Generation Interconnection
Facility Study Report

For

PJM Generation Interconnection Request
Queue Position AA1-046

Somerset-Allegheny 115kV

October 2016

A. Transmission Owner Facilities Study Summary

1. Description of Project

Kimberly Run, LLC (hereinafter referred to as "Developer") has proposed has proposed a wind generating facility located in Somerset County, PA. The installed facilities will have a total capability of 80 MW of WIND generation with 13% (10.4 MW) capacity. The AA1-046 project will interconnect with the Penelec transmission system to the Allegheny-Somerset 115kV line, between Pride Substation and Somerset Substation, approximately 0.41 mile from Pride Substation. This project is located in southwestern Pennsylvania (Ref: Attachment 6).

The generation facility will interconnect with **Pennsylvania Electric Company** (Penelec), a FirstEnergy Company (FE), (hereinafter referred to as "Transmission Owner") at a new three-breaker ring bus-configured switching station (interconnection substation).

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

- An Interim Deliverability Study will need to be performed by PJM since the Facilities Study Commercial Operation Date is 12/01/2017, and the original study year was 2018.
- Developer chose "Option to Build" (OTB) for the interconnection substation.
- Network Upgrade **n4635** includes additional substations for "Adjust remote relaying settings."

3. Interconnection Customer's Submitted Milestone Schedule

Developer's requested Commercial Operation Date (COD) for the generation facility is **December 1, 2017**. Transmission Owner's proposed schedule might not match Developer's requested Milestone Schedule. A Project Kickoff meeting must occur by **November 1, 2016** to meet the Milestone Schedule listed below.

Developer's Requested Milestone Schedule:

10/15/2017	Initial Back-feed through Project Substation Date*
12/01/2017	Project Commercial Operation Date

*Developer was advised by Transmission Owner during the Facilities Study Kick-Off call (12/21/2015), that a 10/31/2017 Back-feed date was more feasible due to outage concerns. Developer agreed to assume the risk of keeping the Back-feed date of 10/15/2017.

Direct Connection and Non-Direct Connection Schedule: in order to meet the Back-feed Date, a proposed **twelve** (**12**)-month 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" and "Non-Direct Connection" sections below.

4. Scope of Customer's Work

Direct Connection Facilities

Developer will construct facilities, including the WIND collection system and generation step-up (GSU) transformer, and connect to the new 115 kV three-breaker ring bus. Since Developer has selected the "Option to Build," it is also responsible for the design, procurement, and construction of the new three-breaker ring bus.

Point of Interconnection (POI): the point where Developer's 115 kV bus work crosses the Transmission Owner interconnection substation fence (Ref: Attachment 3).

Developer is required to own, install, and maintain a fully-rated, fault-interrupting circuit breaker on the high-side of the GSU transformer, between the position on the three-breaker ring bus and the generating station.

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 115 kV three-breaker ring bus. The new interconnection substation is to be constructed on the Allegheny-Somerset 115kV line, between Pride Substation and Somerset Substation, approximately 0.41 mile from Pride Substation. The loop would extend approximately 200 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 3 Since Developer chose the "Option to Build," it is also responsible for the design, procurement, and construction of the new three-breaker ring bus.

Description of Facilities Work Based on "Option to Build"

Transmission Owner Interconnection Substation (Direct Connection)

1. **Transmission Owner Interconnection Substation – OPTION TO BUILD**
   [PJM Network Upgrade n**4630**]

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 115 kV ring bus substation:

- Three (3) 145 kV, 3000 ampere, 40 kA interrupting power circuit breakers
- Six (6) 115 kV, 2000 ampere, three-pole, manually-operated, group disconnect switches
- One (1) 115 kV, 2000 ampere, three-pole, motor-operated, disconnect switch
- Six (6) surge arresters for application on a 115 kV system
- Nine (9) 115 kV capacitor voltage transformers for relaying
- Station Service – Transmission Owner requires a primary and a backup station power supply with automatic transfer. This consists of the following sources:
    - Primary: One (1) 115 kV power voltage transformer
    - Backup: Feed from a local distribution feeder
- Two (2) 115 kV transmission line termination structures
- 115 kV bus and conductor with associated structures
- Prefabricated building with battery and charger
- Transmission Owner relaying and controls per the Protection Requirements (provided as Attachment 2).
- SCADA RTU
- Foundations for the equipment listed above.
- Substation fencing, cable trench & conduit system, ground grid and stoning.
- Compliance with Transmission Owner security standards. Developer to contact Transmission Owner for design / equipment details.

Assumptions / Notes:

- A rough-graded, level site and access road is to be provided by Developer.
- Since Developer chose the "Option to Build," Developer to design and construct new interconnection substation to Transmission Owner's specifications.
- Since Developer chose the "Option to Build" (OTB) for the interconnection substation, Developer is responsible to make all arrangements for station service (primary and backup) for the interconnection substation. No costs or schedule included herein.
- In order to meet the requested Back-feed Date of **10/15/2017**, the exact substation site, pull-off structure location, and structure details (for connection to the transmission line loops) are required from Developer no later than **12/01/2016** (i.e. minimum **eleven** (**11**)-months lead-time from Back-feed 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.

5. Description of Facilities Included in the Facilities Study

Direct Connection Facilities

1. Allegheny-Somerset 115 kV Line Loop (PJM Network Upgrade n4631)
2. Engineering Oversight & Commissioning for the "Option to Build" 115kV ring bus substation (PJM Network Upgrade Number n5059)

Non-Direct Connection Facilities

1. Somerset 115kV Substation- carrier and line upgrades (PJM Network Upgrade Number n4632)
2. Allegheny 115kV Substation- carrier, line, and anti-islanding protection upgrades (PJM Network Upgrade Number n4633)
3. New Baltimore 115kV Substation- anti-islanding protection upgrades (PJM Network Upgrade Number n4634)
4. Hooversville, Rockwood, and Bedford North 115kV Substations- Adjust remote relay settings (PJM Network Upgrade Number n5060)

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.

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

Description	NUN	Estimated Cost	Tax (if applicable)
Direct Connection Facilities			
Install 138kV loop to the proposed 3 breaker ring bus interconnecting substation (approx. 200' in length) @ Allegheny-Somerset 115kV Line.	n4631	$ 469,000	$ 84,300
Project Management, Commissioning, Environmental, Forestry, Real Estate, ROW, SCADA, Metering, and Security.	n5059	$ 1,019,600	$ 183,200
Non-Direct Connection Facilities			
Somerset 115kV Substation- carrier and line upgrades	n4632	$ 304,200	$ 54,700
Allegheny 115kV Substation- carrier, line, and anti-islanding protection	n4633	$ 348,300	$ 62,600

upgrades			
New Baltimore 115kV Substation- anti-islanding protection upgrades	n4634	$ 69,300	$ 12,500
Hooversville, Rockwood, and Bedford North 115kV Substations- Adjust remote relay settings.	n5060	$ 38,500	$ 7,000
Total Estimated Costs		**$ 2,248,900**	**$ 404,300**

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

A proposed **twelve** (**12**)-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	3	6
Detailed Engineering	3	9
Equipment Procurement - Delivery	5	10
Below Grade Construction	10	12
Above Grade Construction	11	12
Testing & Commissioning	11	12

B. Transmission Owner Facilities Study Results

1. Transmission Lines – New

1. Allegheny-Somerset 115 kV Line Loop
[PJM Network Upgrade n**4631**]

Transmission Owner will sectionalize the existing 115 kV transmission line at the new Transmission Owner interconnection substation, at a site to be selected by Developer with agreement from Transmission Owner. This study assumes that the interconnection new substation will be located adjacent to the Transmission Owner 115 kV line right-of-way (See Attachment 5) and the dead-end structures will each be within one (1) span of the 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.

