Generation Interconnection
Facility Study Report

For

PJM Generation Interconnection Request
Queue Position AB2-169

Pantego – Five Points 115kV
39 MW Capacity / 74 MW Energy

August / 2018

General

This Facilities Study has been prepared in accordance with the PJM Open Access Transmission Tariff §207, as well as the Facilities Study Agreement between Wilkinson Solar LLC, (Interconnection Customer (IC)) and PJM Interconnection, LLC (Transmission Provider (TP)). IC has proposed a solar generating facility located at Terra Ceia Rd & Vreugdenhil Rd, Beaufort County, NC. The installed facilities will have a total capability of 74 MW with 39 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is December 31, 2019. **This study does not imply an ITO commitment to this in-service date.**

Point of Interconnection

AB2-169 will interconnect with the ITO transmission system via a new three breaker ring bus switching station that connects at the Pantego – Five Points 115kV line.

Cost Summary

The AB2-169 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$518,119
Direct Connection Network Upgrades	$5,448,314
Non Direct Connection Network Upgrades	$1,544,908
Allocation for New System Upgrades	$0
Contribution for Previously Identified Upgrades	$0
Total Costs	**$7,511,341**

A. Transmission Owner Facilities Study Summary

1. Description of Project

Queue AB2-169 is a request to interconnect 74 MW (Capacity 39 MW) of energy from a new solar facility located on Terra Ceia Road, west of the town of Pantego in Beaufort County, North Carolina. The proposed generation facility will interconnect with the ITO's Pantego – Five Points 115kV line #189 via a new three breaker ringbus switching station. The requested in-service date is December 31, 2019. Attachment Facility and Direct Connection Network upgrade construction is estimated to be 8 - 12 months.

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

Network Impacts

The Queue Project AB2-169 was evaluated as a 74.0 MW (Capacity 39.0 MW) injection as tapping into Five Points - Pantego 115kV in the ITO area. Project AB2-169 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AB2-169 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Analysis - 2020

Generator Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection)

None

Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)

None

Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

None

Affected System Analysis & Mitigation

Duke, Progress & TVA Impacts:

Duke Carolina, Progress, & TVA Impacts to be determined during later study phases (as applicable).

None

Delivery of Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

Only the most severely overloaded conditions are listed. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed, which will study all overload conditions associated with the overloaded element(s) identified.
None

3. Interconnection Customer's Submitted Milestone Schedule

- Plan to break ground January 15, 2019
- Permits – state level CPCN and county level Final Site Plan approval complete by November 30, 2018
- Turn over flat, graded site with 1 inch gravel to ITO for new switching station September 17, 2019
- Substantial site work completed October 30, 2019
- Delivery of major electrical equipment June 30, 2019
- Back Feed Power early to June 3, 2019
- Commercial Operation December 31, 2019

4. Scope of Customer's Work

IC will build a solar generating facility in Beaufort, North Carolina. The generating facility will be comprised of solar arrays. AB2-169 consists of 33 x 2.25 MW SMA Sunny Central inverters. The 33 x 34.5/0.55 kV generator step up (GSU) transformers with a rating of 2.5 MVA will connect the solar inverters to the 34.5 kV collector system. The generating facility will connect to the Point of Interconnection (POI) via a 115/34.5 kV wye grounded wye main power transformer with a rating of 51/68/85 MVA. The AB2-169 POI will be at a new Interconnection switching station on the Pantego – Five Points 115kV line.

5. Description of Facilities Included in the Facilities Study

The ITO will connect the proposed generator lead via Attachment Facilities to a new AB2-169 115kV switching station. The position of the switching station will be adjacent to the right of way of the existing 115 kV Transmission Line #189, on a property provided and rough graded by the IC. The station will be positioned in such a way that the two 115 kV Light Duty Backbones will be installed perpendicular with the existing transmission line, across Terra Ceia Road. The position of the new substation will require that the 115kV Line be routed over a major farm drain, railroad tracks, Terra Ceia Road and a distribution line – considerations to be made for this transmission termination. The line will be cut at Structure #189/219 and routed into the proposed New Three Breaker Ring Substation. The cut lines will consume two of the three positions in the ring bus. The third position will be for the 115 kV feed from the collector station for the solar farm, located adjacent to the New Three Breaker Ring Substation. The demarcation point between the New Three Breaker Ring Substation and the collector station will be the 4-hole pads on the collector station disconnect switch. The ITO will bring its bus to the demarcation point. Metering equipment will be required between the ITO bus and the IC collector station. The grounding systems for both the stations will be tied together. All substation permitting, site preparation and grading activity will be performed by the IC.

