

***Generation Interconnection
Facility Study Report***

For

***PJM Generation Interconnection Request
Queue Position AA1-064***

Heritage – Wake 500kV

Aug / 2016

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 Gaston Green Acres Solar, LLC, (Interconnection Customer (IC)) and PJM Interconnection, LLC (Transmission Provider (TP)). The IC has proposed a solar generating facility located at 1057 N Carolina 46 Gaston in Northampton, North Carolina. The installed facilities will have a total capability of 80 MW with 56 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is October 31, 2019. **This study does not imply an ITO commitment to this in-service date.**

Point of Interconnection

AA1-064 will interconnect with the [ITO transmission system via a new “Beddingfield” three breaker ring bus switching station that connects on the Heritage – Wake (Duke) 500kV line.

Cost Summary

The AA1-064 project will be responsible for the following costs:

| Description | Total Cost |
|---|---------------------|
| Attachment Facilities | \$ 1,005,778 |
| Direct Connection Network Upgrades | \$17,250,487 |
| Non Direct Connection Network Upgrades | \$ 1,279,337 |
| Allocation for New System Upgrades | \$0 |
| Contribution for Previously Identified Upgrades | \$0 |
| Total Costs | \$19,535,602 |

A. Transmission Owner Facilities Study Summary

1. Description of Project

AA1-064 will interconnect a new 80MW solar facility to be located in Northampton County, North Carolina with the ITO transmission system via a new “Beddingfield” three breaker ring bus switching station that connects on the Heritage – Wake (Duke) 500kV line #570. The requested in-service date for the first phase is October 31, 2019. Attachment Facility and Direct Connection Network upgrade construction is estimated to be 16-18 months from the Effective Date of the Interconnection Service Agreement.

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

Stability and Reactive Power Requirements were analyzed as part of the Facilities Study. All fault contingencies tested on the 2018 summer peak case met the recovery criteria. No mitigations were found to be required.

3. Interconnection Customer’s Submitted Milestone Schedule

- Turn over flat, graded site to ITO for new Beddingfield switching station 6/1/2018
- Substantial site work completed 4/29/2019
- Delivery of major electrical equipment 8/28/2019
- Backfeed power 10/1/2019
- Commercial Operation
 - Phase one 10/31/2019
 - Phase two 12/31/2019

4. Scope of Customer’s Work

IC will build a solar generating facility in Northampton County, North Carolina. The generating facility will be comprised of 108 solar arrays. The solar arrays will be connected to 54 x 1.5 MW PowerOne Ultra 1500-TL-OUTD solar inverters. The 27 x 34.5/0.69 kV generator step up (GSU) transformer’s will connect through four 34.5kV circuit breakers to a 34.5kV bus. The generating facility will be connected to the Point of Interconnection (POI) via a 954 ACSR generator lead to two x 500/34.5/13.8 kV main collector transformer with a rating of 24/32/40 (OA/F1/F2) MVA.

5. Description of Facilities Included in the Facilities Study

The ITO will connect the proposed generator lead via Attachment Facilities to a new Beddingfield 500kV ring bus switching station. The Beddingfield 500kV ring bus switching station will be Heritage – Wake 500kV line #570 will looped into and out of the Beddingfield switching station. There will be transmission line protection and anti-islanding work required at

the remote lines terminals in Heritage and Wake (Duke) 500kV substation. The single line is shown in Attachment 1.

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

| Work Description | Direct | | Indirect | | Total Cost |
|--|--------------------|--------------------|--------------------|--------------------|---------------------|
| | Labor | Material | Labor | Material | |
| Attachment Facilities | \$431,839 | \$336,335 | \$132,750 | \$104,854 | \$1,005,778 |
| Total Attachment Facilities Cost | \$431,839 | \$336,335 | \$132,750 | \$104,854 | \$1,005,778 |
| Beddingfield 500 kV Substation (n4720) | \$5,491,552 | \$7,410,206 | \$2,137,096 | \$2,211,633 | \$17,250,487 |
| Loop transmission line #570 into Beddingfield substation (n4721) | \$481,099 | \$325,304 | \$153,415 | \$94,532 | \$1,054,350 |
| Remote substation protection and communication (n4722) | \$136,774 | \$29,658 | \$45,237 | \$13,318 | \$224,987 |
| Total Network Upgrades | \$6,109,425 | \$7,765,168 | \$2,335,748 | \$2,319,483 | \$18,529,824 |
| Total Project Costs | \$6,541,264 | \$8,101,503 | \$2,468,498 | \$2,424,337 | \$19,535,602 |

