Generation Interconnection

Revised System Impact Study Report

for

Queue Project AE2-342

WOODSTOCK 69 KV

26.8 MW Capacity / 40 MW Energy

February 2020

Revised: July 2021

1 Preface

The intent of the System Impact 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 Interconnection Customer. The Interconnection Customer may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the Interconnection Customer 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. Cost allocation rules for network upgrades can be found in PJM Manual 14A, Attachment B. The reinforcement costs may be shared with other projects, and the allocations tables are included in this report, if applicable.

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.

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.

2 General

The Interconnection Customer (IC) has proposed a Solar generating facility located in Champaign County, Ohio. The installed facilities will have a total capability of 40 MW with 26.8 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is December 1, 2022. **This study does not imply a TO commitment to this in-service date.**

Queue Number	**AE2-342**
Project Name	WOODSTOCK 69 KV
State	Ohio
County	Champaign
Transmission Owner	Dayton
MFO	40
MWE	40
MWC	26.8

Queue Number	AE2-342
Fuel	Solar
Basecase Study Year	2022

2.1 Point of Interconnection

AE2-342 will interconnect with The Dayton Power and Light Company transmission system at the existing Woodstock Substation 69 kV bus. The physical Point of Interconnection (POI) will be the last takeoff structure leaving the Woodstock 69 kV yard. Dayton will own the takeoff structure and all attachment hardware. The Interconnection Customer will own the conductor terminating onto the structure.

Under the AE2-342 project, the IC will construct a single 69 kV line up to the POI in the Woodstock 69 kV yard.

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

2.2 Cost Summary

The AE2-342 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$0
Direct Connection Network Upgrade	$3,450,000
Non Direct Connection Network Upgrades	$ 225,000
Total Costs	**$3,675,000**

3 Attachment Facilities

There are no Attachment Facilities to be constructed by the Transmission Owner.

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 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
None	$0
Total Attachment Facility Costs	**$0**

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

4 Direct Connection Cost Estimate

The substation direct connection cost estimate for the AE2-342 project is approximately $3,200,000. The substation direct connection work for this project includes the construction of a four breaker 69 kV ring bus at Woodstock Substation. There will also be 69 kV transmission line construction required to reconfigure the 69kV line that loops in and out of the substation.

The 69 kV generator lead line will be constructed by the developer and will be terminated onto the 69 kV takeoff structure leaving Dayton's Woodstock Substation. The new four breaker 69 kV ring bus will be equipped with the necessary communication systems to facilitate remote supervisory control of the breakers and status monitoring. Dayton will install the physical structures, line relaying, communications, and interconnection metering to accommodate the interconnection of the AE2-342 generator.

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 69 kV four breaker ring bus at the Woodstock Substation to interconnect the AE2-342 project. This will include the installation of all physical structures, P&C equipment, communications equipment, metering equipment, and associated facilities.	$3,200,000
Transmission Line Tie-In work to accommodate new AE2-342 Interconnection Switchyard	$ 250,000
Total Direct Connection Facility Costs	**$3,450,000**

5 Non-Direct Connection Cost Estimate

The substation non-direct connection cost estimate for the AE2-342 project is approximately $225,000. Remote end relaying will need to be evaluated for equipment/settings changes at Woodstock, Kings Creek, and Marysville Substations to facilitate the interconnection of the new generation.

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 upgrades at Woodstock Substation	$75,000
Protection System upgrades at Kings Creek Substation	$75,000
Protection System upgrades at Marysville Substation	$75,000
Total Non-Direct Connection Facility Costs	**$225,000**

6 Schedule

Based on the extent of the Dayton primary Direct Connection and Non-Direct Connection upgrades required to support the AE2-342 generation 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 first three months of engineering design that is related to 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.

7 Transmission Owner Analysis

Power Flow Analysis

PJM performed a power flow analysis of the transmission system using a 2023 summer peak load flow model and the results were verified by Dayton. Additionally, Dayton performed an analysis of its underlying transmission <100 kV system. The AE2-342 project does not create any issues on the Dayton transmission system.

