Generation Interconnection

Feasibility Study Report

for

Queue Project AF2-440

MARTINSVILLE-HIGHLAND 69 KV

25 MW Capacity / 50 MW Energy

July 2020

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1 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 Dayton.

2 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 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 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.

An Interconnection Customer 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 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 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.

3 General

The Interconnection Customer (IC), has proposed a Solar generating facility located in Undetermined County, Undetermined. The installed facilities will have a total capability of 50 MW with 25 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is December 31, 2023. This study does not imply a TO commitment to this in-service date.

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Queue Number	**AF2-440**
Project Name	MARTINSVILLE-HIGHLAND 69 KV
State	Ohio
County	Highland
Transmission Owner	Dayton
MFO	50
MWE	50
MWC	25
Fuel	Solar
Basecase Study Year	2023

Any new service customers who can feasibly be commercially operable prior to June 1st of the basecase study year are required to request interim deliverability analysis.

4 Point of Interconnection

The AF2-440 project will interconnect with The Dayton Power & Light Company transmission system via a new 69 kV three-breaker ring bus switchyard that will tap the Martinsville-Highland 69 kV Line.

The Point of Interconnection (POI) will be the 69kV takeoff structure leaving the new three-breaker ring bus switchyard. Dayton will own the takeoff structure and all attachment hardware. The Interconnection Customer will own the generator lead line conductor terminating onto the structure. The new interconnection substation be located approximately 4.82 miles from the Martinsville 69 kV Substation and 8.06 miles from the Highland 69 kV Substation. This is the primary Point of Interconnection (POI) chosen by the IC. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection substation and the associated attachment facilities.

Attachment 1 shows a one-line diagram of the proposed primary direct connection of the (AF2-440) generation project to The Dayton Power & Light transmission system. Attachment 2 provides the proposed location for the point of interconnection. IC will be responsible for constructing all of the facilities on its side of the POI including the attachment line.

5 Cost Summary

The AF2-440 "Martinsville-Highland 69 KV" project is responsible for the interconnection facilities to the Dayton Power and Light system.

The AF2-440 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	$4,860,000
Total System Network Upgrade Costs	$ 58,000
Total Costs	**$4,918,000**

This cost excludes a Federal Income Tax Gross Up charges. This tax may or may not be charged based on whether this project meets the eligibility requirements of IRS Notice 88-129. If at a future date it is determined that the Federal Income Tax Gross charge is required, the Transmission Owner shall be reimbursed by the Interconnection Customer for such taxes.

Cost allocations for any System Upgrades will be provided in the System Impact Study Report.

The required Attachment Facilities, Direct Connection and Non-Direct Connection work for the interconnection of the AF2-440 generation project to the Dayton Transmission System is detailed in the following sections. The associated one-line with the generation project attachment facilities and primary direct and non-direct connection are shown in Attachment 1.

Note that the Dayton findings were made from a conceptual review of this project. A more detailed review of the connection facilities and their cost will be identified in a future study phase. Further note that the cost estimate data contained in this document should be considered high level estimates since it was produced without a detailed engineering review. The applicant will be responsible for the actual cost of construction. Dayton herein reserves the right to return to any issues in this document and, upon appropriate justification, request additional monies to complete any reinforcements to the transmission systems.

6 Transmission Owner Scope of Work

The AF2-440 project will interconnect with the Dayton Power and Light Company transmission system via a new 69 kV three-breaker ring bus switchyard that will tap the Martinsville-Highland 69 KV line. The Transmission Owner work associated with this project is to build direct connection facilities, provide engineering oversight and make remote relay setting changes at the AF2-440 interconnection substation and the other related adjacent substations.

This report assumes that the Interconnection Customer will use the existing attachment line from its generating facility into the proposed Point of Interconnection since this project is an upgrade to the existing generators 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 costs included below are for the necessary protection system review and any subsequent field changes needed to coordinate with IC attachment facilities.

