Revised Generation Interconnection

Impact Study Report

for

Queue Project AE1-212

GRANDVIEW-CLIFFTOP 138 KV

53.3 MW Capacity / 90 MW Energy

February 2022

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1 Preface

The intent of the 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 System Impact Study is performed.

The 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.

The Interconnection Customer seeking to interconnect a wind or solar generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per Schedule H to the Interconnection Service Agreement and Section 8 of Manual 14D.

2 General

Raleigh Solar I, LLC proposes to install PJM Project #AE1-212, a 90 MW (53.3 MW Capacity) solar facility in Raleigh County, West Virginia (see Figure 2). The point of interconnection will be at a new station cut into Grandview – Clifftop 138 kV section of the Grandview – Cherry Creek 138 kV circuit (see Figure 1).

The requested in service date is September 30th, 2021. This study does not imply AEP's commitment to this in-service date.

Queue Number	AE1-212
Project Name	GRANDVIEW-CLIFFTOP 138 KV
Interconnection Customer	Raleigh Solar I, LLC
State	West Virginia
County	Raleigh
Transmission Owner	AEP
MFO	90
MWE	90
MWC	53.3
Fuel	Solar
Basecase Study Year	2022

2.1 Point of Interconnection

AE1-212 will interconnect with the AEP transmission system via a new station cut into the AEP's Grandview – Clifftop section of Grandview to Cherry Creek 138 kV circuit.

Point of Interconnection (Grandview - Clifftop 138 kV)

To accommodate the interconnection on the Grandview - Clifftop 138 kV section of the Grandview – Cherry Creek 138 kV circuit, a new three (3) circuit breaker 138 kV switching station physically configured in a breaker and half bus arrangement but operated as a ring-bus will be constructed (see Figure 1). Installation of associated protection and control equipment, 138 kV line risers, SCADA, and 138 kV revenue metering will also be required. AEP reserves the right to specify the final acceptable configuration considering design practices, future expansion, and compliance requirements.

2.2 Cost Summary

The AE1-212 project will be responsible for the following costs:

Based upon the results of this Impact Study, the construction of the 90 MW (53.3 MW Capacity) solar generating facility of Raleigh Solar (PJM Project #AE1-212) will require the following additional interconnection charges. This plan of service will interconnect the proposed solar generating facility in a manner that will provide operational reliability and flexibility to both the AEP system and the Raleigh Solar generating Facility.

Description	Total Cost
Attachment Facilities	$500,000
Direct Connection Network Upgrade	$6,000,000
Non Direct Connection Network Upgrades	$1,500,000
Allocation for New System Upgrades	$0
Contribution for Previously Identified Upgrades	$0
Total Costs	$8,000,000

The estimates are preliminary in nature, as they were determined without the benefit of detailed engineering studies. Final estimates will require an on-site review and coordination to determine final construction requirements.

3 Transmission Owner Scope of Work

4 Attachment Facilities

The total preliminary cost estimate for the Attachment work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
Install attachment facility line and associated hardware to accept the Interconnection Customer generator lead line terminating at the AE1-212 Interconnection substation.	$250,000
138 kV Revenue Metering	$250,000
Total Attachment Facility Costs	$500,000

5 Direct Connection Cost Estimate

The total preliminary cost estimate for the Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
Construct a new three (3) circuit breaker 138 kV switching station physically configured in a breaker and half bus arrangement but operated as a ring-bus (See Figure 1). Installation of associated protection and control equipment, 138 kV line risers and SCADA will also be required.	$6,000,000
Total Direct Connection Facility Costs	$6,000,000

6 Non-Direct Connection Cost Estimate

The total preliminary cost estimate for the Non-Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

For AEP building Non-Direct Connection cost estimates:

Description	Total Cost
Upgrade line protection and controls at the Grandview 138 kV substation	$250,000
Upgrade line protection and controls at the Cherry Creek 138 kV substation	$250,000
Grandview – Clifftop 138 kV T-Line Cut In	$1,000,000
Total Non-Direct Connection Facility Costs	$1,500,000

7 Incremental Capacity Transfer Rights (ICTRs)

None

8 Schedule

It is anticipated that the time between receipt of executed agreements and Commercial Operation may range from 12 to 18 months if no line work is required. If line work is required, construction time would be between 24 to 36 months after signing an interconnection agreement.

