Longview 500 kV

Estimated SCADA work at North Longview to support breaker, MOAB, and relay installations. Estimated in-sub fiber run from North Longview control house to developer ran OPGW outside substation.

Non-Direct Connection

North Longview 500 kV

A new 500 kV terminal and breaker will be installed at North Longview substation, converting the existing 3 breaker ring bus to a 4 breaker ring bus to interconnect the AE1-105 natural gas project with the West Penn Power transmission system. The POI will be at the TO-owned dead-end structure inside the substation yard where the generator lead line terminates.

502 Junction Substation

Relay settings will be modified.

Fort Martin Substation

Relay settings will be modified.

Other Work

AE1-105 Customer Substation

Drawings and nameplates will be reviewed and modified.

Metering

Engineering oversight of specification, design, and commissioning of interconnection customer-owned metering. Remote communications checkout. Support setup of new metering in MV90 and Power Billing systems.

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

Description	Total (w/o Tax)	Tax (if applicable)	Total Cost (w/Tax)
Attachment Facilities:	**$ 381,700**	**$ 64,200**	**$ 445,900**
Total Direct Connection (DC) Costs:	**$ 56,800**	**$ 9,600**	**$ 66,400**

Total Non-Direct Connection (NDC) Costs:	**$ 5,679,000**	**$ 939,200**	**$ 6,618,200**
Total Other Costs	**$ 34,900**	**$ 6,000**	**$ 40,900**
New System Upgrades	**$ 0**	**$ 0**	**$ 0**
TOTAL Costs (ALL Categories)	**$ 6,152,400**	**$ 1,019,000**	**$ 7,171,400**

7. Summary of the Schedule for Completion of Work for the Facilities Study

Attachment Facility	*Duration*
AE1-105: Engineering, Procurement, and Construction	17 months

B. Transmission Owner Facilities Study Results

This section describes facilities identified to be installed (attachment facilities), replaced, and/or upgraded (upgrade facilities) by First Energy to accommodate the project. During detailed design and analysis other components may be identified for installation or replacement due to this interconnection.

1. Transmission Lines –New

None

2. Transmission Lines – Upgrade

None

3. New Substation/Switchyard Facilities

None

4. Substation/Switchyard Facility Upgrades

North Longview Substation

- Below Grade
  - Foundations, Conduit and Grounding for New 500kV Terminal Equipment
  - Foundations and Grounding for New 500kV Dead-End Structures
  - Foundations and Grounding for New Bus Supports and CVT Structure
  - Siting, Surveying, Grading, Ground Grid, and Fence for Expansion of New Line Terminal as Indicated on Attached Layout

  - Conduit for fiber connection to customer substation

- Above Grade
  - Install (1) 500kV SF6 Circuit Breaker
  - Install (1) 500kV Breaker MOAB
  - Install (1) 500kV Line MOAB
  - Install (3) 500kV CVTs
  - Install (3) 396kV, 318kV MCOV, Surge Arresters
  - Install (2) 500kV Dead-End Structures
  - One Lot of Rigid Bus, Strain Bus, Insulators, Support Structures
- R&C
  - Install (1) Standard Transmission Line Relaying Panel consisting of: (2) SEL-411L, (1) SEL-451 BFT, and (1) SATEC meter
  - Relay settings changes
- Additional Equipment to be Removed
  - None
- Assumptions
  - Panel will Fit in Existing Control Building
  - Existing AC/DC and SCADA are Sufficient for New Upgrades
  - Relaying will be over Fiber to Customer Location

502 Junction

- Below Grade
  - None
- Above Grade
  - None
- R&C
  - Relay settings changes
- Additional Equipment to be Removed
  - None
- Assumptions
  - None

Fort Martin

- Below Grade
  - None
- Above Grade
  - None
- R&C
  - Relay settings changes
- Additional Equipment to be Removed
  - None
- Assumptions
  - None

