PJM Generator Interconnection Request
Queue AB1-180
Piney View 12 kV
Feasibility/Impact Study Report

February 2016

Preface

The intent of the Feasibility/System Impact 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 possibility of sharing the reinforcement costs with other projects may be identified in the Feasibility Study, but the actual allocation will be deferred until the Feasibility/System Impact Study is performed.

The Feasibility/System Impact Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. The project developer 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.

This report is divided into two sections:

Part I – AEP Distribution Planning Analysis and Results
Part II – Transmission Planning Analysis and Results

Part I - AEP Distribution Planning Analysis and Results

Request

Seven Islands Environmental Solutions, LLC (customer) has requested a combined Feasibility/System Impact Study for two synchronous methane gas generators capable of 4 MVA maximum output power. This installation will be referred to as a distributed generation (DG) facility in the remainder of this study. The proposed generators are to be installed at the Raleigh County Landfill and will generate electricity by burning methane gas. It is the customer's intention to export power to the utility grid. The customer plans to install two-2000 KVA generators initially. The customer has plans for a third generator in the future and has requested that the distribution line be designed for a 5 MVA interconnection. The customer plans to begin generating power later this year. Please see **Figure 1** of this report for the location of facilities, and **Figure 2** for a single line diagram showing the interconnection to the AEP electric transmission and distribution system.

The generators will operate 24 hours per day, seven days per week, except for routine maintenance and unplanned outages.

The DG will be served from the 12 kV, Whitestick/Piney View Feeder. The preferred point of service is AEP pole 38820777A20662.

The AEP Customer DR Interconnection Guide is referred to throughout this document and it is assumed the customer has received a copy to guide them through the application process. A copy of the AEP Customer DR Interconnection Guide is attached for reference.

Disclaimer

The results of this impact study apply only to the system described in the attached Distributed Generation Interconnection Request. All modeling is based on a Transformer/Generator location at the Raleigh County Landfill.

This review is limited to equipment affecting the AEP system operations. The customer must take all necessary steps to assure compliance with all laws, ordinances, building codes and other applicable regulations. AEP granting approval of the requested connection is not an endorsement of a particular design nor does it assure fitness of the DG to accomplish an intended function.

The customer is expected to understand and comply with IEEE 1547 concerning the DG installation and its requirements for interconnection with the utility grid. The customer is required to have the DG Installation tested by a third party as outlined in IEEE 1547-1. The third party will provide APCO with a certified letter stating that the DG Installation was tested and met all of the guidelines per IEEE 1547-1 before final approval will be granted.

Modeling and Assumptions

The Raleigh County Landfill is served from the 46-12 KV, Whitestick Station via the Piney View Feeder. The Piney View Feeder is a radial configuration, three-phase multi-grounded four-wire, wye system. The primary voltage is 12.47 kV line-to-line and 7.2 kV line-to-ground. Presently, the land fill takes a 120/240 volt service for the scales.

The DG system will consist of two Caterpillar, G3520C generators. The DG will contribute up to a maximum of 4 MVA at 80% power factor when operating. The DG output voltage is 4,160 volts. The voltage will be stepped up to 12.47 KV through two 2,500 kVA, 4.16/12.47 KV step-up transformers. The customer's facilities will be protected by an 800 Amp, 15 kV, Viper recloser with a Schweitzer, SEL-651R control. The requested AEP service will connect to the customer through a primary metered PCC.

The customer owned 2,500 kVA, 4.16/12.47 KV step up transformers will be configured Wye-Wye and have an impedance of Z=5.8%. From the point of common coupling, the customer will run 170' of 15 kV, 350 copper cables to a Medium Voltage Switchboard (MVSB). Each transformer will be connected to the MVSB via 35' of 15 kV, #2 copper cable.

Each generator is connected to the main 4 KV bus via a 1200 Amp breaker (52-G).

The DG system is assumed to be equipped with appropriate voltage regulation. As previously stated, the DG system will be operated in parallel with the AEP System and the customer intends to export power to the utility grid.

Analysis

The system conditions of concern are:

1. Generator location.
2. Generator fault contribution.
3. Generator effect on system steady state voltage at peak load.
4. Generator effect on system steady state voltage at light load.
5. Generator effect on power flow at the Whitestick Station transformer.

