Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AC1-007

Crittenden 34.5kV
3.8 MW Capacity / 10 MW Energy

February / 2017

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 Windsor, VA (Isle of Wright County). 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 12/01/2017. **This study does not imply an ITO commitment to this in-service date.**

Point of Interconnection

AC1-007 will interconnect with the ITO distribution system at one of the following points of interconnection:

Option 1 via a tap on to the Crittenden 34.5kV circuit #456;

Option 2 via a tap on to a future Ben's Church 34.5kV circuit.

Attachment facilities and local upgrades (if required) along with terms and conditions to interconnect AC1-007 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.

Cost Summary

The AC1-007 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 300,000
Direct Connection Network Upgrades	$0
Non Direct Connection Network Upgrades	$1,300,000
Total Costs	**$1,600,000**

Transmission Owner Scope of Work

There is an existing single phase 7.2 kV distribution line adjacent to the IC's site and the requested POI. The existing 7.2 kV distribution line is served from a 50 MVA, 230/34.5 kV transformer in Crittenden Substation. That 7.2kV distribution line would need to be upgraded to 19.9/34.5kV to connect to the solar site.

Attachment Facilities

To provide the interconnection the ITO may need to install approximately 300 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, 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. These costs do not include CIAC Tax Gross-up. The single line is shown below in Attachment 1.

Non-Direct Connection Cost Estimate

Upgrades Required at Crittenden Substation:

- Install a 230kV CCVT on Churchland – Surry 230kV line 226;
- Modify existing Transformer #1 and Bus #1 protection schemes to allow tripping of 34.5kV breaker on circuit 456.

Upgrades Required on Crittenden circuit #456:

- AC1-007 has two options to meet the protection requirement: install transfer trip or install a ground bank;
- Install G&W Viper recloser in place of 456 F436;
- Remove 456"O" step-downs;
- All service transformers to be converted from 7.2kV to 19.9kV unless noted to install step-down transformers;
- Reconductor existing #2 ACSR & #6A Copperweld to 477Al. from 456 F436 tap to DG site. ~ 17,000' of reconductoring required;
- Extend 2 additional phases from fuse, 456OF476, to generator site.

The estimated cost of these required System Upgrades is **$1,600,000**. The estimated time to interconnect the IC with the required System Upgrades is **18 months.**

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 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 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.

Option One

Network Impacts

The Queue Project AC1-007 was evaluated as a 10.0 MW (Capacity 3.8 MW) injection at the Crittenden substation in the ITO area. Project AC1-007 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC1-007 was studied with a commercial probability of 53%. 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 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:

Not Required.

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

Not Required.

Affected System Analysis & Mitigation

Duke, Progress & TVA Impacts:

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

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

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

ITO Analysis

Not required

Option Two

Upgrades Required for Benn's Church substation:

.

- Install a new 84MVA, 230/34.5kV substation transformer;
- Install a new circuit breaker;

Upgrades Required on Benn's Church circuit:

- Remove 456 "O" step-downs;
- All service transformers to be converted from 7.2kV to 19.9kV unless noted to install step-down transformers;
- Reconductor existing #2 ACSR & #6A Copperweld to 477Al. from 456 F436 tap to generator site. ~ 17,000' of reconductoring required;
- Extend 2 additional phases from fuse, 456OF476, to generator site.

The estimated cost of these required System Upgrades to accommodate the request for ***Benns Church Substation*** is **$5,800,000.** The estimated time to interconnect the IC with the required System Upgrades is **24 months**.

*****Note: ITO has plans to install a 230/34.5kV, 84MVA substation transformer at Benns Church Substation at the end of year 2018, but those plans could be delayed longer*****

Network Impacts

The Queue Project AC1-007 was evaluated as a 10.0 MW (Capacity 3.8 MW) injection at the Benns Church 230kV substation in the ITO area. Project AC1-007 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC1-007 was studied with a commercial probability of 53%. 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 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:

Not Required.

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

Not Required.

Affected System Analysis & Mitigation

Duke, Progress & TVA Impacts:

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

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

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

ITO Analysis

Not required