AE1-105 Interconnection

- Below Grade
  - None
- Above Grade
  - Review drawings, nameplates, and relay settings
  - Add to HV circuit diagram
- R&C
  - None
- Additional Equipment to be Removed
  - None
- Assumptions
  - None

5. Telecommunications Facilities – Upgrades

IC will design, provide, install, own and maintain a fiber-optic communications cable between the **interconnection** substation, and IC's **generation** (collector) substation. Two (2) fiber-optic channels are required for each generator protection scheme to obtain high-speed tripping capability for any fault within the zone of protection. Should subsequent/additional PJM studies indicate that stability issues exist, the primary and backup relay fiber-optic communication channels must be in separately-routed cable paths and additional fiber-optic connection costs would apply (not included herein).

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

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

6. Metering & Communications

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

The revenue metering system (particularly the revenue metering current transformers) shall be designed to accurately meter the light loads that will occur when the facility is not generating power and only back feeding station service from the Transmission Owner. This may require the use of high accuracy extended range current transformers.

Transmission Owner's Revenue Metering Requirements may be found in the *Requirements for Transmission Connected Facilities* document located at the following links:

www.firstenergycorp.com/feconnect

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

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

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

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

7. Environmental, Real Estate and Permitting

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

- Environmental permitting, Real Estate acquisition, and West Virginia Public Service Commission (WVPSC) notifications vary, some up to twelve (12) months after preliminary engineering is completed to secure the required approvals.
- Assumed IC is to provide all access rights, easements, ROW and permits necessary to complete the Project to the satisfaction of Transmission Owner. Environmental permitting shall encompass all federal, state and local requirements, consultations and agency coordination. Confirmation of meeting all permitting requirements shall be provided to Transmission Owner, prior to start of construction. Following construction and energization, confirmation of permit closeout shall be provided to the satisfaction of Transmission Owner, prior to transfer of ownership. If any of these elements are not included in the final agreement between Transmission Owner and IC, twelve (12)-to-eighteen (18) months should be added to the Project Schedule to secure necessary permits, and additional costs would apply.
- IC is responsible for all property acquisition (including easements/rights-of-way (ROW) for transmission, distribution and communication facilities needed for the generator interconnection.
- All work occurs within an existing transmission line right-of-way or on IC's property with access to all existing structures possible via that property and the right-of- way following established access routes that do not cross wetlands or streams.
- If the IC plans to cross the transmission line right of way with facilities or access roads, please refer to the Transmission Rights-of-Way Restrictions information located at: https://www.firstenergycorp.com/help/safety/real-estate-power-lines/transmission-right-ofway.html#ROWform

8. Summary of Results of Study

Description	Total Cost (w/o Tax)	Tax (if applicable)	Total Cost (w/ Tax)
Attachment Facilities			
Installation of a 500 kV line exit take-off structure, foundations, disconnect switch and associated equipment to accommodate the termination of the 500 kV generator lead line.	$ 381,700	$ 64,200	$ 445,900
Total Attachment Facilities (AF) Costs	**$ 381,700**	**$ 64,200**	**$ 445,900**
Direct Connect Facilities			
Estimated SCADA work at North Longview to support breaker, MOAB, and relay installations. Estimated in-sub fiber run from North Longview control house to developer ran OPGW outside substation.	$ 56,800	$ 9,600	$ 66,400
Total Direct Connect (DC) Costs	**$ 56, 800**	**$ 9,600**	**$ 66,400**
Non-Direct Connect Facilities			
North Longview: Install a new 500kV terminal at North Longview substation.	$ 3,816,300	$ 641,200	$ 4,457,500
Fort Martin: Modify relay settings.	$ 89,500	$ 0	$ 89,500
502 Junction: Modify relay settings.	$ 94,900	$ 16,000	$ 110,900
Project Management: Project Management, Environmental, Real Estate and Right of Way.	$ 1,678,300	$ 282,000	$ 1,960,300
Total Non-Direct Connect (NDC) Costs	**$ 5,679,000**	**$ 939,200**	**$ 6,618,200**
AE1-105 Customer: Modify drawings and nameplates for FE standards.	$ 31,000	$ 5,300	$ 36,300
Metering: Engineering oversight of specification, design, and commissioning of interconnection customer-owned metering. Remote communications checkout. Support setup of new metering in MV90 and Power Billing systems.	$ 3,900	$ 700	$ 4,600