9 Transmission Owner Analysis

None

10 Interconnection Customer Requirements

It is understood that Raleigh Solar is responsible for all costs associated with this interconnection. The costs above are reimbursable to AEP. The cost of Raleigh Solar's generating plant and the costs for the line connecting the generating plant to the Grandview – Clifftop 138 kV section of Grandview – Cherry Creek 138kV circuit are not included in this report; these are assumed to be Raleigh Solar's responsibility.

The Generation Interconnection Agreement does not in or by itself establish a requirement for American Electric Power to provide power for consumption at the developer's facilities. A separate agreement may be reached with the local utility that provides service in the area to ensure that infrastructure is in place to meet this demand and proper metering equipment is installed. It is the responsibility of the developer to contact the local service provider to determine if a local service agreement is required.

Requirement from the PJM Open Access Transmission Tariff:

An Interconnection Customer entering the New Services Queue on or after October 1, 2012 with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

The Interconnection Customer may be required to install and/or pay for metering as necessary to properly track real time output of the facility as well as installing metering which shall be used for billing purposes. See Section 8 of Appendix 2 to the Interconnection Service Agreement as well as Section 4 of PJM Manual 14D for additional information.

11 Revenue Metering and SCADA Requirements

11.1 PJM Requirements

The Interconnection Customer 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 Section 8 of Attachment O.

11.2 AEP Requirements

The Interconnection Customer will be required to comply with all AEP Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "Requirements for Connection of New Facilities or Changes to Existing Facilities Connected to the AEP Transmission System" document located at the following link:

http://www.pjm.com/~/media/planning/plan-standards/private-aep/aep-interconnection-requirements.ashx

12 Network Impacts

The Queue Project AE1-212 was evaluated as a 90 MW (Capacity 53.3 MW) injection via a new station cut into Grandview – Clifftop 138 kV section of Grandview – Cherry Creek 138kV circuit in the AEP area. Project AE1-212 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE1-212 was studied with a commercial probability of 1.00. Potential network impacts were as follows:

Summer Peak Load Flow

13 Generation Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection)

None

14 Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)

None

15 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

16 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.

None

17 Steady-State Voltage Requirements

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

None

18 Stability and Reactive Power Requirement for Low Voltage Ride Through

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

Generator Interconnection Request AE1-212 is for a 90 MW Maximum Facility Output (MFO) solar generating facility consisting of 30 x 3.067 MW TMEIC PVH-3360GR solar inverters with a Point of Interconnection (POI) tapping into American Electric Power (AEP) on 138 kV transmission line between the Grandview substation and the Clifftop substation in Raleigh County, West Virginia.

The power flow scenario for the analysis was based on the RTEP 2022 summer peak case, modified to include applicable queue projects. AE1-212 has been dispatched online at maximum power output, with approximately unity power factor at the high side of the station transformer.

AE1-212 was tested for compliance with NERC, PJM, Transmission Owner and other applicable criteria. For this study, 56 contingencies were simulated, each with a 20 second simulation time period. Studied faults included:

- Steady-state operation (20 second simulation)
- Three-phase faults with normal clearing time
- Single-phase bus faults with normal clearing time
- Single-phase faults with a stuck breaker
- Single-phase faults placed at 80% of the line with delayed (Zone 2) clearing at remote line end because of primary communications/relaying failure
- Three-phase faults with normal clearing time with a prior outage
- Three-phase faults with loss of multiple circuits caused by a common tower contingency

The 58 fault contingencies tested on the 2022 summer peak case met the recovery criteria:

- The AE1-212 generators were able to ride through the faults except for faults where protective actions trip one or more generator(s).
- All generators maintained synchronism and any post-contingency oscillations are positively damped with a damping margin of at least 3%.
- All bus voltages recover to 0.7 p.u. within 2.5 seconds and the final voltage is within the range of 0.92 p.u. to 1.05 p.u. for buses other than 500 kV. The final voltages for 500 kV buses should be within 1.02 p.u. to 1.08 p.u.
- No transmission element trips, other than those either directly connected or designated to trip as a consequence of the fault.

The queue project, AE1-212, met both the 0.95 lagging and 0.95 leading power factor requirement.