Remote relay work will include drawing updates and / or Islanding Transfer Trip schemes at Five Points DP., Wharton, Pantego, Trowbridge, Everetts Substations.

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

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
Substation	$295,747	$154,130	$51,366	$16,876	$518,119
Total Attachment Facilities Cost	$295,747	$154,130	$51,366	$16,876	$518,119
Queue AB2-169 switching station (n5620)	$2,291,977	$2,229,011	$576,152	$288,174	$5,448,314
Transmission line relocation (n5621)	$525,582	$653,667	$95,679	$62,248	$1,337,176
Remote relay (n5622)	$87,570	$85,680	$21,704	$12,778	$207,732
Total Network Upgrades	$2,905,129	$3,031,358	$693,535	$363,200	$6,993,222
Total Project Costs	$3,200,876	$3,185,488	$744,901	$380,076	$7,511,341

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

Facilities are estimated to take 14 - 24 months to construct. The timeline is highly dependent on outage availability as well as the developer providing an easement to cross the railway and road

Proposed Schedule

- Detailed design: 6 - 12 months
- Permitting: 6 - 12 months (Timeline runs concurrent with design)
- Construction 8 - 12 months

The current schedule targets are for the IC to supply the following in order for the ITO to supply backfeed power by June 3, 2019:

- to turn over a flat graded site by September 17, 2018
- obtain easement and permit to cross the rail road track by Feb 2019,
- obtain 911 address so that we can submit the communication request (this is a 14 month process so it is needed now),
- provide a site plan for the Collector Substation so that engineering can start,
- initiate procurement of the long lead material (breakers, control enclosure, backbone, transmission engineered structure) in time to make the date (this will also be difficult).

B. Transmission Owner Facilities Study Results

1. Attachment Facilities

The new 115kV Three Breaker Ring Substation will share a common foot print and fence line with queue AB2-169 Generator Collector Station. The demarcation point between the two

stations will be the 230kV Breaker Disconnect Switch 4-hole pad in the queue AB2-169 Generator Collector Station by the common fence. The ITO will bring its bus to the demarcation point.

The ITO Attachment Facilities will be the bus, structures, disconnect switch, metering accuracy CCVT's, metering accuracy CT's, metering equipment and protection devices for the Attachment line.

Purchase and install substation material :

1. One (1), 115kV, 2000A Center Break Switch
2. Three (3), 115kV, Metering Accuracy CCVT's
3. Three (3), 115kV, Metering Accuracy CT's
4. Conductors, connectors, conduits, control cables, foundations, steel structures and grounding material

Purchase and install relay material :

1. One (1), 1109 – 28" Dual SEL-587Z Transmission Bus Panel
2. One (1), 4200 – Bus Differential C.T. M.U. Box
3. One (1), 1425 – 28" Dual SEL-735 Metering Panel (Transmission & Generation Interconnect)
4. One (1), 4524 – Revenue Metering C.T. M.U. Box
5. One (1), 4531 – Generator Interconnect CCVT Potential M.U. Box
6. One (1), 1323 – 28" SEL-487E/735 PMU & PQ Monitoring Panel
7. One (1), 5603 – Station Network Panel 2 (Fiber)
8. Two (2), 4541 - Control Cable M.U. Box

2. Transmission Line – Upgrades

PJM Network Upgrade #n5621 – Five Points DP – Pantego 115kV line #189 to loop into and out of the new three breaker AB2-169 Switching station at structure 189/219.

