Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AB1-159

Wakefield 34.5kV 3.8MW Capacity / 10MW Energy

Revised April / 2016

Introduction

This Feasibility Study has been prepared in accordance with the PJM Open Access Transmission Tariff, 36.2, as well as the Feasibility Study Agreement between the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is Virginia Electric and Power Company (VEPCO).

Preface

The intent of the Feasibility Study is to determine a plan, with high level estimated cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the IC. The IC may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the IC may be responsible for the cost of constructing: (1) Direct Connections, which are new facilities and/or facilities upgrades needed to connect the generator to the PJM network, and (2) Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system.

In some instances a generator interconnection may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection, 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 Impact Study is performed.

The Feasibility Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. The IC is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by ITO, the costs may be included in the study.

General

The IC has proposed a solar generating facility located in Surry County, VA. The installed facilities will have a total capability of 10 MW with 3.8 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is 10/31/2017. **This study does not imply an ITO commitment to this in-service date.**

Point of Interconnection

AB1-159 will interconnect with the ITO distribution system via a tap onto Wakefield 34.5 circuit 301.

Transmission Owner Scope of Work

The IC site is approximately 12 miles from the IC site. There is an existing distribution line of single-phase 19.9 kV adjacent to the IC's site and the requested POI. The existing 19.9 kV distribution line is served from a 12.5 MVA 115/34.5 kV transformer in Wakefield substation.

Attachment facilities and local upgrades (if required) along with terms and conditions to interconnect AB1-159 will be specified in a separate two party Interconnection Agreement (IA) between ITO and the IC as this project is considered FERC non-jurisdictional per the PJM Open Access Transmission Tariff (OATT). From the transmission system perspective, no network impacts were identified as detailed below. The single line is shown below in Attachment 1.

Attachment Facilities

To provide the interconnection the ITO will install approximately 800 feet of overhead three phase primary voltage conductors to provide an interconnection to the existing primary voltage conductors. A pole mounted electronic recloser, pole mounted primary bi-directional metering equipment, a power quality monitoring relay and a set of disconnects to provide an isolation point will also be provided. The estimated cost of these attachment facilities is $300,000. In addition to the upfront cost of the Attachment Facilities there will be an ongoing monthly charge for the Operation and Maintenance of the Attachment Facilities. These costs do not include CIAC Tax Gross-up. The single line is shown below in Attachment 1.

Local Upgrades Cost Estimate

To accept the requested 10 MW there will be approximately 9.5 miles of reconductoring and upgrading various sized conductors to 477 MCM al. This generation will require a substation transformer upgrade to a 33 MVA 115/34.5 kV from the existing 12.5 MVA. The complexity of the substation work will be more defined in the Combined System Impact/Facility Study phase. Transfer Trip will be studied as a worst case option.

- Reconductor approximately 8 miles of the existing 4/0 or 346Al to 477Al. Reconductor and add conductors to be three phase for approximately 1 mile. The anticipated cost is $2,800,000. The existing conductor can accept a 7.5MW generation request although further studies would be required to determine if generation ramping triggers voltage change greater than the allowable 3%.
- A Transfer Trip protection scheme may be required with anticipated cost of $300,000. This required may be waived in lieu of the IC installing external resistance grounding or a ground bank transformer depending on transformer configuration.
- Substation upgrades including but not limited to the installation of a new transformer, circuit breaker, control house, and getaway protection will have an anticipated cost of $3,500,000. The existing 12.5MVA transformer is limited to a 7.5MW generation request.

The estimated time to interconnect the IC with the required System Upgrades is 18-24 months from the execution of an IA and payment of the estimated cost to build the ITO's Attachment Facilities and System Upgrades.

The total preliminary cost estimate for Direct Connection work is given in the table below:

Description	Total Cost

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New 34.5kV circuit to Wakefield substation	$2,800,000
Transfer trip	$ 300,000
Wakefield substation upgrade	$3,500,000
	$6,600,000

Remote Terminal Work: During the Facilities Study, ITO's System Protection Engineering Department will review transmission line protection as well as anti-islanding required to accommodate the new generation and interconnection substation. System Protection Engineering will determine the minimal acceptable protection requirements to reliably interconnect the proposed generating facility with the transmission system. The review is based on maintaining system reliability by reviewing ITO's protection requirements with the known transmission system configuration which includes generating facilities in the area. This review may determine that transmission line protection and communication upgrades are required at remote substations.

