Generation Interconnection

Feasibility Study Report

for

Queue Project AF1-092

HUNTINGTON JCT. 138 KV

115 MW Capacity / 150 MW Energy

January, 2020

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1 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.

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.

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.

PJM utilizes manufacturer models to ensure the performance of turbines is properly captured during the simulations performed for stability verification and, where applicable, for compliance with low voltage ride through requirements. Turbine manufacturers provide such models to their customers. The list of manufacturer models PJM has already validated is contained in Attachment B of Manual 14G. Manufacturer models may be updated from time to time, for various reasons such as to reflect changes to the control systems or to more accurately represent the capabilities turbines and controls which are currently available in the field. Additionally, as new turbine models are developed, turbine manufacturers provide such new models which must be used in the conduct of these studies. PJM needs adequate time to evaluate the new models in order to reduce delays to the System Impact Study process timeline for the Interconnection Customer as well as other Interconnection Customers in the study group. Therefore, PJM will require that any Interconnection Customer with a new manufacturer model must supply that model to PJM, along with a $10,000 fully refundable deposit, no later than three (3) months prior to the starting date of the System Impact Study (See Section 4.3 for starting dates) for the Interconnection Request which shall specify the use of the new model. The Interconnection Customer will be required to submit a completed dynamic model study request form (Attachment B-1 of Manual 14G) in order to document the request for the study.

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.

2 General

The Interconnection Customer has proposed to install PJM project #AF1-092, a solar and storage generating facility located in Huntington County, Indiana. The installed facilities will have a total capability of 150 MW with 115 MW of this output being recognized by PJM as Capacity. The Primary Point of Interconnection will be a direct connection to AEP's Huntington JCT 138 kV substation. The Secondary Point of Interconnection will be to the Sorenson – Van Buren 138 kV section of the Sorenson – Delaware 138 kV circuit.

The proposed in-service date for this project is 06/01/2022. This study does not imply AEP's commitment to this in-service date.

Queue Number	AF1-092
Project Name	HUNTINGTON JCT. 138 KV
State	Indiana
County	Huntington
Transmission Owner	AEP
MFO	150
MWE	150
MWC	115
Fuel	Solar
Basecase Study Year	2023

2.1 Primary Point of Interconnection

AF1-092 will interconnect with the AEP transmission system via expanding AEP's Huntington JCT 138 kV switching station.

To accommodate the interconnection at the Huntington JCT 138 kV switching station, the station must be expanded with four (4) new 138 kV circuit breakers, physically configured in a breaker and half bus arrangement, but operated as a ring-bus (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 AF1-092 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$250,000
Direct Connection Network Upgrade	$6,000,000
Non Direct Connection Network Upgrades	$750,000
Total Costs	$7,000,000

In addition, the AF1-092 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	$0

Cost allocations for these upgrades will be provided in the System Impact Study Report.

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
138 kV Revenue Metering	$250,000
Total Attachment Facility Costs	$250,000

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
Expand Huntington Junction 138 kV switching station into a four (4) circuit breaker 138 kV switching station physically configured in a breaker and half bus arrangement but operated as a ring-bus. 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.

Description	Total Cost
Upgrade line protection and controls at the expanded Huntington JCT	$250,000
Upgrade line protection and controls at the Sorenson 138 kV substation to coordinate with the expanded Huntington JCT 138 kV substation.	$250,000
Upgrade line protection and controls at the Hummel Creek 138 kV substation to coordinate with the expanded Huntington JCT 138 kV substation.	$250,000
Total Non-Direct Connection Facility Costs	$750,000

7 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 Agreement execution.

8 Interconnection Customer Requirements

It is understood that the Interconnection Customer is responsible for all costs associated with this interconnection. The costs above are reimbursable to AEP. The cost of the Interconnection Customer's generating plant and the costs for the line connecting the generating plant to the Huntington Junction 138 kV station are not included in this report; these are assumed to be the Interconnection Customer'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.

In addition, if the Interconnection Customer considers use of the Option to Build, they should consult the guidance AEP has posted at:
https://www.aep.com/assets/docs/requiredpostings/TransmissionStudies/docs/2019/MerchantGenerationGuidelinesPJMoptiontoBuild.pdf

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 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

10 Network Impacts – Option 1

The Queue Project AF1-092 was evaluated as a 150.0 MW (Capacity 115.0 MW) injection at the Huntington Junction 138 kV station in the AEP area. Project AF1-092 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-092 was studied with a commercial probability of 0.53. Potential network impacts were as follows:

Summer Peak Load Flow

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 Flow Gate Details

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact. It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

Affected Systems

16 Affected Systems

16.1 LG&E

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

16.2 MISO

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

16.3 TVA

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

16.4 Duke Energy Progress

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

16.5 NYISO

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

Short Circuit

17 Short Circuit

The following Breakers are overduty:

None

17.1 Secondary Point of Interconnection

AF1-092 will interconnect with the AEP transmission system at a new switching station cut into the Sorenson – Van Buren 138 kV section of the Sorenson – Delaware 138 kV circuit.

To accommodate the interconnection on the AEP-owned Sorenson – Van Buren line, 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 (Figure 3). 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.