19 System Reinforcements

None

Affected Systems

20 Affected Systems

20.1 LG&E

None

20.2 MISO

None

20.3 TVA

None

20.4 Duke Energy Progress

None

20.5 NYISO

None

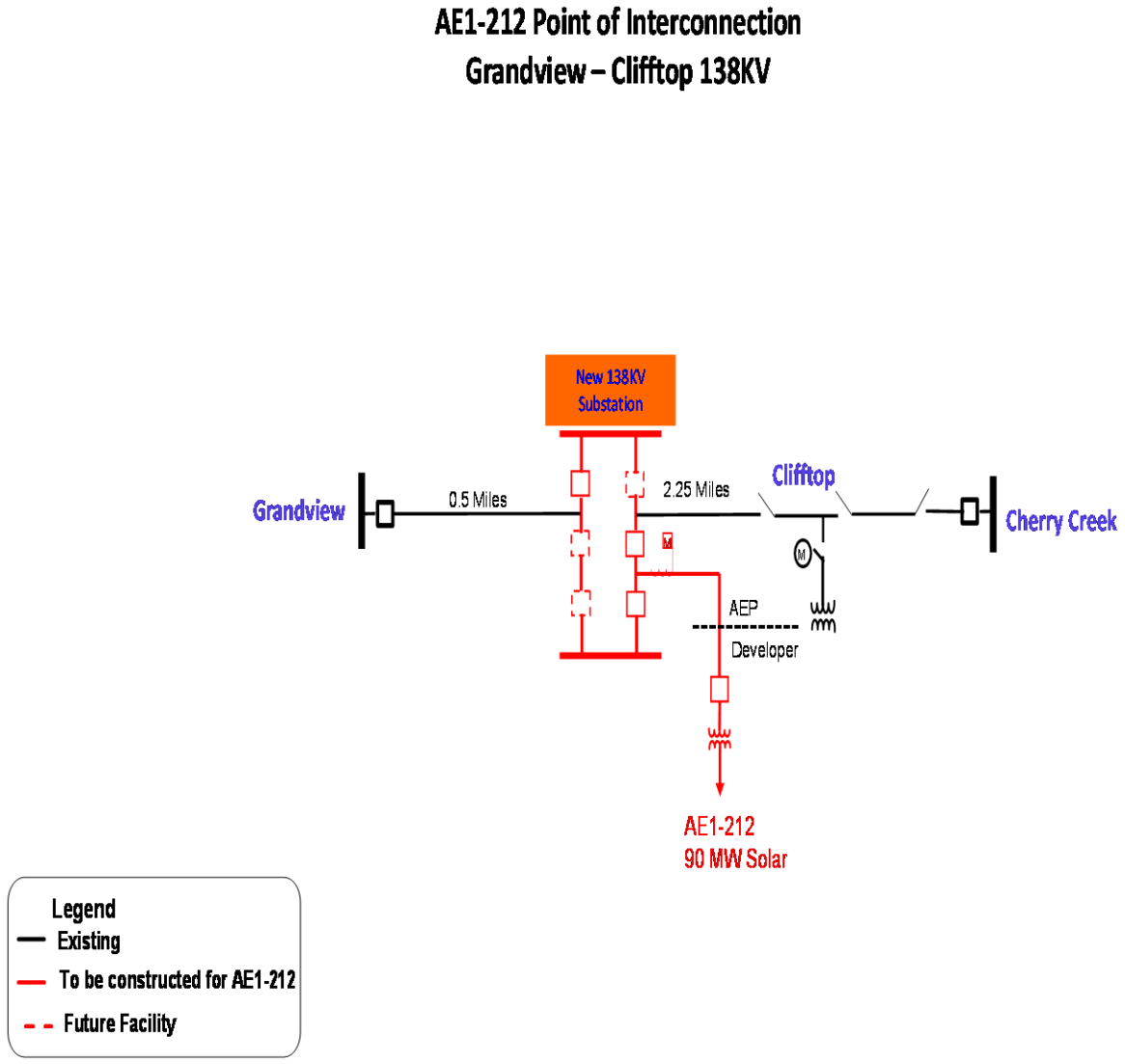
Short Circuit

21 Short Circuit

The following Breakers are overduty

None

22 Figure 1: Point of Interconnection (Grandview – Clifftop 138 kV) Single-Line Diagram



23 Figure 2: AE1-212 Point of Interconnection (Grandview – Clifftop 138 kV)