



Generation Interconnection

Feasibility Study Report

for

Queue Project AF2-191

NEW CARLISLE 138 KV

66 MW Capacity / 110 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 AEP.

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 St. Joseph County, Indiana. The installed facilities will have a total capability of 110 MW with 66 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is June 30, 2023. This study does not imply a TO commitment to this in-service date.

Queue Number	AF2-191
Project Name	NEW CARLISLE 138 KV
State	Indiana
County	St. Joseph
Transmission Owner	AEP
MFO	110
MWE	110
MWC	66
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

AF2-191 will interconnect with the AEP transmission system along one of the following Points of Interconnection:

Primary POI: New Carlisle 138 kV.

To accommodate the interconnection to the New Carlisle 138 kV substation, the substation will be expanded and one (1) new 138 kV circuit breaker will be installed (Attachment 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.

Installation of the generator lead first span exiting the POI station, including the first structure outside the AEP fence, will also be included in AEP's scope. In the case where the generator lead is a single span, the structure in the customer station will be the customer's responsibility.

Secondary POI: Tap - Olive to Rickerman Road 138 kV line.

To accommodate the interconnection on the Olive – Rickerman Road 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 Attachment 2). 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.

5 Cost Summary

The AF2-191 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	\$ 1,466,000
Total System Network Upgrade Costs	\$0
Total Costs	\$ 1,466,000

The estimates provided in this report are preliminary in nature, as they were determined without the benefit of detailed engineering studies. Final estimates will require an onsite review and coordination to determine final construction requirements. In addition, Stability analysis will be completed during the Facilities Study stage. It is possible that a need for additional upgrades could be identified by these studies.

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.

6 Transmission Owner Scope of Work

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
138kV Revenue Metering	\$ 388,000
Generator lead first span exiting the POI station, including the first structure outside the AEP fence	\$ 400,000
Total Attachment Facility Costs	\$ 788,000

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
The substation will be expanded and one (1) new 138 kV circuit breaker will be installed (Attachment 1). Installation of associated protection and control equipment, 138 kV line risers, and SCADA will also be required.	\$ 633,000
Total Direct Connection Facility Costs	\$ 633,000

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
Review Protection and Control Settings at the New Carlisle 138 kV Substation	\$ 45,000
Total Non-Direct Connection Facility Costs	\$ 45,000

7 Incremental Capacity Transfer Rights (ICTRs)

Will be determined at a later study phase

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 generally be between 24 to 36 months after signing Agreement execution.

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 Meteorological Data Reporting Requirements

Solar generation facilities shall provide the Transmission Provider with site-specific meteorological data including:

- Back Panel temperature (Fahrenheit)
- Irradiance (Watts/meter²)
- Ambient air temperature (Fahrenheit) – (Accepted, not required)
- Wind speed (meters/second) – (Accepted, not required)
- Wind direction (decimal degrees from true north) – (Accepted, not required)

10.3 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 Summer Peak - Load Flow Analysis – Primary POI

The Queue Project AF2-191 was evaluated as a 110.0 MW (Capacity 66.0 MW) injection at the New Carlisle 138 kV substation in the AEP area. Project AF2-191 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF2-191 was studied with a commercial probability of 53.0 %. Potential network impacts were as follows:

11.1 Generation Deliverability

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

None

11.2 Multiple Facility Contingency

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

None

11.3 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)

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CK T ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC DC	MW IMPACT
95768018	243349	05NEWCAR	138.0	AEP	247489	05BOSSERMAN	138.0	AEP	1	AEP_P4_#7187_05BOSSERMAN 138_E	breaker	156.0	103.81	106.95	DC	10.86

11.4 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	CK T ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC DC	MW IMPACT
95341234	247489	05BOSSERMAN	138.0	AEP	255184	17TRAIL_CRK	138.0	NIPS	1	AEP_P1 - 2_#9204	operation	156.0	97.24	100.41	DC	10.96