General Assumptions:

- Transmission Owner will construct a one (1) span transmission line loop of the Allegheny-Somerset 115kV line, between Pride Substation and Somerset Substation, approximately 0.41 mile from Pride Substation. The tap will be located near structure #296 or #297.
- The scope for this estimate consists of installing a loop, approximately 200 ft. in length. It is likely that a single H-frame structure will be removed (either structure #296 or #297) and replaced with two (2) new three (3)-pole dead-end structures in order to loop into the new substation.
- Schedule is based on no outage, right-of-way, or siting/permitting issues.
- In order to meet the requested Back-feed Date of **10/15/2017**, the exact substation site, pull-off structure location, and structure details (for connection to the transmission line loops) are required from Developer no later than **12/01/2016** (i.e. minimum **eleven** (**11**)-months lead-time from Back-feed Date). Delays in provision of substation site details will affect the schedule.

Assumptions:

Engineering Assumptions:

1. Two (2) three (3)-pole dead-end structures for the loop.
2. Single H-frame structure to be removed.
3. Substation is adjacent to the existing line with the loop being approximately 200 ft. in length.
4. Exact substation location and details are required prior to the start of engineering.
5. Cost associated with installation of a SCADA-controlled switch on Developer's tap is assumed to be part of the station work and has not been included in this estimate.
6. Access to new structures will be generally provided by development of property for the new station; limited access improvements will be required.

Siting Assumptions:

1. A letter of notification (LON) is required to the PaPUC.
2. No significant ecological impacts in the area of the project. Transmission owner is assuming 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 Developer's and/or 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.
5. PaPUC will not review submittal prior to right-of-way acquisition.

Right-of-Way (ROW) Assumptions:

1. Right-of-way is required from Developer only. The project is entirely on the Developer's and/or substation property.
2. Right-of-way acquisition must occur prior to PaPUC review of LON submittal.
3. Standard Easement requires a minimum of a 60 ft. wide (30 ft. from Centerline) ROW, with adjacent tree rights, for single-ircuit single wood pole 115kV construction.

Forestry/Vegetation Management Assumptions:

1. The only vegetation clearing work on the project is associated with the 115kV Loop Line.
2. Vegetation contractor is not responsible for E&S installation, access road construction and rehabilitation.
3. Standard Conditions - logs and brush windrowed along edge of ROW

2. Transmission Line – Upgrades

None.

3. New Substation/Switchyard Facilities

Engineering Oversight and Commissioning for Transmission Owner Interconnection Substation

PJM Network Upgrade n5059

AA1-046 requested Option-to-Build for the three-breaker 115 kV ring bus substation. Ownership will transfer to Penelec (First Energy) prior to connecting Penelec's 115 kV transmission lines into the switchyard. This 115 kV switchyard will be built by AA1-046, and owned and operated by Penelec (First Energy).

4. Upgrades to Substation / Switchyard Facilities

1. Somerset Substation
[PJM Network Upgrade n**4632**]

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

115kV Carrier & Line Upgrades.

Assumptions:

- Estimate assumes existing wavetrap stand and foundation will be reused, no new steel required.
- Estimate assumes existing AC/DC systems and ground grid are adequate for required additions.
- Estimate assumes existing SCADA RTU system is adequate for required additions.
- Estimate assumes new relay panel will be installed in existing control building.

2. Allegheny Substation
[PJM Network Upgrade n**4633**]

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

115kV Carrier, Line & Anti-Islanding Upgrades.

Assumptions:

- Estimate assumes existing wavetrap stand and foundation will be reused, no new steel required.
- Estimate assumes existing AC/DC systems and ground grid are adequate for required additions.
- Estimate assumes existing SCADA RTU system is adequate for required additions.
- Estimate assumes new relay panel will be installed in existing control building.
- Estimate assumes anti-islanding equipment/fiber from Allegheny to New Baltimore is existing and adequate.

3. New Baltimore Substation
[PJM Network Upgrade n**4634**]

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

115kV Anti-Islanding Upgrades.

Assumptions:

- Estimate assumes existing AC/DC systems are adequate.
- Estimate assumes existing SCADA RTU system is adequate.
- Estimate assumes anti-islanding equipment/fiber from Allegheny to New Baltimore is existing and adequate, and new transmitter will be installed in existing panel.
- Estimate assumes anti-islanding equipment & TX/RX from New Baltimore to Bedford North is existing and adequate, and relay settings will need adjustments.

Detailed Protection Requirements are provided as Attachment 2

4. Hooversville, Rockwood, and Bedford North Substations
[PJM Network Upgrade n**5060**]

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

115kV Adjust remote relay settings.

5. Metering & 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 SCADA Assumptions:

- SCADA work needed for four (4) substations: interconnection, Somerset, Allegheny, and New Baltimore.
- Network transport for SCADA will be via MPLS over microwave.
- Assumed existing Berlin tower is structurally sufficient to add antenna for additional microwave hop.
- New microwave tower/equipment required for SCADA transport at new interconnection substation.

- Assumed new microwave tower would be located within the bounds of the new interconnection substation.
- Transmission Owner to erect a typical 150 ft. monopole; expected to utilize 9-10 ft. diameter land area.
- Developer is responsible for obtaining all associated land, Rights-of-Way (ROW), Easements, and Permits for new microwave tower at new interconnection substation. Schedule is contingent upon Developer providing the aforementioned items to Transmission owner, prior to the start of construction.

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 **Somerset** substation will be via Power Line Carrier (PLC).

Communications for transmission line protection between the new **interconnection** substation, and the **Allegheny** substation will be via Power Line Carrier (PLC).

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 responsibilities:
Per the attached Protection Requirements (Ref: Attachment 2), 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 protection schemes 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, therefore requiring dual, high-speed tripping schemes, 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). Since Developer chose the "Option to Build" for the interconnection substation, Developer will make the fiber-optic 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-optic cable.

6. Environmental, Real Estate and Permitting Issues

Environmental, Real Estate and Permitting Issues

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

- Environmental permitting, Real Estate acquisition, and Pennsylvania Public Utility Commission (PUC) notification durations vary, some up to six (6) 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 Transmission Owner interconnection substation may involve environmental surveys, permits, approvals and plans with federal, state, and/or local agencies.
- It is assumed Developer will provide a permitted area for all work, including, but not limited to any property, ROW, and access for Transmission Owner. These permits should encompass all federal, state and local requirements, consultations, and agency reviews. Copies should be provided to Transmission Owner, prior to work commencing.
- Since Developer chose the "Option to Build" for the interconnection substation, Developer will provide copies of all of the relative environmental permits and other necessary approvals to Transmission Owner before Transmission Owner accepts the interconnection facilities.
- Developer is required to install an access road from the new interconnection substation to the nearest public road (must be approved by Transmission Owner), and obtain access rights for Transmission Owner. Developer is responsible to maintain access road and ensure unimpeded access for Transmission Owner at all times.
- Developer is responsible for all property acquisition (including easements/rights-of-way (ROW)) for transmission, distribution and communication facilities needed for the generator interconnection.
- If Developer owns the project property, in fee title, Transmission Owner will require a fee property transfer for the interconnection substation site which may require subdivision approval, together with permanent access rights to and from the substation, as well as a perpetual easement for any transmission lines to the substation. Developer is responsible for all costs, including but not limited to subdivision, associated with the property transfer.
- If Developer leases the project property, the Developer will be required to obtain fee property from the underlying fee property owner, on behalf of Transmission Owner, for the interconnection substation site, together with permanent access rights to and from the substation, as well as a perpetual easement for any transmission lines to the substation.
- 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 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 Pennsylvania Public Utility Commission (PUC) 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 southern-side of the transmission corridor (see Attachment 6) 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.
- 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 adjacent (i.e. share a common fence). The 115 kV connection between the substations will be via rigid bus over the fence (i.e. no 115 kV transmission line between the substations).
- In order to meet the requested Back-feed Date of **10/15/2017**, the exact substation site, pull-off structure location, and structure details (for connection to the transmission line loops) are required from Developer no later than **12/01/2016** (i.e. minimum **eleven** (**11**)-months lead-time from Back-feed 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.

