Generation Interconnection

System Impact Study Report

for

Queue Project AE1-007

CAMDEN-CRYSTAL III 69 KV

7.6 MW Capacity / 20 MW Energy

August 29, 2019
Revised: June 8, 2021

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 Revision History:

This Study is a revision to the original issue System Impact Study report. This revision incorporates Direct Connection scope and costs for estimates for a new three breaker ring bus to interconnect the AE1-007 uprate.

3 General

The Interconnection Customer (IC) has proposed a **20 MW MFO (7.6 MWC**) upgrade to their prior solar queue projects AC2-067 “Camden-Crystal I 69 kV” and AC2-068 “Camden-Crystal II 69 kV” also to be located at 1731 West Consolidated Road in Eaton, Ohio. The projects combined will have a total capability of **89.9 MW** with **34.1 MW** of this output being recognized by PJM as capacity. All of the projects will be behind the same Point of Interconnection (POI) and will share the same interconnection facilities.

The project capability is summarized below:

Queue	MFO	Energy	Capacity
AC2-067	49.9	49.9	18.9
AC2-068	20	20	7.6
AE1-007	20	20	7.6
Total	**89.9**	**89.9**	**34.1**

The expected Commercial Operation Date for this uprate project is **December 2020**. **This study does not imply a Dayton Power & Light Company (DP&L) commitment to this in-service date.**

Queue Number	**AE1-007**
Project Name	CAMDEN-CRYSTAL III 69 KV
Interconnection Customer	Alamo Solar I, LLC
State	Ohio
County	Preble
Transmission Owner	Dayton
MFO	89.9
MWE	20
MWC	7.6
Fuel	Solar
Basecase Study Year	2022

3.1 Point of Interconnection

The **AE1-007 "Camden-Crystal III 69 kV"** uprate project will interconnect behind the same Point of Interconnection (POI) as the AC2-067 "Camden-Crystal I 69 kV" and AC2-068 "Camden-Crystal II 69 kV" projects and will share the same interconnection facilities.

For the AC2-067 and AC2-068 projects, the interconnection with the Dayton Power & Light Company transmission system was planned to be a tap location on the Hutchings-Crystal 69 kV line between Crystal and Camden Substations. However, the increase in generation proposed by AE1-007 will require that a new three breaker ring bus be constructed to interconnect the projects to the Hutchings-Crystal 69 kV line between Crystal and Camden Substations. Presently, the Hutchings-Crystal 69kV line serves distribution loads at Camden, Gratis, and Germantown Substations.

Under the AC2-067 project, the IC will construct a single 69kV line up to the POI on the Crystal-Camden 69kV line section. The POI will be the last 69kV takeoff structure leaving the new three breaker ring bus switchyard. The Interconnection Customer will own the generator lead line conductor terminating onto the structure.

See **Attachment 1** for a one line of the physical interconnection point.

3.2 Cost Summary

The AC2-067 "Camden-Crystal I 69 kV" project is responsible for the connection facilities to the Dayton Power and Light system. AC2-068 "Camden-Crystal II 69 kV" and AE1-007 "Camden-Crystal III 69 kV" will share the same interconnection facilities. Should both the AC2-067 and AC2-068 projects elect not to move forward, the AE1-007 project would assume the responsibility of the interconnection facilities.

The AE1-007 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$15,000
Direct Connection Network Upgrade	$3,000,000
Non Direct Connection Network Upgrades	$30,000
Allocation for New System Upgrades	$0
Contribution for Previously Identified Upgrades	$0
Total Costs	**$3,045,000**

4 Transmission Owner Scope of Work

4.1 Attachment Facilities

This report assumes that the Interconnection Customer will construct and own the attachment line from its generating facility into the proposed Point of Interconnection as depicted on the one line diagram in Attachment 1. The IC will also be responsible for the fiber/OPGW that Dayton requires on the generator line for the communication assisted trip scheme.

The metering may be classified as an Attachment Facility in future study reports.

This work is primarily for engineering drawing review. The main scope of work for Attachment Facilities is addressed by queue project AC2-067.

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
Engineering oversight and commissioning	$15,000
Total Attachment Cost Estimate	**$15,000**

4.2 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
Install a new 69 kV three breaker ring bus switchyard to interconnect the AE1-007 project. This will include the installation of all physical structures, P&C equipment, communications equipment, metering equipment, and associated facilities.	$3,000,000
Total Direct Connection Facility Costs	**$3,000,000**

After a more detailed protection system review at the System Impact Study, Dayton has determined that the AE1-007 project will require the three breaker ring bus substation for the AE1-007 project to meet protection system requirements.