11.5 System Reinforcements - Summer Peak Load Flow - Primary POI

ID	Idx	Facility	Upgrade Description	Cost
95768018	1	05NEWCAR 138.0 kV - 05BOSSERMAN 138.0 kV Ckt 1	<p><u>AEP</u> Non AEP limiting element (531) : NIPSCO rating limitation on conductor section 4. Project Type : FAC Cost : \$0 Time Estimate : 0.0 Months</p> <p><u>NIPS</u> NonPJMArea (1630) : The external (i.e. Non-PJM) Transmission Owner, NIPS, will not evaluate this violation until the impact study phase. Project Type : FAC Cost : \$0 Time Estimate : N/A Months</p>	\$0
			TOTAL COST	\$0

11.6 Flow Gate Details - Primary POI

The following indices contain additional information about each facility presented in the body of the report. For each index, a description of the flowgate and its contingency was included for convenience. The intent of the indices is to provide more details on which projects/generators have contributions to the flowgate in question. All New Service Queue Requests, through the end of the Queue under study, that are contributors to a flowgate will be listed in the indices. Please note that there may be contributors that are subsequently queued after the queue under study that are not listed in the indices. Although this information is not used "as is" for cost allocation purposes, it can be used to gage the impact of other projects/generators. It should be noted the project/generator MW contributions presented in the body of the report are Full MW Impact contributions which are also noted in the indices column named "Full MW Impact", whereas the loading percentages reported in the body of the report, take into consideration the PJM Generator Deliverability Test rules such as commercial probability of each project as well as the ramping impact of "Adder" contributions. The MW Impact found and used in the analysis is shown in the indices column named "Gendeliv MW Impact".

11.6.1 Index 1

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADIN G%	POST PROJECT LOADIN G%	AC DC	MW IMPACT
95768018	243349	05NEWCAR	AEP	247489	05BOSSERMAN	AEP	1	AEP_P4_#7187_05BOSSERMAN 138_E	breaker	156.0	103.81	106.95	DC	10.86

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
247967	05OLIV SLR E	0.1619	Adder	0.19
944931	AF1-158 C O1	5.2976	Adder	6.23
944932	AF1-158 E O1	3.5318	Adder	4.16
959001	AF2-191 C	2.9358	Adder	6.52
959002	AF2-191 E	1.9572	Adder	4.34
LGEE	LGEE	0.0416	Confirmed LTF	0.0416
NEWTON	NEWTON	0.3181	Confirmed LTF	0.3181
CPL	CPL	0.0628	Confirmed LTF	0.0628
FARMERCITY	FARMERCITY	0.0454	Confirmed LTF	0.0454
G-007A	G-007A	0.5227	Confirmed LTF	0.5227
VFT	VFT	1.4125	Confirmed LTF	1.4125
CALDERWOOD	CALDERWOOD	0.0084	Confirmed LTF	0.0084
PRAIRIE	PRAIRIE	1.1598	Confirmed LTF	1.1598
CHEOAH	CHEOAH	0.0070	Confirmed LTF	0.0070
EDWARDS	EDWARDS	0.4263	Confirmed LTF	0.4263
CBM-S2	CBM-S2	0.3584	Confirmed LTF	0.3584
TILTON	TILTON	0.1783	Confirmed LTF	0.1783
GIBSON	GIBSON	0.0158	Confirmed LTF	0.0158

11.7 Queue Dependencies

The Queue Projects below are listed in one or more indices for the overloads identified in your report. These projects contribute to the loading of the overloaded facilities identified in your report. The percent overload of a facility and cost allocation you may have towards a particular reinforcement could vary depending on the action of these earlier projects. The status of each project at the time of the analysis is presented in the table. This list may change as earlier projects withdraw or modify their requests.

Queue Number	Project Name	Status
AF1-158	Edison-Gravel Pit 138 kV	Active
AF2-191	New Carlisle 138 kV	Active

11.8 Contingency Descriptions - Primary POI

Contingency Name	Contingency Definition
AEP_P1-2_#9204	CONTINGENCY 'AEP_P1-2_#9204' OPEN BRANCH FROM BUS 247489 TO BUS 255153 CKT 1 / 247489 05BOSSERMAN 138 255153 17MICH_CITY 138 1 END
AEP_P4_#7187_05BOSSERMAN 138_E	CONTINGENCY 'AEP_P4_#7187_05BOSSERMAN 138_E' OPEN BRANCH FROM BUS 247489 TO BUS 244142 CKT 1 / 247489 05BOSSERMAN 138 244142 05MARQUETTE 138 1 OPEN BRANCH FROM BUS 247489 TO BUS 243349 CKT 2 / 247489 05BOSSERMAN 138 243349 05NEWCAR 138 2 END

12 Light Load Analysis

Light Load Studies (As applicable)

Not Applicable.