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 design information and site construction (estimated cost for Engineering Oversight and Commissioning support would be provided by Transmission Owner).

7. Information Required for Interconnection Service Agreement

Description	Direct Labor	Direct Material	Indirect Labor	Indirect Materials
Direct Connection Facilities				
Install 138kV loop to the proposed 3 breaker ring bus interconnecting substation (approx. 200' in length) @ Allegheny-Somerset 115kV Line.	$ 307,000	$ 53,800	$ 87,200	$ 21,000
Project Management, Commissioning, Environmental, Forestry, Real Estate, ROW, SCADA, Metering, and Security.	$ 469,000	$ 300,400	$ 133,100	$ 117,100
Non-Direct Connection Facilities				
Somerset 115kV Substation- carrier and line upgrades	$ 150,900	$ 79,400	$ 42,900	$ 31,000
Allegheny 115kV Substation- carrier, line, and anti-islanding protection upgrades	$ 173,100	$ 90,700	$ 49,100	$ 35,400
New Baltimore 115kV Substation- anti-islanding protection upgrades	$ 41,600	$ 11,400	$ 11,800	$ 4,500
Hooversville, Rockwood, and Bedford North 115kV Substations- Adjust remote relay settings.	$ 30,000	$ 0	$ 8,500	$ 0
Total	**$ 1,171,600**	**$ 535,700**	**$ 332,600**	**$ 209,000**

Schedule:

A proposed **twelve** (**12**)-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	3	6
Detailed Engineering	3	9
Equipment Procurement - Delivery	5	10
Below Grade Construction	10	12
Above Grade Construction	11	12
Testing & Commissioning	11	12

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" for the interconnection substation, it 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:	2415 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:	115 kV
• Maximum phase-to-phase:	121 kV
• Basic impulse level (BIL):	550 kV
• Maximum continuous current carrying capacity:	2000 A
• Design fault current:	40 kA
• Single Contingency (breaker failure) clearing time:	45 cycles

Clearances and Spacing

- Recommended rigid bus center-to-center phase spacing: 84”
- Minimum phase-to-phase, metal-to-metal distance: 53”
- Recommended phase-to-ground: 45”
- Minimum phase-to-ground: 42”
- Low bus height above top of foundations (match existing): 15’-1”
- High bus height above top of foundations (match existing): 21’-1”
- Minimum vertical clearance from live parts to grade: 11’-7”
- Minimum horizontal clearance from live parts: 6’-1”
- Minimum conductor clearance above roads in switchyard: 20’-2”
- Minimum bottom of insulator to top of foundation: 8’-6”

Attachment 2. Detailed Protection Requirements

Not to be used for Construction

Following is the protection scope information (Facilities Study Stage only) for the AA1-046 wind generation project. These relay requirements reflect only the project scope for the installation of the AA1-046 Interconnection Substation on the Allegheny-Somerset 115kV line, between Pride Substation and Somerset Substation, approximately 0.41 mile from Pride Substation. This study assumes no dual pilot relaying is required for stability. It also assumes the AA1-046 Collector Substation will be directly adjacent to the AA1-046 Interconnection Substation.

Short Circuit Analysis

Fault values for the AA1-046 Interconnection Substation location with the new generation in service are:

Three phase = 8330 A
Single line to ground = 7664 A
Z1= 1.657 + j 6.233 %
Z0= 0.996 + j 6.761 %

Impedances are given on a 100 MVA and 115kV base. The fault currents provided are bolted, symmetrical values for normal system conditions. Future increases in fault currents are possible and it is Developer's responsibility to upgrade its equipment and/or protective equipment coordination when necessary.

AA1-046 Interconnection Substation

Construct a new three (3) breaker 115kV ring bus to sectionalize the Somerset-Allegheny 115kV line. Install three (3) SEL-501 relays, one per breaker, for Failure-to-Trip protection. Install three (3) sets of three-phase CCVTs, one for each line exit. Install three (3) SATEC meters, one per breaker. Install a GPS Clock, and SEL RTAC for remote relay access and SCADA distance to fault.

Somerset 115kV line exit – Install SEL-421 primary line protection relay for Directional Comparison Blocking (DCB) over Power Line Carrier (PLC), and SEL-421 backup relay for step distance and directional overcurrent protection, reclosing, and sync check. Install RFL-9780 Frequency Shift Keyed (FSK) Transmitter/Receiver (Tx/Rx) to receive the anti-islanding signal from Somerset. Reuse the existing DCB power line carrier frequency and install an RFL-9785 Tx/Rx for the DCB line protection scheme. Install a wide band tuner, wide band wave trap, and skewed hybrid.

Allegheny 115kV line exit – Install SEL-421 primary line protection relay for Directional Comparison Blocking (DCB) over Power Line Carrier (PLC), and SEL-421 backup relay for step distance and directional overcurrent protection, reclosing, and sync check. Install RFL-9780 Frequency Shift Keyed (FSK) Transmitter/Receiver (Tx/Rx) to transmit and receive anti-islanding signals to and from Allegheny. Install new RFL-9785 Tx/Rx for the DCB line

protection scheme using a newly assigned PLC frequency. Install a wide band tuner, wide band wave trap, and skewed hybrid.

AA1-046 Generation Sub 115kV line exit – Install SEL-411L primary and SEL-411L backup relays for line protection, each utilizing a current differential protection scheme over dedicated fiber, with backup overcurrent and step distance protection. The SEL-411L relays will send transfer trip over fiber to the AA1-046 Collector Substation for anti-islanding and failure to trip, and will receive transfer trip over fiber from the AA1-046 Collector Substation for failure to trip. Install an anti-islanding scheme to trip AA1-046 generation, utilizing the AA1-046 Interconnection Substation breaker 'b' breaker contacts, and breaker status from the remote substations via FSK carrier.

AA1-046 Collector Substation

AA1-046 Interconnection Substation 115kV line exit – Install SEL-411L primary and SEL-411L backup line protection relays, each utilizing a current differential protection scheme over dedicated fiber, with backup overcurrent and step distance protection. Install a SEL-501 relay for Failure to Trip. The SEL-411L line protection relays will be used to send transfer trip over fiber to the AA1-046 Interconnection Substation for failure to trip, and receive transfer trip over fiber from the AA1-046 Interconnection Substation for anti-islanding and failure to trip.

Somerset Substation

AA1-046 Interconnection Sub 115kV line exit (formerly Allegheny 115kV line exit) – Remove the existing electromechanical line protection relays. Install SEL-421 primary relay (DCB over PLC), SEL-421 backup relay for step distance and directional overcurrent protection, reclosing, and sync check. Replace existing electromechanical FT scheme with a SEL-501 relay for Failure-to-Trip. Install anti-islanding scheme to transmit breaker open status of the AA1-046 Interconnection 115kV line breaker at Somerset substation. Install RFL-9780 FSK Tx/Rx, replace single-band tuner with a wide-band tuner, and install a skewed hybrid.