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

The ITO schedule duration is:

- Engineering 5- 7 months
- Construction 10 – 12 months

Total Timeline to Engineer and Construct the proposed facilities is 16-18 months and is based on the ability to obtain outages to construct and test the proposed facilities. Engineering and construction timelines are based on the IC providing a graded and permitted site to the ITO at the time of executing an ICSA.

B. Transmission Owner Facilities Study Results

1. Attachment Facilities

The attachment facilities include that portion of the interconnecting switching station which is associated solely with the single feed to the generating facilities. The equipment associated with the Attachment Facilities includes the following. The work required is as follows:

1. Three (3), 500kV Metering Accuracy CCVTs
2. Three (3), 500kV Metering Accuracy CTs
3. One (1), 500kV, 4000A, Double End-Break Switch
4. Install flexible conductor, rigid bus (6" Aluminum Tubing), connectors, conduit, control cable, foundations, structural steel, cable trough and grounding material as necessary.

Purchase and Install Attachment Facilities 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), 1421 – Generation/NUG/PJM/IPP Metering Panel
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), 1611 – 28” SEL-451 PMU Panel w/SEL 735/735
7. One (1), Customer Interface Box

2. Transmission Line – Upgrades

The following estimate is for the transmission line work to loop it into and out of the proposed new “Beddingfield” switching station on Transmission Line 570 between Heritage Substation and Wake Substation (Duke). (PJM Network Upgrade #n4721).

Permanent facilities to be installed

1. Install one (1) Single Circuit 500kV backbone structure with concrete foundations in proposed Beddingfield Substation.
2. Deadend existing 7#7 static and 2-2500 ACAR Conductor on the proposed backbone at Beddingfield Substation.
3. Install two sets of 3-phase 2-2500 ACAR risers for lines 570 and 5XX.
4. Renumber the Beddingfield – Heritage section of line 570 to line number 5XX. The structure numbers shall remain the same, only the line number changes, There are approximately 92 structures in this section (Existing BB 570/122 to existing suspension structure 570/213)

Design notes

1. The final location of the Solar facility was not firmly established at the time of this estimate. The project scope was evaluated and established for location between existing spans 570/213 – 570/214 or 570/214 – 570/215.
2. The new substation will break Line 570. The new line number will be assigned upon final project approval.

3. New Substation/Switchyard Facilities

A three breaker 500 kV “Beddingfield switching station (PJM Network Upgrade #4720).

Purchase and install the following:

1. Substation Pad to be purchased, cleared and graded by Sun Energy One per Dominion Civil Engineering Design Standards for Substation Sites (VEP-2964 Rev 1)
2. One (1), 500kV A-Frame Dead-End Structure (by Transmission Lines)
3. Three (3), 500kV Relay Accuracy CCVTs (to Heritage Substation)
4. Three (3), 500kV Metering Accuracy CCVTs (to Wake Substation)
5. Three (3), 500kV Metering Accuracy CTs (to Wake Substation)
6. Two (2), 500kV, 4000A Wave Traps
7. Six (6), 500kV, 4000A, Double End-Break Switches

8. Three (3), 550kV, 4000A, 50kA, SF6 Dead Tank Breakers
9. Six (6), 396kV MO, Station Class, 318kV MCOV Arresters
10. One (1), 24' X 50' Control Enclosure
11. One (1), 300AH Battery and 50A Charger
12. Install Primary Station Service from nearby 15kV source (upgrade to three phase service)
13. Two (1), 150kW Generator w/ Propane Tanks (Secondary Station & HS Fence Service)
14. Install 20'-0" High Security Fence w/ two (2) 20'-0" Slide Gates
15. One (1), Security Control Enclosure
16. Install High Voltage Protection
17. Install flexible conductor, rigid bus (6" Aluminum Tubing), connectors, conduit, control cable, foundations, structural steel, cable trough and grounding material as necessary