DG Location

The DG system's modeled location is at AEP distribution pole #38810777A20662.

Fault Contribution

Maximum available fault at PCC

The total maximum available three-phase bolted fault (LLL) at the customer PCC is 4,187 amps symmetrical when the DG system is connected. The maximum available AEP contribution to a three-phase bolted fault (LLL) at the customer PCC is 3,241 amps symmetrical.

The total maximum available single-phase fault (LG) at the customer PCC is 2,935 amps when the DG is connected. The maximum available AEP contribution to a single-phase fault (LG) at the customer PCC is 2,515 amps symmetrical.

The DG system results in a 29.2% raise in available three-phase bolted fault (LLL) and a 16.7% raise in available L-G fault when connected. The rise in fault current exceeds the 4,000 Amp interrupting rating on a set of 3-140 Amp L reclosers. These reclosers will have to be upgraded with V4L units which have an interrupting rating of 6,000 Amps. Other than the reclosers, the rise in fault current is not expected to significantly impact the operation of the AEP protection system at Whitestick Station. It is important to note that these values are subject to change if AEP distribution system enhancements and/or substation enhancements are made in the future. These values are also subject to change if the customer changes their equipment.

System Protection

The customer responsibilities include providing adequate protection to AEP facilities due to events arising from the operation of the DG under all AEP distribution system operating conditions. The customer is responsible for protecting their own facility under all AEP distribution system operating conditions whether the DG is connected to AEP facilities or not, including but not limited to:

1. Abnormal voltage or frequency
2. Loss of a single phase of supply
3. Equipment failure
4. Distribution system faults
5. Lightning
6. Excessive harmonic voltages
7. Excessive negative sequence voltages
8. Separation from supply
9. Loss of synchronization

Ground Current Sources – Protective relays must be utilized to detect line-to-ground faults. Seven Islands Environmental shall provide adequate protection to comply with IEEE 1547 to clear generation source for all types of faults on the AEP system including any breaker failure events. Adequate protection requires that all fault types are cleared before equipment damage occurs to AEP facilities. If Seven Islands fails to provide adequate protection for faults on the AEP system, then Seven Islands will pay all costs associated with AEP facility damage.

When the AEP source breakers trip and isolate Seven Lakes' facilities, Seven Lakes shall ensure that their generation equipment is disconnected from AEP facilities in accordance with requirements established in IEEE 1547 prior to automatic recloser by AEP.

Automatic reclosing out-of-phase with Seven Lakes' generation equipment may cause damage to Seven Lakes' equipment. Seven Lakes is solely responsible for the protection of their equipment from automatic reclosing by AEP.

Under Frequency Load Shedding(UFLS) is enabled on the Piney View SEL 351S control. Transmission Operations has been consulted and the UFLS settings will be disabled prior to the interconnection.

Voltage Regulation

Generator effect on system steady state voltage at peak load

The generator output has negligible effect on utility voltage at peak demand load.

Generator effect on system steady state voltage at light load

Light load conditions are assumed to be ½ peak demand. The generator output has negligible effect on utility voltage at light demand load.

Generator effect on power flow for the Whitestick Transformer during light load

During fall and spring months, the load on Piney View Feeder drops as low as 1.5 MVA. During light load periods, the possibility exists that power will flow back through the Whitestick transformer and on to the Beckley-Bradley 46 kV line. The Whitestick transformer is an LTC regulated transformer but is equipped with an LTC control that can handle the back flow of power.

Summary

Facilities

The proposed interconnection will require the following improvements:

Distribution Line Improvements:

- Reconductor 1,000 ft. of existing 12 kV, #2AA primary with 556 AL primary
- Construct 2,500 ft. of new, 12 kV, 1/0 AA primary
- Install 15 kV, 600 Amp hook operated switches on the source side of the primary metering
- Installation of 1-800 Amp, Viper Recloser with SEL-651R control
- Upgrade 3-140 Amp L reclosers with V4L units

$174,700

Telecom/Communications:

- Install cellular antenna, Coax, CGR Router and mis hardware

$22,000

SCADA Interface

- Install a B9 cabinet on the customer's recloser pole, Install Cooper SMP4-RTU, create the Relay Point Assignment (RPA) document, test and perform the SCADA checkout.