The 189 line between Five Points DP and Pantego Substation was built in 1993. Its typical structure type is wood and concrete monopoles. The project work summary is described below:

EXISTING FACILITIES TO BE REMOVED

1. Remove (1) Wood monopole suspension structure 189/219

EXISTING FACILITIES TO BE TRANSFERRED

1. Transfer existing 3-phase 4/0 ACSR conductor and 3#6 static wire to new steel DC monopole 189/219

PERMANENT FACILITIES TO BE INSTALLED

1. Install (2) Galvanized Steel DC monopoles DDE structures.
2. Install (2) 115KV Standard Backbones Structures.
3. Install (1) Engineered Static Pole.
4. Install *approximately 0.11 miles* of 3-phase 768 ACSS (20/7) conductor.
5. Install *approximately 0.15 miles* of 7#7 ALWD static wire

DESIGN NOTES:

1. No FOSW is required for this project
2. New ROW is required (100' wide by 250'), for the spans that tap off the main line cross a railroad, drainage ditch, and a road
3. Estimate includes the cost for installation of static and conductor dampers in all spans as well as the replacement and installation of all existing fault indicators

3. New Substation/Switchyard Facilities

PJM Network Upgrade #n5620 - Build a three breaker AB2-169 115 kV switching station. The site is located near the ITO's existing right of way for the Five Points – Pantego 115kV line #189.

Queue AB2-169 requires a new 115kV three breaker ring-bus substation at transmission structures 189/219. The site is located along the ITO's existing 115kV, 189 Line from Five Points DP to Pantego Substation. The cut line will consume two of the positions in the ring bus. The third position will be for the 115kV feed from queue AB2-169 Generator Collector Station. The new 115kV Three Breaker Ring Substation will share a common foot print and fence line with queue AB2-169 Generator Collector Station. The grounding systems for each station will be tied together.

Purchase and install substation material :

1. Approximately 300' X 230' site preparation and grading as required for installation of the switching station (by Otter Creek Solar, LLC) not including any added land as required for SWM, etc
1. Approximately 1060 linear FT of 5/8" Chain Link, 12 FT tall, perimeter fence around the station along with the security cameras and integrators (Design 4 Standard).
2. Full substation ground grid as per engineering standards
3. Two (2), Single Circuit Backbones (by Transmission)
4. One (1), Shield wire pole and two span of shield wires (by Transmission)
5. Three (3), 115kV, 3000A, 40 kA, SF6 Circuit Breakers
6. Six (6), 115kV, 2000A Center Break Switches
7. Six (6), 115kV, CCVT's, relay accuracy
8. Two (2), 2000A, Vertically Mounted, Wave Traps along with two (2), Line Tuners
9. Nine (9), 90kV MO, 74kV MCOV Station Class Arresters
10. Four (4), 115kV, 100 KVA Power PT's for Station Service
11. Two (2), 115kV, 2000A, 2-Pole Center Break Switches (for PVT's)
12. One (1), 24' x 40' Control Enclosure
13. One (1), 135VDC, 577Ah Batteries and 50A Charger
14. Oil Containment system for the 115kV PVT's.
15. Cable Trough, concrete w/cover, 2' 6'' wide, approximately 250 FT, with a 20 FT road crossing section.
16. Steel structures as required including switch stands, bus supports, station service transformers, CCVT and wave trap supports
17. Foundations as required including control house, equipment and bus support stands
18. Conductors, connectors, conduits, control cables and grounding materials

Purchase and install relay material:

1. Three (3), 1510 – 28" Dual SEL-351-7 Transmission Breaker w/ Reclosing Panel

2. Three (3), 4510 - SEL-2411 Breaker Annunciator
3. Two (2), 1320 – 28" Dual SEL-421-5 DCB Line Panel
4. Two (2), 4506 – 3 Phase CCVT Potential M.U. Box
5. One (1), 1603 – 28" SEL-451 Islanding Control Scheme Panel
6. Two (2), 4000 – Station Service Potential M.U. Box
7. Two (2), 4018 – 500A Station Service AC Distribution Panel
8. Two (2), 4007 – 225A Outdoor Transmission Yard AC NQOD
9. Two (2), 4019 – 225A Three Phase Throwover Switch
10. Two (2), 4016 – 600A PVT Disconnect Switch
11. One (1), 4153 – Wall Mount Station Battery Monitor
12. One (1), 5612 - SEL-3530 Data Concentrator Panel
13. One (1), 1255 – Station Annunciator Panel
14. One (1), 5021 – SEL-2411 RTU Panel
15. One (1), 5609 – Fiber Optic Management Panel
16. Three (3), 4526_A – Circuit Breaker Fiber Optic M.U. Box
17. One (1), 5202 – 26" APP 601 Digital Fault Recorder
18. One (1), 5603 – Station Network Panel 1
19. One (1), 5616 – Station Security Panel
20. One (1), Telephone Interface Box
21. One (1), High Voltage Protection (HVP) Box (Provided by IT)

4. Upgrades to Substation / Switchyard Facilities

PJM Network Upgrade #n5622 - Remote protection and communication work. ITO protection requirements to reliably interconnect the proposed generating facility with the transmission system determined that work is required at Five Points DP., Wharton, Pantego, Trowbridge, Everetts Substations.