18 Network Impacts

The Queue Project AF1-092 was evaluated as a 150.0 MW (Capacity 115.0 MW) injection to the Sorenson – Van Buren 138 kV line in the AEP area. Project AF1-092 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-092 was studied with a commercial probability of 0.53. Potential network impacts were as follows:

Summer Peak Load Flow

19 Generation Deliverability

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

None

20 Multiple Facility Contingency

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

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
52172629	939770	AE1-208 TAP	138.0	AEP	243275	05DELAWR	138.0	AEP	1	AEP_P4_#7457_05SORENS 138_M	breaker	210.0	73.86	145.29	DC	150.0
52172574	944240	AF1-092 TAP	138.0	AEP	243377	05SORENS	138.0	AEP	1	AEP_P4_#10637_05DELAWR 138_B	breaker	167.0	92.87	182.69	DC	150.0

21 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

22 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
52173192	939770	AE1-208 TAP	138.0	AEP	243275	05DELAWR	138.0	AEP	1	AEP_P1-2_#5595-B-B	operation	210.0	63.02	121.05	DC	121.87
52173036	944240	AF1-092 TAP	138.0	AEP	243377	05SORENS	138.0	AEP	1	AEP_P1-2_#5595-A	operation	167.0	75.27	158.73	DC	139.36

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
5217303 7	944240	AF1-092 TAP	138.0	AEP	243377	05SORENS	138.0	AEP	1	Base Case	operation	136.0	36.51	121.72	DC	115.88

23 Flow Gate Details

The following indices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact. It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

23.1 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 LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
52172629	939770	AE1-208 TAP	AEP	243275	05DELAWR	AEP	1	AEP_P4_#7457_05SORENS 138_M	breaker	210.0	73.86	145.29	DC	150.0

Bus #	Bus	MW Impact
939771	AE1-208 C	55.0000
939772	AE1-208 E	75.0000
941691	AE2-169	33.0000
944241	AF1-092 C O2	115.0000
944242	AF1-092 E O2	35.0000

23.2 Index 2

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
52172574	944240	AF1-092 TAP	AEP	243377	05SORENS	AEP	1	AEP_P4_#10637_05DELAWR 138_B	breaker	167.0	92.87	182.69	DC	150.0

Bus #	Bus	MW Impact
939771	AE1-208 C	55.0000
939772	AE1-208 E	75.0000
941691	AE2-169	33.0000
944241	AF1-092 C O2	115.0000
944242	AF1-092 E O2	35.0000

Affected Systems

24 Affected Systems

24.1 LG&E

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

24.2 MISO

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

24.3 TVA

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

24.4 Duke Energy Progress

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

24.5 NYISO

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

25 Contingency Descriptions

Contingency Name	Contingency Definition
Base Case	
AEP_P4_#10637_05DELAWR 138_B	CONTINGENCY 'AEP_P4_#10637_05DELAWR 138_B' OPEN BRANCH FROM BUS 243275 TO BUS 939770 CKT 1 / 243275 05DELAWR 138 939770 AE1-208 TAP 138 1 OPEN BRANCH FROM BUS 243275 TO BUS 243393 CKT 1 / 243275 05DELAWR 138 243393 05WESDEL 138 1 OPEN BRANCH FROM BUS 243275 TO BUS 246037 CKT 1 / 243275 05DELAWR 138 246037 05DELAWARE 34.5 1 OPEN BRANCH FROM BUS 245987 TO BUS 245999 CKT 1 / 245987 05MTETNA T 69.0 245999 05VAN BURE 69.0 1 END
AEP_P1-2_#5595-B-B	CONTINGENCY 'AEP_P1-2_#5595-B-B' OPEN BRANCH FROM BUS 243377 TO BUS 944240 CKT 1 / 243377 05SORENS 138 944240 AF1-092 TAP 138 1 END
AEP_P1-2_#5595-A	CONTINGENCY 'AEP_P1-2_#5595-A' OPEN BRANCH FROM BUS 243275 TO BUS 939770 CKT 1 / 243275 05DELAWR 138 939770 AE1-208 TAP 138 1 END
AEP_P4_#7457_05SORENS 138_M	CONTINGENCY 'AEP_P4_#7457_05SORENS 138_M' OPEN BRANCH FROM BUS 246282 TO BUS 243315 CKT 1 / 246282 05ILLIN EQ 999 243315 05ILLINO 138 1 OPEN BRANCH FROM BUS 246282 TO BUS 246284 CKT 1 / 246282 05ILLIN EQ 999 246284 05ILLINOIS 69.0 1 OPEN BRANCH FROM BUS 243315 TO BUS 243316 CKT 1 / 243315 05ILLINO 138 243316 05INDUSP 138 1 OPEN BRANCH FROM BUS 243315 TO BUS 243377 CKT 1 / 243315 05ILLINO 138 243377 05SORENS 138 1 OPEN BRANCH FROM BUS 243377 TO BUS 944240 CKT 1 / 243377 05SORENS 138 944240 AF1-092 TAP 138 1 OPEN BRANCH FROM BUS 246110 TO BUS 246284 CKT 1 / 246110 05ABOITE 8 69.0 246284 05ILLINOIS 69.0 1 OPEN BRANCH FROM BUS 246284 TO BUS 247259 CKT 1 / 246284 05ILLINOIS 69.0 247259 05LINCWTAPSS69.0 1 OPEN BRANCH FROM BUS 245987 TO BUS 245999 CKT 1 / 245987 05MTETNA T 69.0 245999 05VAN BURE 69.0 1 END

Short Circuit

26 Short Circuit

The following Breakers are overduty:

None