The total physical interconnection costs is given in the tables below:

6.1 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
Engineering review and commissioning	$15,000
Total Attachment Facility Costs	**$15,000**

6.2 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 AF2-440 project. This will include the installation of all physical structures, P&C equipment, communications equipment, metering equipment, and associated facilities.	$2,200,000
Total Direct Connection Facility Costs	**$2,200,000**

6.3 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
Potential Highland 69 kV Substation – relay setting changes	$15,000
Potential Wilmington 69 kV Substation – relay setting changes	$15,000
Potential New Vienna 69 kV Substation – relay setting changes	$15,000
69 kV transmission line tie-In work to accommodate new AF2-440 Interconnection Switchyard	$2,600,000
Total Non-Direct Connection Facility Costs	**$2,645,000**

7 Schedule

Based on the extent of the Dayton primary Attachment Facilities and Non-Direct Connection work required to support the AF2-440 generation project, it is expected to take a minimum of **twenty-four (24) months** from the date of a fully executed Interconnection Construction Service Agreement to complete the installation. This includes the requirement for the IC to make a preliminary payment to Dayton which funds the Non-Direct Connection work and the first three months of engineering design that is related to the construction of the Attachment Facilities. It further assumes that the IC will provide all rights-of-way, permits, easements, etc. that will be needed. A further assumption is that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the defined Attachment Facilities and Non-Direct Connection work, and that all system outages will be allowed when requested.

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8 Summer Peak - Load Flow Analysis (underlying transmission <100 kV system)

8.1 Power Flow Analysis & System Reinforcements

Dayton identified the following violation on their lower voltage system:

Id	Violation Description	kV
AF2-440-L1	Overload on Wilmington-Martinsville 69 kV Contingency: DAY_6658S_HIGHLAND_MARTINSVILLE_69KV_UPDATED2 (AF2-440 TAP - Highland 69 kV) Notes: Loading on the monitored facility increases with addition of generation in the area. Overload is shown after added AF2-440 queue generator. Contingency Flow: 89.8 MVA	69 kV

Additionally, Dayton performed an analysis of its underlying transmission <100 kV system. The following issues were found to be existing in the Dayton transmission system. This project does not currently have a financial responsibility towards these upgrades, but may get an allocation based on projects withdrawing from the queue.

Allocations to upgrades are determined in the System Impact phase. The upgrades may need to be completed prior to initial operation of this facility.

Facility	Contingency Description	Existing Upgrade	Cost
253181 09NHOLLN 69 kV - 253201 09ROBINS 69 kV Ckt 1	Adkins – Beatty 345 kV	PJM Network Upgrade, N5456: From AC1-166, replace wave trap with 2000A wave trap. Project Cost: $56,000 Time Estimate: 20 weeks	$56,000
253099 09ATLNTA 69 kV - 253100 09ATLNTA 345 kV Ckt 1	Atlanta – New Holland 69 kV Robinson – New Holland 69 kV	Reinforcement Project, r190012: Add a second 250 MVA 345/69kV transformer. Project Cost: $5,000,000 Time Estimate: 24 months	$5,000,000
		TOTAL COST	**$0**

8.2 Generation Delivery/Multiple Facility Contingency

At the Primary POI, the AF2-440 project contributes to new overloads in the Dayton transmission system as shown below. The estimated cost of system reinforcements necessary to mitigate these overloads are provided.

From Bus Number	From Bus Name	From Bus Area	To Bus Number	To Bus Name	To Bus Area	CKT ID	kV	Contingency Description
253094	09WILMNG	DAY	936250	AD2-031 TAP	DAY	1	69.0	Loss of Highland – AF2-440 69 kV

Facility	Upgrade Description	Cost
253094 09WILMNG 69.0 kV - 936250 AD2-031 TAP 69.0 kV Ckt 1	Reinforcement Project ID, DAYr20000: Replace 600A relay thermal with 960A relay. Project Cost: $58,000 Time Estimate: 24 Months	$58,000
	TOTAL COST	**$58,000**

Note: Only the most severely overloaded conditions are listed above.