Allegheny Substation

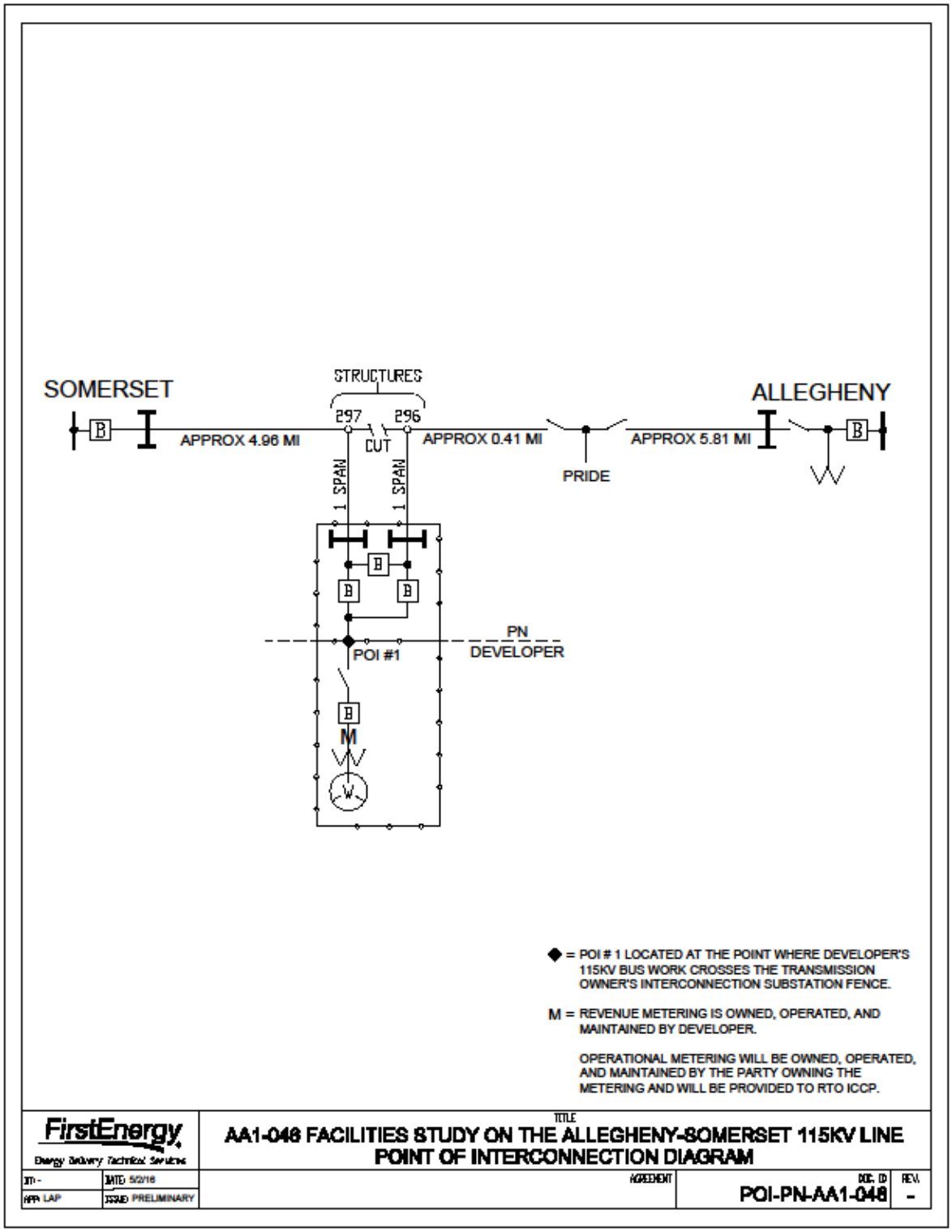
AA1-046 Interconnection Substation 115kV line exit (formerly Somerset 115kV line exit) – Remove the existing electromechanical line protection relays. Install SEL-421 primary relay (DCB over PLC), SEL-421 backup relay for step distance and directional overcurrent protection, reclosing, and sync check. Install anti-islanding scheme to transmit DTT to AA1-046 for breaker open status of the Bus Tie 115kV breaker at Allegheny Substation, or for anti-islanding signal received from New Baltimore. Install RFL-9780 FSK Tx/Rx, replace single-band tuner with a wide-band tuner, and install a skewed hybrid.

New Baltimore 115kV line exit – Add anti-islanding status to existing RFL-9745 Teleprotection Channel Tx/Rx (existing fiber) from AA1-046 Interconnection Substation (both B1 and B3 are open) and transmit to New Baltimore.

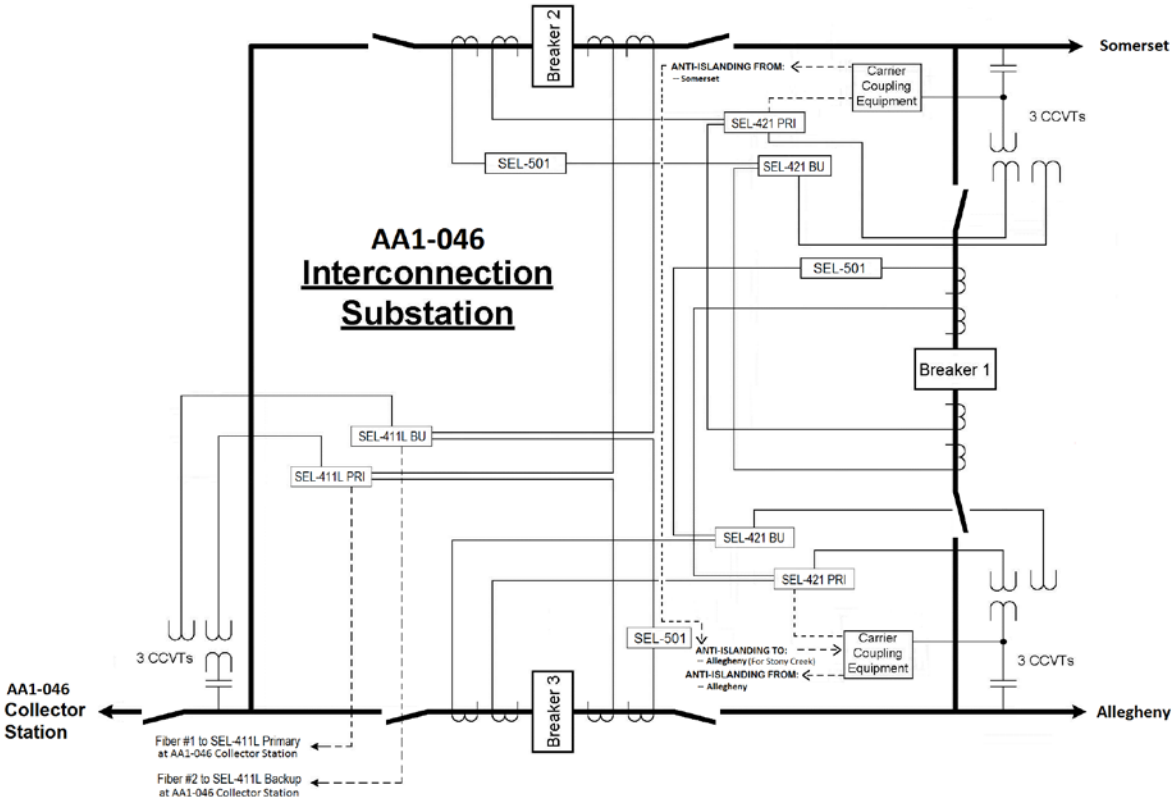
New Baltimore Substation

Allegheny 115kV line exit – Add anti-islanding status input to existing RFL-9745 Teleprotection Channel Tx/Rx (existing fiber) from New Baltimore Substation to transmit to Allegheny when both B1 and B2 or B1 and B3 are open or for anti-islanding signal receive from Bedford North.