$56,000

Metering

- Install bi-directional primary metering (5 MVA capability)

$9,100

Total Project Cost: $261,800

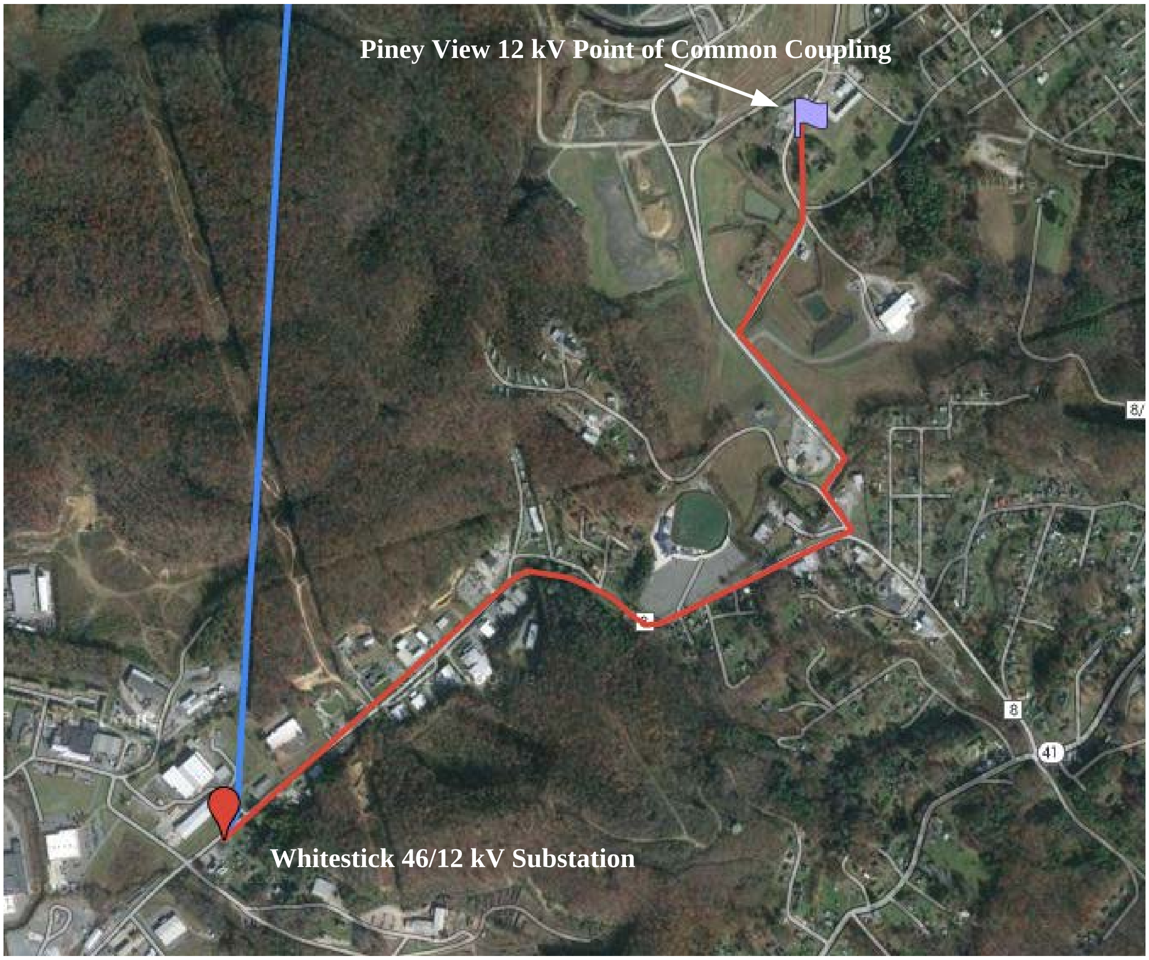

Figure 1 – Location of Point of Common Coupling (PCC) and Point of Interconnection (POI)