The direct connection cost estimate for the AE1-007 project is approximately **$3,000,000.** The substation direct connection work for this project includes the construction of a 69 kV three breaker ring bus switchyard which will be tapped off the Camden-Crystal 69 kV line. There will also be 69 kV transmission line construction required to accommodate the new switchyard. The 69 kV generator lead line will be constructed by the developer and will be terminated onto the 69 kV takeoff structure leaving the new three breaker ring bus switchyard. The new 69 kV breakers will be equipped with the necessary communication systems to facilitate remote supervisory control of the breaker and status monitoring. Dayton will install the line relaying, communications, and interconnection metering to accommodate the interconnection of the AE1-007 generator.

4.3 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.

Description	Total Cost
Protection System changes at Crystal Substation	$15,000
Protection System changes at Hutchings Substation	$15,000
Total Non-Direct Facilities Cost Estimate	**$30,000**

The substation non-direct connection cost estimate for the AE1-007 project is approximately **$30,000**. Remote end relaying will need to be evaluated for settings changes at Crystal and Hutchings Substations to facilitate the interconnection of the new generation.

5 Schedule

Based on the extent of the Dayton primary Non-Direct Connection and Attachment upgrades required to support the AE1-007 uprate project, it is expected to take a minimum of **24 months** from the date of a fully executed Interconnection Construction Service Agreement to complete the installation subject to market conditions and vendor lead times. This includes the requirement for the Interconnection Customer to make a preliminary payment to Dayton which funds the construction of the Non-Direct Connection facilities. It assumes that there will be no environmental or permitting issues to implement the Non-Direct Connection upgrades for this project and that all system outages will be allowed when requested.

6 Interconnection Customer Requirements

6.1 Dayton Interconnection Requirements

The Dayton Power and Light Company (DP&L) has prepared this Facilities Connection Requirements document to ensure compliance with North American Electric Reliability Council (NERC) Reliability Standards and applicable Regional Reliability Organization, sub regional, Power Pool, and individual Transmission Owner planning criteria and facility connection requirements in compliance to NERC Standard FAC-001-2. These connection requirements apply to all generation facilities, transmission facilities, and end-users connecting to the DP&L transmission system. Detailed information outlining DP&L interconnection requirements can be reviewed utilizing the following link:

http://www.pjm.com/~/media/planning/plan-standards/private-dayton/dayton-facilities-connection-requirements.ashx

7 Revenue Metering and SCADA Requirements

7.1 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.

7.2 Dayton Requirements

The Interconnection Customer will be required to comply with all Dayton Revenue Metering Requirements for Generation Interconnection Customers as outlined in the link below. The Revenue Metering Requirements may be found within the Dayton Power & Light Co. “Requirements for the Connection of Facilities to the Dayton Power & Light Co. Transmission System” document located at the following link:

http://www.pjm.com/~/media/planning/plan-standards/private-dayton/dayton-facilities-connection-requirements.ashx

http://www.pjm.com/planning/design-engineering/to-tech-standards.aspx

8 Network Impacts

The Queue Project AE1-007 was evaluated as a 20.0 MW (Capacity 7.6 MW) injection into the AC2-068 Tap 69 kV bus (which is a tap of the Camden – Crystal 69 kV line) in the Dayton area. Project AE1-007 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE1-007 was studied with a commercial probability of 1.00. Potential network impacts were as follows:

Summer Peak Load Flow

9 Generation Deliverability

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

None

10 Multiple Facility Contingency

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

None

11 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

12 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

13 System Reinforcements

None

14 Stability and Reactive Power Requirement for Low Voltage Ride Through

See Attachment 2

The AE1-007 queue project did not meet the 0.95 lagging power factor requirement. An additional 14.97 Mvar would be required for the plant to meet the 0.95 lagging power factor requirement. The plant did meet the 0.95 leading power factor requirement.

15 Light Load Analysis

No mitigations are required.

Affected Systems

16 Affected Systems

16.1 LG&E

None

16.2 MISO

MISO Impacts to be determined during later study phases (as applicable).

