Generation Interconnection Feasibility Study Report

for

PJM Generation Interconnection Request Queue Position Z2-043

Kelford 34.5kV 14MW Capacity / 20MW Energy

August / 2014

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 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 ballpark 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 Kelford, NC. The installed facilities will have a total capability of 20 MW with 14 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is 10/31/2015. **This study does not imply an ITO commitment to this in-service date.**

Point of Interconnection

Z2-043 will interconnect with the ITO distribution system via a tap onto the existing 34.5kV circuit which is fed out of Kelford 115 / 34.5kV substation.

Cost Summary

The Z2-043 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$250,000
Direct Connection Network Upgrades	$
Non Direct Connection Network Upgrades	$
Total Costs	**$250,000**

In addition, the Z2-043 project will be responsible for a contribution to the following costs:

Description	Total Cost
New System Upgrades	$4,000,000
Previously Identified Upgrades	$
Total Costs	**$4,000,000**

Cost allocations for these upgrades will be provided in the System Impact Study Report.

Attachment Facilities

The ITO has an existing 34.5 kV distribution line in proximity to the IC's site served from a 22 MVA, 115/34.5 kV transformer in Kelford substation. To provide the interconnection the ITO will install overhead primary voltage conductor. 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 $250,000. 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. That Monthly charge is 0.543% of the installed cost of the Attachment Facilities. These costs do not include CIAC Tax Gross-up. The single line is shown below in Attachment 1.

Non-Direct Connection Cost Estimate

Due to 10 MW's of queue requests ahead of the Kelford request, the 22 MVA Kelford Substation Transformer #1 will need to be changed out with a 56 MVA transformer to accommodate the IC's 20 MW interconnection request.

The estimated cost of these required System Upgrades to change out the transformer and its associated facilities is $4,000,000.

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

Interconnection Customer Requirements

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

Before the ITO studies can be completed the IC will need to provide the ITO with detailed inverter and Generator Step Up transformer information. 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 will 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.

Revenue Metering and SCADA Requirements

PJM Requirements

The ICwill 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 Z2-043 was studied as a 20.0 MW (Capacity 14 MW) injection as a tap of the Kelford 115kV substation in the ITO area. Project Z2-043 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and ITO) for summer peak conditions in 2018. Project Z2-043 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Contingency Descriptions

The following contingencies resulted in overloads:

None

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, further analysis performed during the Impact Study

Short Circuit

(Summary of impacted circuit breakers)

To be determined during Impact Study.

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)

ITO will perform the analysis for this project under the subsequent Impact and Facility Studies.

Stability and Reactive Power Requirement

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

To be determined if required 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 developer 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

ITO Analysis

ITO assessed the impact of the proposed Queue Project #Z2-043 interconnection of 20.0 MW of energy (Capacity 14 MW) for compliance with reliability criteria on ITO's Transmission System. The system was assessed using the summer 2018 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 and multiple facility contingency (both normal and stressed system conditions). ITO's 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 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 Contingency)

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