13 Short Circuit Analysis – Primary POI

The following Breakers are overdutied:

To be determined during later study phases.

14 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.

15 Affected Systems

15.1 TVA

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

15.2 Duke Energy Progress

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

15.3 MISO

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

15.4 LG&E

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

15 Summer Peak – Load Flow Analysis – Secondary POI

The Queue Project AF2-191 was evaluated as a 110.0 MW (Capacity 66.0 MW) injection tapping the Olive to Rickerman Road 138 kV line in the AEP area. Project AF2-191 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF2-191 was studied with a commercial probability of 53.0 %. Potential network impacts were as follows:

:

15.1 Generation Deliverability

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

None

15.2 Multiple Facility Contingency

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

None

15.3 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)

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
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15.4 Potential Congestion due to Local Energy Deliverability

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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

15.5 Flow Gate Details - Secondary POI

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15.5.1 Index 1

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CK T ID	CONT NAME	Type	Rating MVA	PRE PROJE CT LOADIN G %	POST PROJE CT LOADIN G %	AC D C	MW IMPAC T
95768018	243349	05NEWCA R	AEP	247489	05BOSSERM AN	AEP	1	AEP_P4_#7187_05BOSSER MAN 138_E	breaker	156.0	103.81	106.19	DC	8.25

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
247967	05OLIV SLR E	0.1619	Adder	0.19
944931	AF1-158 C O1	5.2976	Adder	6.23
944932	AF1-158 E O1	3.5318	Adder	4.16
959001	AF2-191 C O2	2.2294	Adder	4.95
959002	AF2-191 E O2	1.4863	Adder	3.3
LGEE	LGEE	0.0416	Confirmed LTF	0.0416
NEWTON	NEWTON	0.3181	Confirmed LTF	0.3181
CPL	CPL	0.0628	Confirmed LTF	0.0628
FARMERCITY	FARMERCITY	0.0454	Confirmed LTF	0.0454
G-007A	G-007A	0.5227	Confirmed LTF	0.5227
VFT	VFT	1.4125	Confirmed LTF	1.4125
CALDERWOOD	CALDERWOOD	0.0084	Confirmed LTF	0.0084
PRAIRIE	PRAIRIE	1.1598	Confirmed LTF	1.1598
CHEOAH	CHEOAH	0.0070	Confirmed LTF	0.0070
EDWARDS	EDWARDS	0.4263	Confirmed LTF	0.4263
CBM-S2	CBM-S2	0.3584	Confirmed LTF	0.3584
TILTON	TILTON	0.1783	Confirmed LTF	0.1783
GIBSON	GIBSON	0.0158	Confirmed LTF	0.0158

15.6 Contingency Descriptions - Secondary POI

Contingency Name	Contingency Definition
AEP_P4_#7187_05BOSSERMAN 138_E	CONTINGENCY 'AEP_P4_#7187_05BOSSERMAN 138_E' OPEN BRANCH FROM BUS 247489 TO BUS 244142 CKT 1 / 247489 05BOSSERMAN 138 244142 05MARQUETTE 138 1 OPEN BRANCH FROM BUS 247489 TO BUS 243349 CKT 2 / 247489 05BOSSERMAN 138 243349 05NEWCAR 138 2 END

16 Light Load Analysis – Secondary POI

Light Load Studies (As applicable).

To be determined during later study phases.

17 Short Circuit Analysis – Secondary POI

The following Breakers are overdutied

To be determined during later study phases.

18 Stability and Reactive Power Assessment – Secondary POI

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

To be determined during later study phases.

19 Affected Systems – Secondary POI

19.1 TVA

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

19.2 Duke Energy Progress

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

19.3 MISO

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

19.4 LG&E

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