16.3 TVA

None

16.4 Duke Energy Progress

None

16.5 NYISO

None

Short Circuit

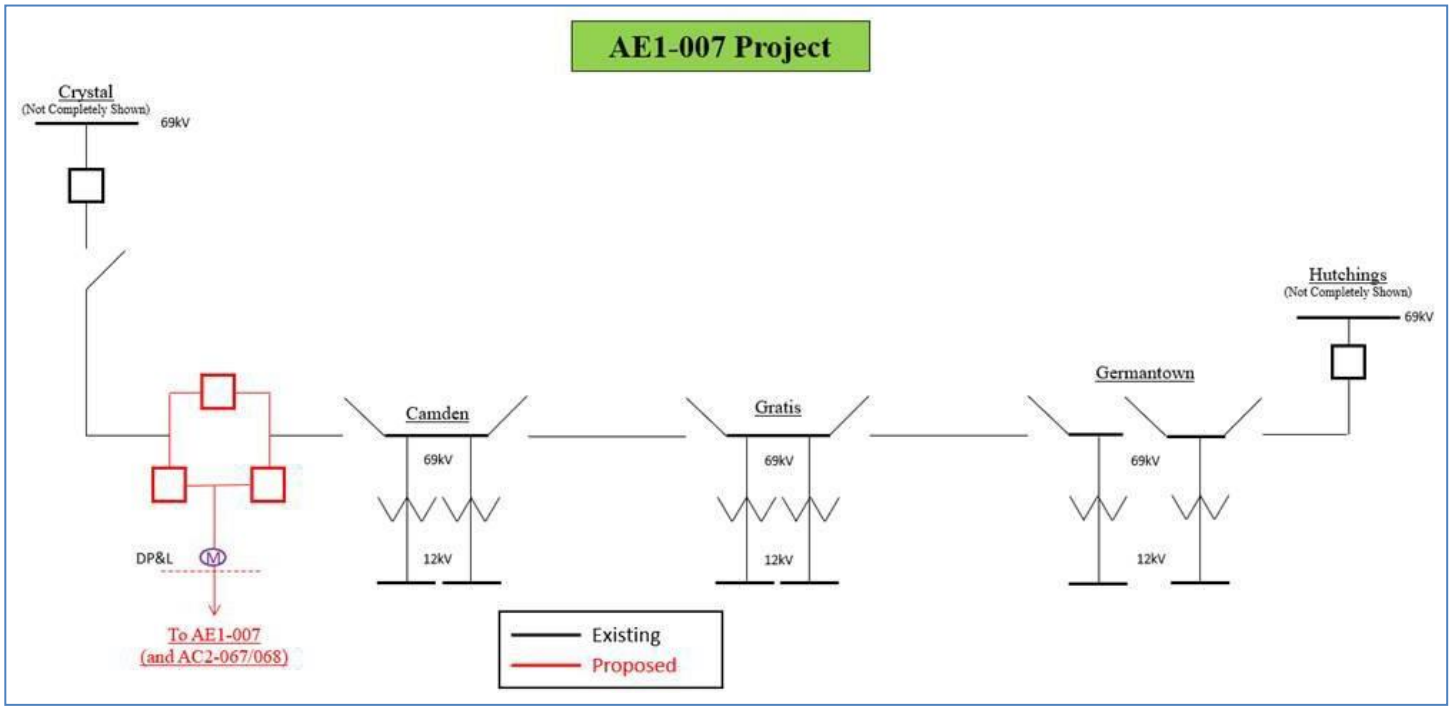
17 Short Circuit

The following Breakers are over duty

None

Attachment 1

Single Line Diagram



Attachment 2

Dynamic Simulation

EXECUTIVE SUMMARY

Generator Interconnection Request AE1-007 is for an increase in energy injection capability of the prior queue projects AC2-067 and AC2-068. The increase in the Maximum Facility Output (MFO) of the plant is from 69.9 MW to 89.9 MW. AE1-007 consists of 10 x 2.09 MW SMA SC2200 PV inverters with a Point of Interconnection (POI) connecting to the AC2-067 69 kV substation located in Preble County, Ohio, in the Dayton Power & Light (DP&L) transmission system.

The power flow scenario for the analysis was based on the RTEP 2022 summer peak case, modified to include applicable queue projects. The AE1-007 generators were set to their maximum power output and near unity power factor at the high side of the station transformer.

AE1-007 was tested for compliance with NERC, PJM, Transmission Owner and other applicable criteria. For this study, 103 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
- Single-phase faults with a stuck breaker
- Single-phase faults with delayed clearing at remote end
- Single phase faults with loss of multiple-circuit towers

The 103 fault contingencies tested on the 2022 summer peak load case met the recovery criteria:

- The AE1-007 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. excluding 500 kV buses. 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 AE1-007 queue project did not meet the 0.95 lagging power factor requirement. An additional 14.97 Mvar would be required for the plant to meet the 0.95 lagging power factor requirement. The plant did meet the 0.95 leading power factor requirement.