Attachment 3. One-Line Diagram

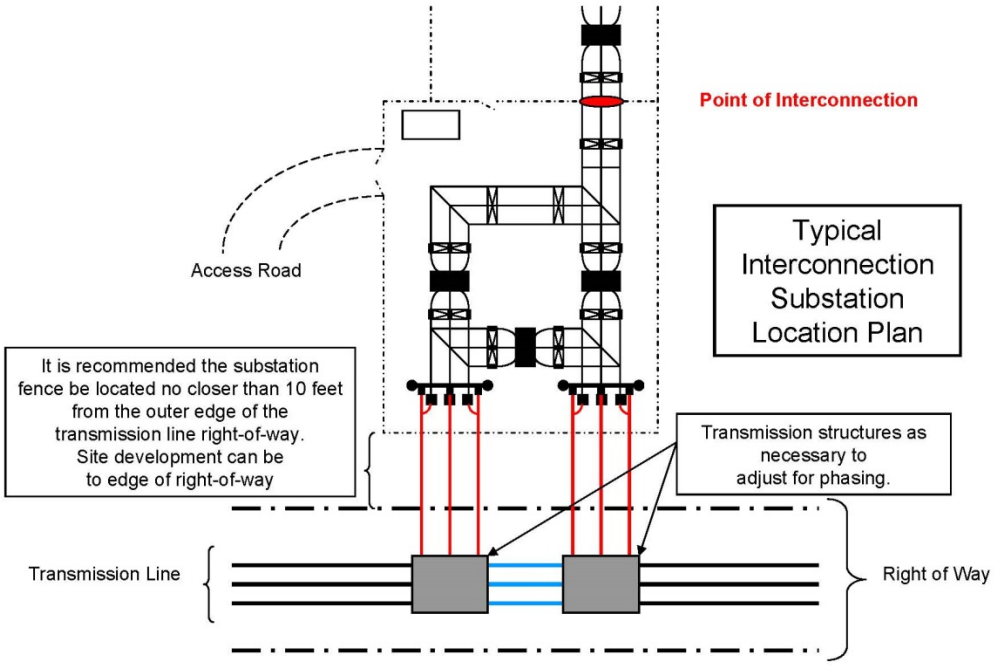


Attachment 4. Relay Sketch

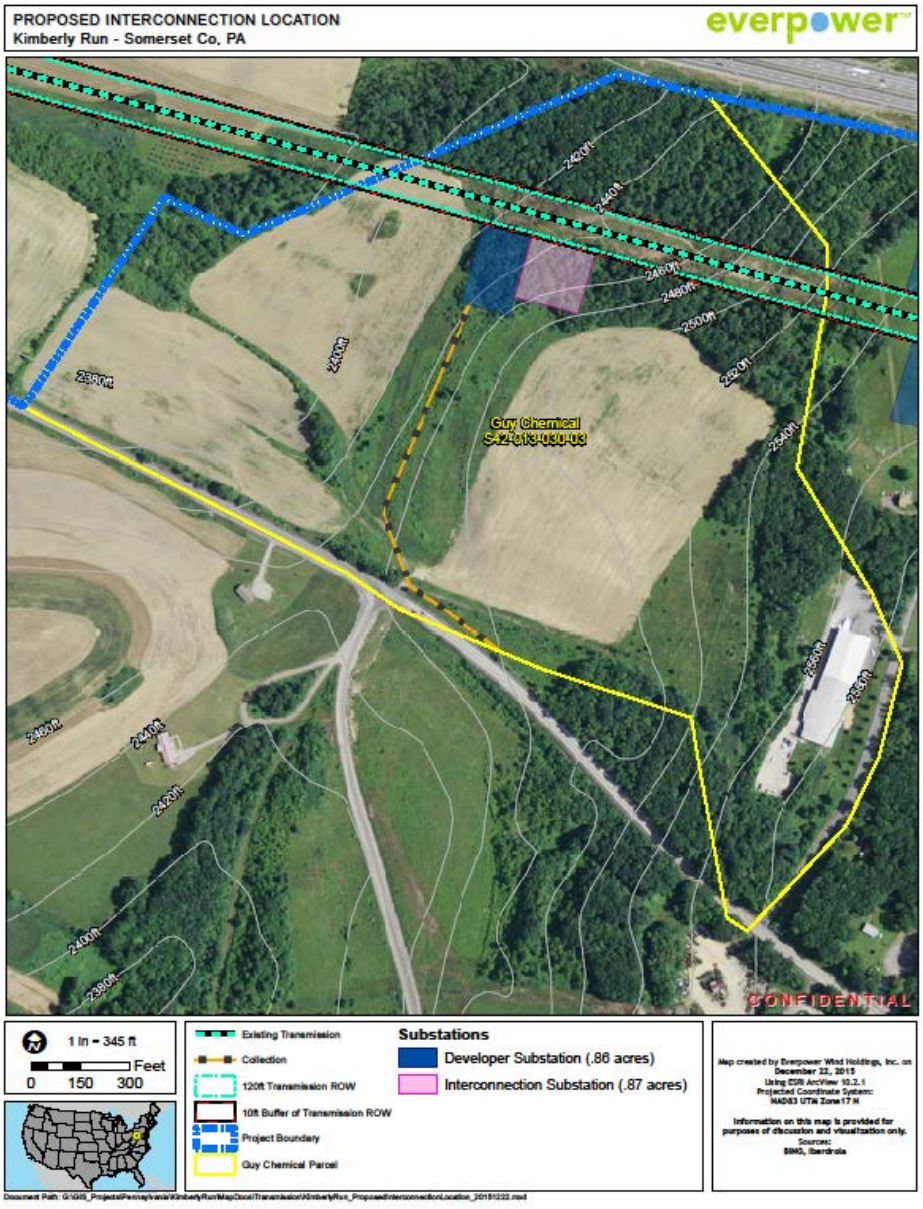


Note: Diagram does not represent a physical layout. Not to be used for construction.

Attachment 5. Typical Interconnection Substation Location Plan



Attachment 6. Site Plan By Developer



* Notes:

- This report assumes that the new interconnection substation will be located adjacent to the Transmission Owner 115 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.
- This report assumes the interconnection substation and generation (collector) substation are adjacent (i.e. share a common fence. The 115 kV connection between the substations will be via rigid bus over the fence (i.e. no 115 kV transmission line between the substations).

Attachment 7. Dynamic Simulation Analysis

Executive Summary

PJM Queue project AA1-046 is a request for 80.0 MW Maximum Facility Output (MFO) wind farm. The Point of Interconnection is a new three breaker ring station tapping the Somerset – Allegheny 115 kV circuit in PENELEC115 kV transmission system. AA1-046 project consist 40 Gamesa 2.0 MW G97 Wind Turbines.

This study is based on the RTEP SP_2018BaseCase_2014_12_10 summer peak load case and modified to include applicable queue projects. PJM queue project AA1-046 was dispatched at a Maximum Facility Output (MFO) of 80.0 MW and POI voltage of 117.0 kV, consistent with the default generator reference voltage specified in PJM Manual 03 *Transmission Operations* Section 3.3.3 for generator connections to the PJM 115.0 kV system.

AA1-046 was tested for compliance with NERC, PJM and other applicable criteria. 38 contingencies were studied, each with a 15 second simulation time period.