Total Other(O) Costs	**$ 34,900**	**$ 6,000**	**$ 40, 900**
Total AF + DC + NDC+O Costs	**$ 6,152,400**	**$ 1,019,000**	**$ 7,171,400**

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

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

9. Schedules and Assumptions

A proposed **seventeen (17) month Direct Connection** schedule is estimated to complete the engineering, construction and the associated activities, from the date of a fully executed Interconnection Construction Service Agreement and Construction Kick-Off Meeting. This schedule assumes that all issues covered by the "Environmental, Real Estate and Permitting Issues" section of this document are resolved, and outages (typically not granted from June through September) will occur as planned. Construction cannot begin until after all applicable permits and/or easements have been obtained.

17 month Schedule

Activity	Start Month	End Month
Preliminary Engineering	1	3
Siting, Permits & Real Estate	2	11
Detailed Engineering	2	11
Equipment Delivery	11	12
Below Grade Construction – Substation	12	14
Above Grade Construction – Substation	14	16
Testing & Commissioning	17	17

10. ***Information Required for Interconnection Service Agreement***

Work Description	Direct		Indirect		Total Cost
	Labor	**Material**	**Labor**	**Material**	
Installation of a 500 kV line exit take-off structure, foundations, disconnect switch and associated equipment to accommodate the termination of the 500 kV generator lead line.	$ 126,200	$ 196,600	$ 43,700	$ 15,200	$ 381,700
Total Attachment Facilities Cost	**$ 126,200**	**$ 196,600**	**$ 43,700**	**$ 15,200**	**$ 381,700**
Estimated SCADA work at North Longview to support breaker, MOAB, and relay installations. Estimated in-sub fiber run from North Longview control house to developer ran OPGW outside substation. (PJM Network Upgrade Number n8121.1)	$ 38,900	$ 4,100	$ 13,500	$ 300	$ 56,800
Total Direct Connection Cost	**$ 38,900**	**$ 4,100**	**$ 13,500**	**$ 300**	**$ 56,800**
North Longview: Install a new 500kV terminal at North Longview substation. (PJM Network Upgrade Number 8121.2)	$ 1,261,600	$ 1,965,500	$ 436,800	$ 152,400	$ 3,816,300
Fort Martin: Modify relay settings. (PJM Network Upgrade Number 8121.3)	$ 70,500	$ 0	$ 19,000	$ 0	$ 89,500
502 Junction: Modify relay settings. (PJM Network Upgrade Number 8121.4)	$ 70,500	$ 0	$ 24,400	$ 0	$ 94,900
Project Management: Project Management, Environmental, Real Estate and Right of Way.	$ 1,246,700	$ 0	$ 431,600	$ 0	$ 1,678,300
Total Non-Direct Connection Network Upgrades	**$ 2,649,300**	**$ 1,965,500**	**$ 911,800**	**$ 152,400**	**$ 5,679,000**

AE1-105 Customer: Modify drawings and nameplates for FE standards.	$ 23,000	$ 0	$ 8,000	$ 0	$ 31,000
Metering: Engineering oversight of specification, design, and commissioning of interconnection customer-owned metering. Remote communications checkout. Support setup of new metering in MV90 and Power Billing systems.	$ 2,900	$ 0	$ 1,000	$ 0	$ 3,900
Total Other Costs	**$ 25,900**	**$ 0**	**$ 9,000**	**$ 0**	**$ 34,900**
Total Project Costs	**$ 2,840,300**	**$ 2,166,200**	**$ 978,000**	**$ 167,900**	**$ 6,152,400**

Attachment #1: Protection Study

Protection Requirements:

North Longview SS

- New 500kV breaker
- New 500kV SCADA controlled line switch
- Dedicated fiber optic channels are required for primary and backup line protection and transfer trip between North Longview and the AE1-105 substation. If a stability study determines that dual high-speed tripping schemes are required, the two fiber channels must be in separately routed paths
- Dual SEL-411L Standard BES line protection for primary and backup line differential schemes communicating over fiber channels for interconnection tie line to generator collector substation.
- SEL-451 failure to trip relay
- (3) CVTs on the new line terminal for AE1-105
- Add voltage, current, and breaker status inputs from the new line into the existing DFR
- Perform a relay coordination study and revise settings on existing relays at North Longview as necessary

Generator SS

- Primary and Backup SEL-411L relays for line differential protection over dedicated fiber between the Generator SS and FE's North Longview SS.
- The GSUs connecting to the FE system shall be grounded-wye / delta, with the grounded-wye on the utility-side, and delta on the generator side.
- The generator owner (GO) is to design their protective system to clear any faults within their zones of protection with one or more of their local breakers. Each zone of protection covering the 100 kV and higher portion of the GO system, including the GSU Transformers, is to be protected by two independent relay schemes that each provide high speed fault protection. The terminal breaker at the GO end of the direct connection line is to be included in one of these zones of protection. • The CTs used for the zones of protection covering the 100 kV and higher portion of the GO's 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 tap ratio in use.
- Each breaker on the 100 kV and higher portion of the GO system is to have a dedicated relay for 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 GO station, and the breaker failure-to-trip protection on the direct connection line breaker shall send DTT through the fiber to the FirstEnergy substation.

502 Junction SS

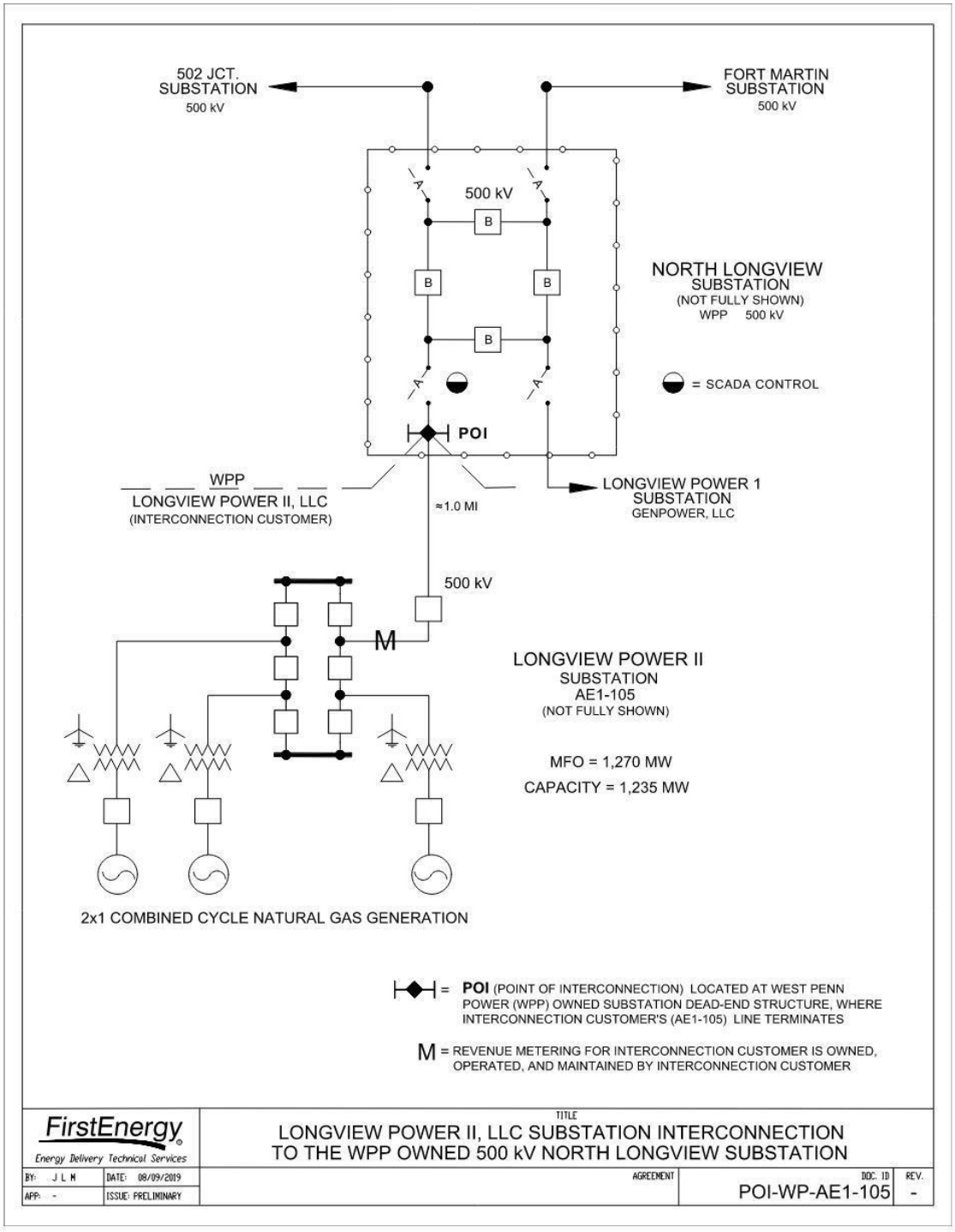
- Perform a relay coordination study and revise settings on existing relays at 502 Junction as necessary.