Everetts 115kV Substation

Project Summary

Install Line 82 Islanding Transfer Trip set to support new generator and Queue AB2-169 Switching Station.

Purchase and install relay material (Everetts Substation):

1. One (1), Islanding Transmission Transfer Trip set CT–51C.

Five Points DP Substation

Project Summary

Drawing updates required and any field support necessary to change the destination from Pantego Substation to the new Queue AB2-169 Switching Station.

Pantego Substation

Project Summary

Install Line 1020 & old 189 Islanding Transfer Trip set to support new generator and Queue AB2-169 Switching Station.

Purchase and install relay material:

1. One (1), 1604 – 28" Transmission Transfer Trip Panel

Trowbridge Substation

Project Summary

Install Line 1020 Islanding Transfer Trip set to support new generator and Queue AB2-169 Switching Station.

Purchase and install relay material:

1. One (1), Islanding Transmission Transfer Trip set CT–51C.

Wharton Substation

Project Summary

Install Line 82 & 189 Islanding Transfer Trip set to support new generator and Queue AB2-169 Switching Station.

Purchase and install relay material:

1. One (1), 1604 – 24" Transmission Transfer Trip Panel

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
Everetts	$13,067	$15,100	$3,444	$2,252	$33,863
Five Points	$5,460	$0	$1,818	$0	$7,278
Pantego	$27,988	$27,740	$6,499	$4,137	$66,364
Trowbridge	$13,067	$15,100	$3,444	$2,252	$33,863
Wharton	$27,988	$27,740	$6,499	$4,137	$66,364
Total Remote Relay Upgrades	$87,570	$85,680	$21,704	$12,778	$207,732

5. Metering & Communications

PJM Requirements

The IC will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Sections 24.1 and 24.2.

Meteorological Data Reporting Requirement

The solar generation facility shall provide the Transmission Provider with site-specific meteorological data including:

- Temperature (degrees Fahrenheit)
- Atmospheric pressure (hectopascals)
- Irradiance
- Forced outage data

ITO Requirements

Metering and SCADA/Communication equipment must meet the requirements outlined in section 3.1.6 Metering and Telecommunications of ITO's Facility Interconnection Connection Requirement NERC Standard FAC-001 which is publically available at www.dom.com.

At the IC's expense, the ITO will supply and own at the Point of Interconnection bi-directional revenue metering equipment that will provide the following data:

a. Hourly compensated MWh received from the Customer Facility to the ITO;
b. Hourly compensated MVARh received from the Customer Facility to the ITO;
c. Hourly compensated MWh delivered from the ITO to the Customer Facility; and
d. Hourly compensated MVARh delivered from the ITO to the Customer Facility.

The IC will supply and own metering equipment that will provide Instantaneous net MW and MVar per unit values in accordance with PJM Manuals M-01 and M-14D, and Sections 8.1 through 8.5 of Appendix 2 to the ISA;

The IC will access revenue meter via wireless transceivers or fiber cabling to meter with RS-485 or Ethernet communication port for dial-up reads. IC must provide revenue and real time data to PJM from Interconnection Customer Market Operations Center per "PJM Telemetry Data Exchange Summary" document available at PJM.com.

6. Environmental, Real Estate and Permitting Issues

The IC would be responsible for the following expectations in the area of Environmental, Real Estate and Permitting:

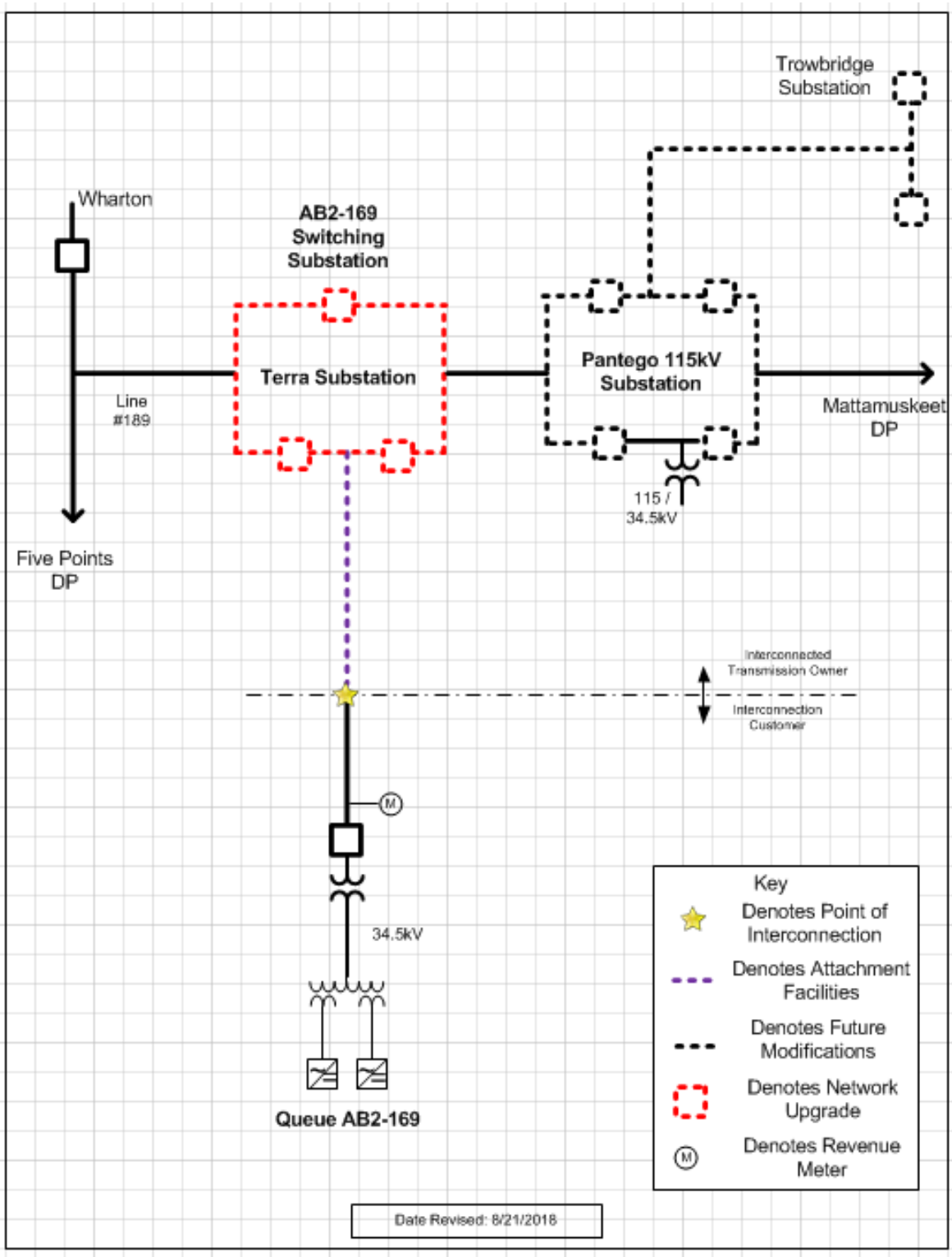
- Suitable Access Road from Substation to a North Carolina Maintained Roadway.
- Any additional land needed for Storm Water Management, Landscaping, and Wetlands/Wetlands Mitigation.
- Conditional Use Permit for Substation.
- Any other Land/Permitting requirements required by the Substation.

ITO Real Estate Needs:

- The substation layout is complete and ITO requires a 230'x 300' piece of property (title in fee) to build the substation. The property includes the piece of property between the substation and collector station for the strain bus.
    - ITO requires ownership transfer of the substation site before they start construction. Target for the deed by September 17, 2018.

    - The size of the station assumes ITO will not need a separate storm water management system for the substation. If the county rules differently than the ITO will need to revisit the land requirements.
- New transmission Right Of Way is required (100' wide by 250'), for the transmission spans that tap off the main line cross a railroad, drainage ditch, and a road
- ITO will need a letter similar to the zoning letter from the county stating that if the solar farm is retired and / or decommissioned the substation will remain.

Attachment 1.
Single Line



Attachment 2.
Site Plan