Interconnection Customer Requirements

ITO's Facility Connection Requirements as posted on PJM's website
http://www.pjm.com/~/media/planning/plan-standards/private-dominion/facility-connection-requirements1.ashx

The ITO's preferred transformer configuration is wye grounded (primary)/delta (secondary) with provisions for external resistance grounding of the primary with the level of resistance to be determined by the IC and approved by the ITO. If a wye (primary)/wye (secondary) transformer configuration is utilized the IC may need to apply a ground bank configured transformer [zig-zag or wye (interconnection side) – delta (floated)] at (near) the point where the generation is connected. Additionally, the ITO will require the IC to provide specific inverter information including the model and parameter data required for a short-circuit analysis including Positive, Negative and Zero Sequence Resistance and Reactance for the initial 4 to 6 cycles.

Voltage Ride Through Requirements - The Customer Facility shall be designed to remain in service (not trip) for voltages and times as specified for the Eastern Interconnection in Attachment 1 of NERC Reliability Standard PRC-024-1, and successor Reliability Standards, for both high and low voltage conditions, irrespective of generator size, subject to the permissive trip exceptions established in PRC-024-1 (and successor Reliability Standards).

Frequency Ride Through Requirements - The Customer Facility shall be designed to remain in service (not trip) for frequencies and times as specified in Attachment 2 of NERC Reliability Standard PRC-024-1, and successor Reliability Standards, for both high and low frequency condition, irrespective of generator size, subject to the permissive trip exceptions established in PRC-024-1 (and successor Reliability Standards).

Reactive Power - The Generation Interconnection Customer shall design its non-synchronous Customer Facility with the ability to maintain a power factor of at least 0.95 leading to 0.95 lagging measured at the generator's terminals.

Revenue Metering and SCADA Requirements

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.

Network Impacts

The Queue Project AB1-159 was evaluated as a 10.0 MW (Capacity 3.8 MW) injection at the Wakefield 115kV substation in the ITO area. Project AB1-159 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AB1-159 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Contingency Descriptions

The following contingencies resulted in overloads:

None

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 contingencies were studied for the full energy output. The contingencies of Line with Failed Breaker and Bus Fault will be performed for the Impact Study.)

None

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

None

Contributions to previously identified circuit breakers found to be over-duty:

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

(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

To be determined during Impact Study.

Stability and Reactive Power Requirement for Low Voltage Ride Through

(Summary of the VAR requirements based upon the results of the dynamic studies)

To be determined during Impact Study.

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)

None

Potential Congestion due to Local Energy Deliverability

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 IC can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

Note: Only the most severely overloaded conditions are listed below. 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 shall study all overload conditions associated with the overloaded element(s) identified.

None

Light Load Analysis - 2019

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

ITO Analysis

ITO assessed the impact of the proposed Queue Project #AB1-159 interconnection of a 10 MW Energy (3.8 MW Capacity) injection into the ITO's Transmission System, for compliance with NERC Reliability Criteria on ITO's Transmission System. The system was assessed using the summer 2019 RTEP case provided to ITO by PJM. When performing a generation analysis, ITO's main analysis will be load flow study results under single contingency (both normal and stressed system conditions). ITO Criteria considers a transmission facility overloaded if it exceeds 94% of its emergency rating under normal and stressed system conditions. A full listing of ITO's Planning Criteria and interconnection requirements can be found in the ITO's Facility Connection Requirements which are publicly available at: http://www.dom.com.

The results of these studies evaluate the system under a limited set of operating conditions and do not guarantee the full delivery of the capacity and associated energy of this proposed generation facility under all operating conditions. NERC Planning and Operating Reliability Criteria allow for the re-dispatch of generating units to resolve projected and actual deficiencies in real time and planning studies. Specifically NERC Category C Contingency Conditions (Bus Fault, Tower Line, N-1-1, and Stuck Breaker scenarios) allow for re-dispatch of generating units to resolve potential reliability deficiencies. For ITO's Planning Criteria the re-dispatch of generating units for these contingency conditions is allowed as long as the projected loading does not exceed 100% of a facility Load Dump Rating.

As part of its generation impact analysis, the ITO routinely evaluates the impact that a proposed new generation resource will have under maximum generation conditions, stress system conditions and import/export system conditions. The results of these studies are discussed in more detail below.

Category B Analysis (Single Contingency):

1. System Normal – No deficiencies identified
2. Critical System Condition (No Surry 230 kV Unit) – No deficiencies identified.

Category C Analysis: (Multiple Facility Analysis)

1. Bus Fault - No deficiencies identified
2. Line Stuck Breaker - No deficiencies identified
3. Tower Line – No deficiencies identified

The import and export conditions into and out of the ITO System are evaluated with any new interconnection greater than 20 MW, any new facility that is interconnected with the ITO System should not significantly decrement FCITC between utilities. These studies will be performed during the System Impact Study.

Affected System Analysis & Mitigation Affected System Analysis & Mitigation

Duke, Progress & TVA Impacts:

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