Fort Martin SS

- Perform a relay coordination study and revise settings on existing relays at Fort Martin as necessary.

Attachment #2: One-Line Diagrams

First Energy One-Line



Attachment #3: IC Site Plan and Substation Attachment Facilities

IC Site Plan

Attachment #4: Generation Connection Requirements

Generation Connection Requirements

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

www.firstenergycorp.com/feconnect

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

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.*

For projects that entered PJM's New Service Queue after November 1, 2016, the power factor requirement will be as follows:

Generation Type	New / Increase	Size	Power Factor Requirement	Measurement Location
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	High Side of the Facility Substation Transformers
Synchronous	Increase	> 20 MW	1.0 (unity) to 0.90 lagging	Generator's Terminals
Synchronous	Increase	<= 20 MW	1.0 (unity) to 0.90 lagging	Point of Interconnection
Wind or Non-Synchronous	Increase	All	0.95 leading to 0.95 lagging	High Side of the Facility Substation Transformers

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

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

Design Requirements

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

Transmission Design Requirements

Design Criteria

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

General Design Requirements

- System phasing (counter clockwise) 1-2-3
- System frequency: 60 hertz
- Elevation, AMSL: Less than 1000 meters
- Isokeraunic level: 40
- Maximum ambient temperature: 40 degrees C
- Minimum ambient temperature: -40 degrees C
- Maximum conductor operating temperature: Contact Transmission Owner

• Wind Loading (round shapes):	Per ASCE 10, per Fig. 250-2B depending on location
• Ice loading – Substations (no wind):	25 mm
• Seismic zone:	Per ASCE Manual 113 Substation Structure Design Manual. Equipment qualification per IEEE 693- 2005 and IEE 1527-2006

Voltage and Current Ratings

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

Clearances and Spacing

• Recommended rigid bus center-to-center phase spacing:	300”
• Minimum phase-to-phase, metal-to-metal distance:	222”
• Recommended phase-to-ground:	152”
• Minimum phase-to-ground:	144”
• Low bus height above top of foundations (match existing):	30’-0”
• High bus height above top of foundations (match existing):	55’-0”
• Minimum vertical clearance from live parts to grade:	20’-6”
• Minimum horizontal clearance from live parts:	15’-0”
• Minimum conductor clearance above roads in switchyard:	42’-0”
• Minimum bottom of insulator to top of foundation:	8’-6”