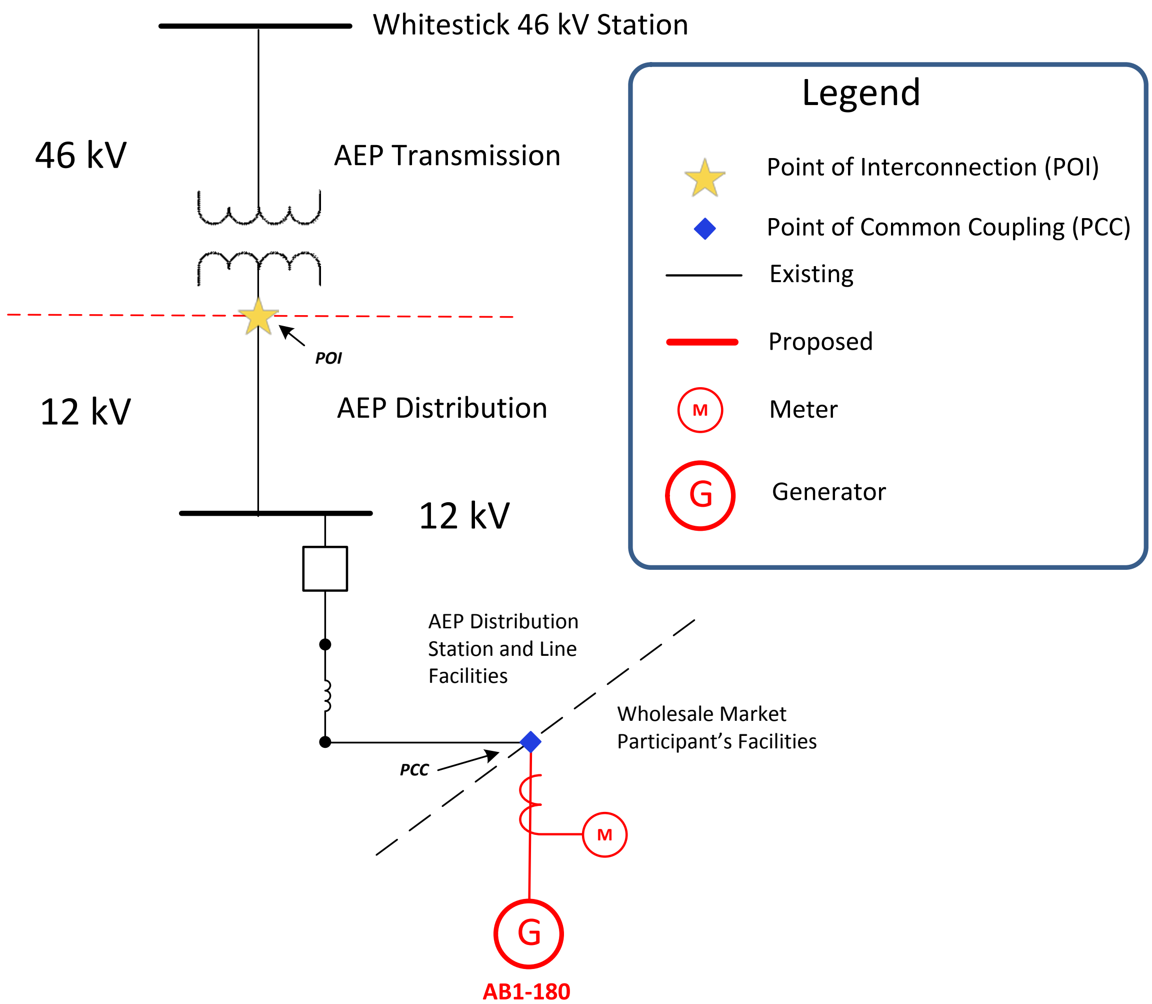

Figure 2 – Single Line Diagram

Part II – Transmission Planning Analysis and Results

Network Impacts

The Queue Project AB1-180 was studied as a 3.2 MW (Capacity 2.4 MW) injection at the Whitestick 46 kV substation in the AEP area. Project AB1-180 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AB1-180 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Analysis - 2019

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

Steady-State Voltage Requirements

(Results of the steady-state voltage studies should be inserted here)

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

Light Load Analysis - 2018

Not required

System Reinforcements

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)

None

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)
(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

None

Short Circuit

(Summary form of Cost allocation for breakers will be inserted here if any)

None

Stability and Reactive Power Requirement

(Results of the dynamic studies should be inserted here)

Not required