Based on the contingencies tested, AA1-046 meets criteria for all contingencies tested.

Description

This study evaluates the stability, low voltage ride-through (LVRT) and dynamics for PJM queue project AA1-046 which is 80.0 MW MFO wind turbine facility. The proposed POI is a three breaker ring bus which taps the existing Allegheny – Somerset 115 kV circuit in PENELEC area. The AA1-046 project is a wind turbine facility unit made up of 40 Gamesa 2.0 MW G97 wind turbines. The wind turbines facility is modeled at 80.0 MW gross out-put. For this stability study, the AA1-046 project was studied for a total net injection of 78.4 MW into the 115.0 kV Transmission System.

Criteria

The stability study for AA1-046 was performed on a RTEP SP_2018 BaseCase_2014_12_10 Summer Peak load-case for normal operating conditions, and modified to include applicable queue projects. The range of contingencies evaluated was limited to those necessary to assess compliance with NERC, PJM and other applicable criteria. Simulation time was 15 seconds for all faults.

Simulated NERC Standard TPL-001faults include:

1. Three-phase (3ph) fault with normal clearing (Category P1)
2. Single-line-to-ground (slg) with delayed clearing as a result of breaker failure (Category P4)
3. Single-line-to-ground (slg) with delayed clearing as a result of protection failure

(Category P5)

4. Single-line-to-ground (slg) with normal clearing for common structure (Category P7)

Note: For generator interconnection studies, Category P2, P3 and P6 faults will be studied on an as needed basis.

Other applicable criteria tested include:

1. TO specific criteria
2. Other criteria

The system was tested for an all lines in service condition and the faults listed above. Specific fault descriptions and breaker clearing times used for this study are provided in Appendix A.

All generators were monitored to assess transient stability and satisfactory post-contingency conditions.

Case Setup

Generators within 5 to 8 buses from the generator(s) under study are dispatched at their maximum power output and set at unity power factor at the high side of the generator step up transformer. Alternatively, generators can be adjusted to hold scheduled voltages.

Specific dispatch conditions at the generator terminals for the AA1-046 generator, as obtained in the power flow solution, are illustrated below:

	40 Gamesa 2.0 MW G97Wind Turbines
Gross power output (MW)	80.0
Reactive power output (MVARS)	2.9
Auxiliary Load (MW/MVARS)	0.0
Station Service Load (MW/MVARS)	0.0
Net real power injection (MW)	78.4
Voltage at the POI (P.U.)	1.017

Results

Simulation Initialization

The case was initialized successfully. No errors were reported.

20 second no fault test (Steady State evaluation)

The system successfully met the 20 second run test without any significant deviations in system states.

Simulation Results

Dynamics and stability was tested using Siemens/PTI PSS/E Version 32.0, the 2018 case with a Summer Peak Load condition and the data supplied by the developer.

Transient Stability: For all contingencies studied, transient stability is maintained, with all oscillations stabilized in less than 15 seconds. Also, the voltage levels returned to acceptable levels for all contingencies following the fault clearance. Hence, no transient stability issues were identified for the contingencies tested.

LVRT: For the cases studied, the queue project rides through the faults shown in Appendix A thus meeting the LVRT test specified in FERC order 661 and 661A.

Small Signal (if applicable):

SPS:

Maintenance outage: No maintenance outage conditions were evaluated.

Conclusion

Transient stability is maintained for all contingencies tested.

Mitigations:

None

Recommendations:

1) **Installation of out-of-step protection is recommended**: This study was made using a certain set of operating conditions. There may be other operating conditions, although less probable, that can create stability problems. It is the Customer's responsibility to protect their own equipment from damage due to disturbances on the transmission system by installing out-of-step protection on their generators.

Note: While the stability analysis has been performed at extreme system conditions, there is a potential that evaluation at a different level of generator MW and/or MVAR output at different system load levels and operating conditions may disclose unforeseen stability problems. The regional reliability analysis routinely performed to test all system changes will include one such evaluation. Any problems uncovered in that or other operating or planning studies will need to be resolved.

Moreover, when the proposed generating station is designed and plant specific dynamic data for the plant and its controls are available, it must be forwarded to PJM. If it is different than the data provided for this study, a transient stability analysis at a variety of expected operating conditions using the more accurate data shall be performed to verify impact on the dynamic performance of the system. Note that any and all changes to the generation equipment's dynamic data, including the GSU data, must be submitted to PJM for evaluation.

Appendix A: Fault Table

No.	Contingency ID	Type of Fault	Clearing time (cycles)		Results
			Normal	Delayed	
Criteria = TPL 001-4_P1					
01	01-AA1-046-TAP-P1-01	3ph fault on AA1-046 Tap - Allegheny 115 kV (BAS) + Allegheny 115/23 kV TF1	7.0	N/A	Stable
02	02-AA1-046-TAP-P1-02	3ph fault on AA1-046 Tap - Somerset 115 kV (BAS)	7.0	N/A	Stable
03	03-AA1-046-ALLE-P1-01	3ph fault on Allegheny – P60-Tap (New Baltimore) 115 kV (ANB) + Allegheny 115 / 23 kV TF2	7.0	N/A	Stable
04	04-AA1-046-ALLE-P1-02	3ph fault on Allegheny 115/23 kV TF1	7.0	N/A	Stable
05	05-AA1-046-ALLE-P1-03	3ph fault on Allegheny 115/23 kV TF2	7.0	N/A	Stable
06	06-AA1-046-BALT-P1-01	3ph fault on New Baltimore – Allegheny 115 kV (ANB)	7.0	N/A	Stable
07	07-AA1-046-BALT-P1-02	3ph fault on New Baltimore – Bedford 115 kV (BNNB)	7.0	N/A	Stable
08	08-AA1-046-BFRD-P1-01	3ph fault on Bedford – Snakes Spring 115 kV (SSB)	7.0	N/A	Stable
09	09-AA1-046-BFRD-P1-02	3ph fault on Bedford – Oeyster - Claysburg 115 kV (BNC)	7.0	N/A	Stable
10	10-AA1-046-BFRD-P1-02	3ph fault on Bedford 115/230 kV TF2	7.0	N/A	Stable
11	11-AA1-046-BFRD-P1-03	3ph fault on Bedford 115/230 kV TF1	7.0	N/A	Stable
12	12-AA1-046-SOMR-P1-01	3ph fault on Somerset – Ralphton 115 kV (RPS) + Ralphton – Hooversville 115 kV (HQR) + Ralphton 115/23 kV TF	7.0	N/A	Stable
13	13-AA1-046-SOMR-P1-02	3ph fault on Somerset – Hooversville 115 kV (HD)	7.0	N/A	Stable
14	14-AA1-046-SOMR-P1-03	3ph fault on Somerset – Rockwood 115 kV (SDC3)	7.0	N/A	Stable
15	15-AA1-046-SOMR-P1-04	3ph fault on Somerset 115/23 kV TF1 + Somerset – Ralphton 115 kV (RPS) + Ralphton – Hooversville 115 kV (HQR) + Ralphton 115/23 kV TF	7.0	N/A	Stable
16	16-AA1-046-SOMR-P1-05	3ph fault on Somerset 115/23 kV TF2 + AA1-046 Tap - Allegheny 115 kV (BAS) + Allegheny 115/23 kV TF1 + Somerset – Rockwood 115 kV (SDC3) + Somerset –	7.0	N/A	Stable