Purchase and Install Relay Material:

1. Three (3), 1510 – 28" Dual SEL-351 Transmission Breaker w/ Reclosing Panel
2. Three (3), 4510 - SEL-2411 Breaker Annunciator
3. One (1), 1320 – 28" Dual SEL-421-5 DCB Line Panel
4. Two (2), 1320 – 28" Single SEL-421-5 DCB Line Panel (570 Line to Wake)
5. Two (2), 4506 – 3 Phase CCVT Potential M.U. Box
6. One (1), 1421 – Generation/NUG/PJM/IPP Metering Panel
7. One (1), 4524 – Revenue Metering C.T. M.U. Box
8. Two (2), 4018 – 800A Station Service AC Distribution Panel
9. Two (2), 4007 – 225A Outdoor Transmission Yard AC NQOD
10. Two (2), 4019 – 225A Three Phase Throwover Switch
11. Four (4), 4000 – Station Service Potential M.U. Box
12. Three (3), 600A Fused Disconnect Switch
13. Two (2), 600A Non-Fused Disconnect Switch
14. One (1), 600A Throwover Switch
15. One (1), 4527 – Security Power Fiber MU Box
16. Two (2), 4529 – Emergency Generator & ATS Alarm Interface Box
17. One (1), 4153 – Wall Mount Station Battery Monitor
18. One (1), 5612 - SEL-3530 Data Concentrator Panel
19. One (1), 1255 – Station Annunciator Panel
20. One (1), 5021 – SEL-2411 RTU Panel
21. One (1), 5609 – Fiber Optic Management Panel
22. Three (3), 4526_A – Circuit Breaker Fiber Optic M.U. Box
23. One (1), 5202 – 26" APP 601 Digital Fault Recorder
24. One (1), 5203 – 24" Traveling Wave Fault Locator Panel
25. One (1), 5603 – Station Network Panel
26. One (1), 5611 – Transmission Fiber Patch Panel
27. One (1), 5603 – Station Security Panel
28. One (1), Telephone Interface Box

4. Upgrades to Substation / Switchyard Facilities

Remote protection and communication work (PJM Network Upgrade #4721). ITO protection requirements to reliably interconnect the proposed generating facility with the transmission system determined that work is required at Heritage 500kV substations. The installation of the

new Beddingfield Substation splits the 570 Line approximately 20 miles from Heritage Substation.

Heritage 500 kV Substation

Queue project AA1-064 provides for the installation of Beddingfield Substation. This is a 500kV Solar Generator Interconnect that will split the 570 Line between Heritage and Wake (Duke) Substations. Due to this split, the function of equipment associated with metering the 570 Line to Wake will now move to the new Beddingfield Substation. At Heritage this will include removal of the Line 570 Metering Panel and external Metering CT's. The Wave Trap at Heritage will be replaced to accommodate new frequencies. Changes will be made to the Line 570 relay protection including removal of Primary 2 Carrier Set, enabling Line Transfer Trip, and relay resets. Drawing line destinations will be changed from Wake (Duke) to Beddingfield Substation. The line number will change as well. This project is associated with Project GITAA1064, installation of Beddingfield Substation.

Purchase and install substation material:

1. One (1), 4000A, 115-300kHz Vertically Mounted Wave Trap

Remove:

1. Three (3), 500kV Metering Class CTs and associated Pipe Stands

Purchase and install relay material:

1. One (1), Panel Retirement (Panel 18)

Wake (Duke)

IC will need to enter into a Construction Agreement with Duke for any upgrades at Wake Substation to ensure relay coordination with Beddingfield Substation.

5. Metering & Communications

PJM Requirements

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

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 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 State 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 would prefer to own the Substation in fee simple but would accept a perpetual easement.

The expected substation fence line is 304' x 185'.

Attachment 1. Single Line