Short Circuit Analysis

PJM performed a short circuit analysis and the results were verified by Dayton. The connection of AE2-342 project to the system does not result in any newly overdutied circuit breakers on the Dayton transmission system.

Stability Analysis

PJM performed the dynamic stability analysis and the results were reviewed by Dayton. There were no stability concerns identified in PJM's study.

8 Interconnection Customer Requirements

System Protection

The IC must design its Customer Facilities in accordance with all applicable standards, including the standards in Dayton's "Requirements for the Connection of Facilities to the Dayton Power & Light company Transmission System" document located at: https://www.pjm.com/planning/design-engineering/to-tech-standards/private-dayton.aspx. Preliminary Protection requirements will be provided as part of the Facilities Study. Detailed Protection Requirements will be provided once the project enters the construction phase.

Compliance Issues and Interconnection Customer 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:

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

Power Factor Requirements

The IC shall design its non-synchronous Customer Facility with the ability to maintain a power factor of at least 0.95 leading (absorbing VARs) to 0.95 lagging (supplying VARs) measured at the high-side of the facility substation transformer(s) connected to the Dayton transmission system.

9 Revenue Metering and SCADA Requirements

9.1 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.

9.2 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

10 Network Impacts

The Queue Project AE2-342 was evaluated as a 40.0 MW (Capacity 26.8 MW) injection at the Woodstock 69kV substation in the Dayton area. Project AE2-342 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-342 was studied with a commercial probability of 1.00. Potential network impacts were as follows:

11 Generation Deliverability

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

None

12 Multiple Facility Contingency

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

None

13 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

14 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

15 System Reinforcements

None 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

17 Short Circuit

The following Breakers are over duty:

None

18 Stability and Reactive Power Capability Assessment

Executive Summary

Generator Interconnection Request AE2-342 is for a 40 MW Maximum Facility Output (MFO) solar generating facility, which consists of 14 Sungrow SG3150U solar inverters. The AE2-342 solar generating facility will be located in Champaign County, Ohio.

The AE2-342 solar generating facility will interconnect to the existing Woodstock 69 kV substation in the Dayton Power & Light Company (DAY) transmission system. The Point of Interconnection (POI) will be where the last takeoff structure leaving the Woodstock 69 kV yard.

This report describes a dynamic simulation analysis of AE2-342 as part of the overall system impact study. The load flow scenario for the analysis was based on the RTEP 2022 peak load case, modified to include applicable queue projects. AE2-342 has been dispatched online at maximum power output, with approximately 0.995 pu voltage at the generator terminals.

AE2-342 was tested for compliance with NERC, PJM, Transmission Owner, and other applicable criteria. 76 contingencies were studied, each with a 20 second simulation time period (with 1.0 second initial run prior to any events). The studied faults include:

a) Steady state operation (Category P0);

b) Three phase faults with normal clearing time on the intact network (Category P1);

c) Single phase to ground faults with delayed clearing due to a stuck breaker (Category P4);

d) Single phase faults placed at 80% of the line with delayed (Zone 2) clearing at line end remote from the fault due to primary communications/relay failure (Category P5).

For all 76 fault contingencies tested on the 2022 peak load case:

a) AE2-342 was able to ride through the faults (except for faults where protective action trips a generator(s)).

b) Post-contingency oscillations were positively damped with a damping margin of at least 3%.

c) Following fault clearing, all bus voltages recover to a minimum of 0.7 per unit after 2.5 seconds (except where protective action isolates that bus).

d) No transmission element trips, other than those either directly connected or designed to trip as a consequence of that fault.

Please also note that the project AE2-342 does not meet the 0.95 leading and lagging reactive power requirement at the high side of the facility main transformer. It requires additional 0.27 MVar capacitive reactive power.

Attachment 1 – One Line