		Rockwood 115 kV (SDC3)			
17	17-AA1-046-ROC-P1-01	3ph fault on Rockwood – Lick Run 115 kV (LRR)	7.0	N/A	Stable
18	18-AA1-046-ROC-P1-02	3ph fault on Rockwood – Y1-033Tap	7.0	N/A	Stable
19	19-AA1-046-ROC-P1-03	3ph fault on Rockwood 115/23 kV TF	7.0	N/A	Stable
20	20-AA1-046-RALP-P1-01	3ph fault on Ralphton – Hooversville 115 kV (HQR)	7.0	N/A	Stable
21	21-AA1-046-RALP-P1-02	3ph fault on Ralphton 115/23 kV TF	7.0	N/A	Stable
22	22-AA1-046-HOOV-P1-01	3ph fault on Hooverville – Sclap – Rachel Hill 115 kV (HH)	7.0	N/A	Stable
23	23-AA1-046-HOOV-P1-02	3ph fault on Hooverville 115/230 kV TF + Hooverville – Quemahoning 230 kV (HCH)	7.0	N/A	Stable
24	24-AA1-046-HOOV-P1-03	3ph fault on Hooverville – Statler Hill 115 kV (SHS)	7.0	N/A	Stable
25	25-AA1-046-HOOV-P1-04	3ph fault on Hooverville – Tower 115 kV	7.0	N/A	Stable
26	26-AA1-046-HOOV-P1-05	3ph fault on Hooverville 115/23 kV TF1	7.0	N/A	Stable
27	27-AA1-046-HOOV-P1-06	3ph fault on Hooverville 115/23 kV TF2	7.0	N/A	Stable
Criteria = TPL 001-4_P4					
28	28-AA1-046-ALLE-P4-01	SLG fault on Allegheny 115/23 kV TF, SB @ Allegheny 115 kV, Loss of AA1-046 Tap - Allegheny 115 kV (BAS)	7.0	20.0	Stable
29	29-AA1-046-ALLE-P4-02	SLG fault on Allegheny – AA1-046 Tap, SB @ Allegheny 115 kV, Loss of Allegheny 115/23 kV TF1	7.0	20.0	Stable
30	30-AA1-046-ALLE-P4-03	SLG fault on Allegheny – P60-Tap (New Baltimore) 115 kV (ANB), SB @ Allegheny 115 kV, Loss of AA1-046 Tap - Allegheny 115 kV (BAS) + Allegheny 115/23 kV TF1	7.0	20.0	Stable
31	31-AA1-046-ALLE-P4-04	SLG fault on Allegheny 115/23 kV TF2, SB @ Allegheny 115 kV, Loss of Allegheny – P60-Tap (New Baltimore) 115 kV (ANB)	7.0	20.0	Stable
32	32-AA1-046-BALT-P4-01	SLG fault on New Baltimore – Bedford 115 kV (BNNB), SB @ Baltimore, Loss of Allegheny – P60-Tap (New Baltimore) 115 kV (ANB) + Allegheny 115 / 23 kV TF2 + Baltimore Generation	7.0	20.0	Stable
33	33-AA1-046-BALT-P4-02	SLG fault on New Baltimore – Allegheny 115 kV (ANB) + Allegheny 115/23 kV TF2, SB @ Baltimore 115 kV, Loss of New Baltimore – Bedford 115 kV (BNNB) + Baltimore Generation	7.0	20.0	Stable
34	34-AA1-046-SOMR-P4-01	SLG fault on Somerset – Ralphton 115 kV (RPS) + Ralphton – Hooversville 115 kV (HQR) + Ralphton 115/23 kV TF, SB '3' @ Somerset, Loss of Somerset 115/23 kV TF1	7.0	20.0	Stable
35	35-AA1-046-SOMR-P4-02	SLG fault on Somerset 115/23 kV TF1, SB '4' @ Somerset 115 kV, Loss of Somerset Station	7.0	20.0	Stable
36	36-AA1-046-SOMR-P4-03	SLG fault on Somerset 115/23 kV TF2 + AA1-046 Tap - Allegheny 115 kV (BAS) + Allegheny 115/23 kV TF1 + Somerset – Rockwood 115 kV (SDC3) + Somerset – Rockwood 115 kV (SDC3), SB '4' @ Somerset 115 kV,	7.0	20.0	Stable

		Loss of Somerset Station			
Criteria = TPL 001-4_P5					
37	66-AA1-056-TAP-P5-01	SLG fault @ 80% on AA1-046 Tap - Allegheny 115 kV (BAS)	5.0	20.0	Stable
38	67-AA1-056-TAP-P5-02	SLG fault @ 80% on AA1-046 Tap - Somerset 115 kV (BAS)	5.0	20.0	Stable