9 Interconnection Customer Requirements

It is understood that the Interconnection Customer (IC) is responsible for all costs associated with this interconnection. The costs above are reimbursable to the Transmission Owner. The cost of the IC's generating plant and the costs for the line connecting the generating plant to the Point of Interconnection are not included in this report; these are assumed to be the IC's responsibility.

The Generation Interconnection Agreement does not in or by itself establish a requirement for the Transmission Owner 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.

1. 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.

2. 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.

10 Revenue Metering and SCADA Requirements

10.1 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.

10.2 Interconnected Transmission Owner Requirements

The IC will be required to comply with all Interconnected Transmission Owner's revenue metering requirements for generation interconnection customers located at the following link:

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

11 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.

12 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

13 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.

14 Summer Peak - Load Flow Analysis (Transmission System) – Primary POI

The Queue Project AF2-440 was evaluated as a 50.0 MW (Capacity 25.0 MW) injection tapping the Martinsville to Highland 69 kV line in the Dayton area. Project AF2-440 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF2-440 was studied with a commercial probability of 53.0 %. Potential network impacts were as follows:

14.1 Generation Deliverability

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

None

14.2 Multiple Facility Contingency

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

None

14.3 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

14.4 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.

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
9557827 4	96149 0	AF2-440 TAP	69. 0	AEP	25304 3	09MRTNS V	69. 0	DAY	1	DAY_P1_161_B3 _1	operatio n	68.0	78.05	103.84	DC	17.53

14.5 System Reinforcements - Summer Peak Load Flow (Transmission) – Primary POI

ID	Idx	Facility	Upgrade Description	Cost
AF2-440-L1	N/A	**Wilmington-Martinsville 69 kV**	Dayton **DAYr20000: Replace 600A relay thermal with 960A relay.** **Project Type : FAC** **Cost : $ 58,000** **Time Estimate : 24 Months**	$58,000
			TOTAL COST	**$58,000**

14.6 Contingency Descriptions – Primary POI

Contingency Name	Contingency Definition
DAY_P1_161_B3_1	CONTINGENCY 'DAY_P1_161_B3_1' OPEN BRANCH FROM BUS 253014 TO BUS 253027 CKT 1 / 253014 09CLINTO 345 253027 09GREENE 345 1 OPEN BRANCH FROM BUS 253014 TO BUS 253013 CKT 1 / 253014 09CLINTO 345 253013 09CLINTO 69.0 1 OPEN BRANCH FROM BUS 253014 TO BUS 253013 CKT 2 / 253014 09CLINTO 345 253013 09CLINTO 69.0 2 END

15 Light Load Analysis

Light Load Studies (As applicable)

Not Applicable.

16 Short Circuit Analysis

The following Breakers are overdutied:

PJM filed FERC waiver request (ER20-1392-000) which included a “waiver of the short circuit analyses to be performed for and included in the AF2 New Service Queue Interconnection Feasibility Study reports due by July 31, 2020”. This was accepted by the FERC. Short Circuit Analysis will be performed during the SIS phase..

17 Stability and Reactive Power Assessment

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

To be determined during later study phases.

18 Affected Systems

18.1 MISO

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

18.2 LG&E

LG&E Impacts to be determined during later study phases (as applicable).

18.3 TVA

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

18.4 Duke Energy Progress

Duke Energy Progress Impacts to be determined during later study phases (as applicable).

19 Summer Peak - Load Flow Analysis - Secondary POI

The Queue Project AF2-440 was evaluated as a 50.0 MW (Capacity 25.0 MW) injection tapping the Hillsboro to Middleboro 138 kV line. in the Dayton area. Project AF2-440 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF2-440 was studied with a commercial probability of 53.0 %. Potential network impacts were as follows:

19.1 Generation Deliverability

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

None

19.2 Multiple Facility Contingency

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

None

19.3 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

19.4 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