Appendix B: Project Model

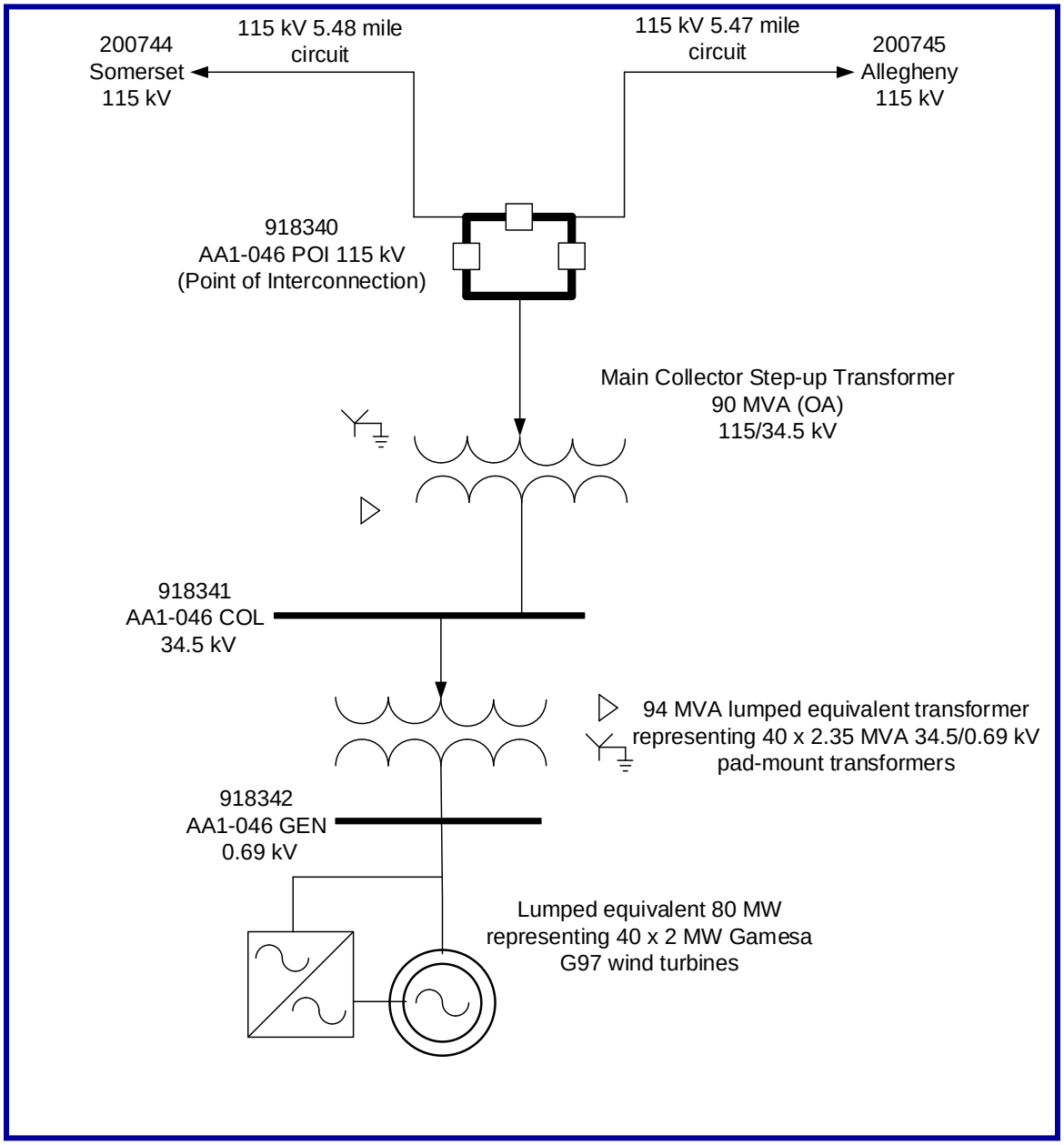


Figure B-1: PJM AA1-046modeling details

Appendix C: Power Flow and Dynamic Models

C.1) Power Flow Model Data

```
BAT_LTAP,200744,200745,'1', 0.5,918340,'AA1-046_TAP', 115.0


VERSION 32

RDCH

1

918340,'AA1-046_TAP ', 115.0000,1, 226, 208,   1,1.01740, -13.3777

918341,'AA1-046_COL ',  34.5000,1, 226, 208,   1,0.99643,  -6.7613

918342,'AA1-046_GEN ',   0.6900,2, 226, 208,   1,1.00576,  -1.0461

0 / END OF BUS DATA, BEGIN LOAD DATA

0 / END OF LOAD DATA, BEGIN FIXED SHUNT DATA

0 / END OF FIXED SHUNT DATA, BEGIN GENERATOR DATA

918342,'G1',    80.000,    -4.362,    26.300,   -26.300,1.01740,918340,    80.00, 0.006301,
0.1507237, 0.00000E+0, 0.00000E+0,1.00000,1,  100.0,    80.000,    12,   1,1.0000

0 / END OF GENERATOR DATA, BEGIN BRANCH DATA

200744,918340,'1 ', 1.17000E-2, 3.27000E-2,   0.00403,  133.00,  160.00,  160.00,  0.00000,
0.00000,  0.00000,  0.00000,1,1,   0.00,   1,1.0000

200745,918340,'1 ', 1.17000E-2, 3.27000E-2,   0.00403,  133.00,  160.00,  160.00,  0.00000,
0.00000,  0.00000,  0.00000,1,2,   0.00,   1,1.0000

0 / END OF BRANCH DATA, BEGIN TRANSFORMER DATA

918340,918341,     0,'1 ',1,2,1, 0.00000E+0, 0.00000E+0,2,'            ',1,   1,1.0000

 2.70000E-3, 8.00000E-2,    54.00

1.00000,   0.000,   0.000,    90.00,     0.00,     0.00, 0,      0, 1.05000, 0.95000, 1.05000,
0.95000,   5, 0, 0.00000, 0.00000,  0.000

1.00000,   0.000
```

C.2) Dynamic Data

```
/*********************************************

/*** AA1-046 - 80 MW

/*** PSSE Version 32

/*** MODULE: GAMESA G97 - voltage control mode was set to local Q control

/*********************************************


// Gamesa 2.0MW EXtQ v4.9 Release - Gamesa

918342 'USRMDL' G1 'GXX049' 1  1  8  45  0  94

  46  1  40  0  8  1  1  1

  0.00 0.00 15.00
```

C.3) PSS/E Single Line Diagram

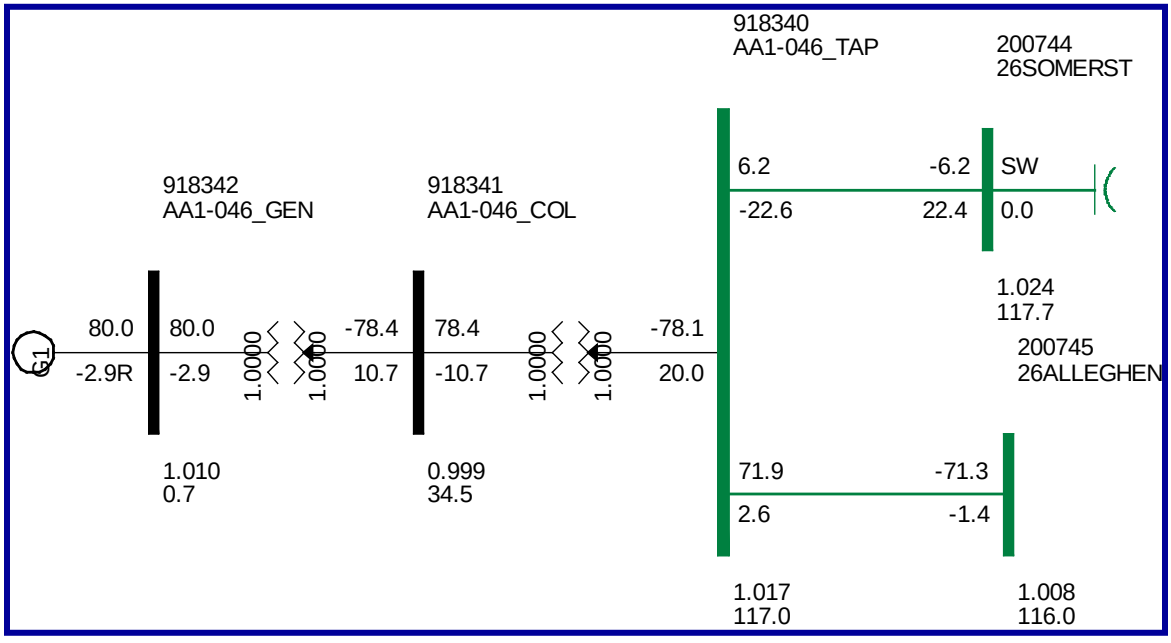


Figure C-1: Single-line diagram for AA1-046 2018-SP case (Breaker information not shown)

C.4) Area Generation

Bus Number	Bus Name	Id	Code	In Service	Pgen (MW)	Pmax (MW)
200499	ALTOONA SVC 230.00	1	2	1	0.0	0.0
200503	26C.SLOPE 115.00	1	2	1	99.0	99.0
200503	26C.SLOPE 115.00	31	2	1	50.0	50.0
200809	26SITHE 138.00	1	-2	1	36.0	36.0
200813	26YOUGH 4.0000	1	-2	1	6.0	6.0
200833	26SEWRDB34 22.000	1	-2	1	593.0	593.0
200834	26SOMERWIN 115.00	W1	-2	1	10.0	10.0
200835	26DSGENWIN 25.000	W1	-2	1	15.0	15.0
200837	26HOMER C1 20.000	1	2	1	620.0	620.0
200838	26HOMER C2 20.000	2	2	1	614.0	614.0
200839	26HOMER C3 24.000	3	2	1	650.0	650.0
200864	26FORWARD 34.500	W1	-2	1	27.0	28.0
200886	ARWF 34.500	W1	-2	1	80.0	80.0
200891	L13 0.5750	1	-2	1	40.5	40.5
291409	S-029 23.000	1	-2	1	5.7	5.7
292340	K-022 115.00	1	-2	1	1.7	1.8
293801	O-038 C 0.6900	1	-2	1	10.0	10.0
293802	O-038 E 0.6900	1	-2	1	40.0	40.0
294512	P-022 C 0.6900	1	-2	1	3.9	4.0
294902	P60 0.5750	1	-2	1	52.5	52.5
913241	Y1-033 WT C0.6900	1	-2	1	39.9	39.9
918342	AA1-046_GEN 0.6900	G1	2	1	80.0	80.0