Generation Interconnection

Feasibility Study Report

for

Queue Project AF1-144

HAYDEN 345 KV

66.9 MW Capacity / 100 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.

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 (IC), has proposed a Solar generating facility located in Franklin County, Ohio. The installed facilities will have a total capability of 100 MW with 66.9 MW of this output being recognized by PJM as Capacity. The primary point of interconnection for the solar facility will be a direct connection to the Hayden 345 kV substation.

The secondary point of interconnection will be at a new substation cut into the First Energy-owned Tangy–London 138 kV line.

The proposed in-service date for this project is 12/1/2023. This study does not imply a TO commitment to this in-service date.

Queue Number	**AF1-144**
Project Name	HAYDEN 345 KV
State	Ohio
County	Franklin
Transmission Owner	AEP
MFO	100
MWE	100
MWC	66.9
Fuel	Solar
Basecase Study Year	2023

2.1 Primary Point of Interconnection

AF1-144 will interconnect with the AEP transmission system via a direct connection to the Hayden 345 kV substation (See Figure 1).

To accommodate the interconnection at the Hayden 345 kV substation, the substation will have to be expanded requiring the installation of one (1) 345 kV circuit breaker (see Figure 2). Installation of associated protection and control equipment, 345 kV line risers, SCADA, and 345 kV revenue metering will also be required.

2.2 Cost Summary

The AF1-144 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$350,000
Direct Connection Network Upgrade	$2,500,000
Non Direct Connection Network Upgrades	$0
Total Costs	$2,850,000

In addition, the AF1-144 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
345 kV Revenue Metering	$350,000
Total Attachment Facility Costs	$350,000

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 the Hayden 345 kV substation: Install one (1) additional 345 kV circuit breaker. Installation of associated protection and control equipment, 345 kV line risers and SCADA will also be required.	$2,500,000
Total Direct Connection Facility Costs	$2,500,000

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
Total Non-Direct Connection Facility Costs	$0

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 Hayden 345 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 AF1-144 was evaluated as a 100.0 MW (Capacity 66.9 MW) injection at Hayden 345 kV substation in the AEP area. Project AF1-144 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-144 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

Bus Number	Bus Name	BREAKER	Type	Capacity (Amps)	Duty Percentage Post Queue	Duty Percentage Pre Queue

17.1 Secondary Point of Interconnection

AF1-144 will interconnect with the First energy transmission system tapping the Tangy to London 138 kV line.

18 Network Impacts – Option 2

The Queue Project AF1-144 was evaluated as a 100.0 MW (Capacity 66.9 MW) injection tapping the Tangy to London 138 kV line in the AEP area. Project AF1-144 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-144 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
43816567	926010	AC1-078 TAP	138.0	AEP	243469	05BEATTY	138.0	AEP	1	ATSI-P2-3-OES-138-010A	breaker	242.0	90.16	112.92	DC	55.08
43816568	926010	AC1-078 TAP	138.0	AEP	243469	05BEATTY	138.0	AEP	1	ATSI-P2-3-OES-138-011	breaker	242.0	86.4	109.16	DC	55.08
52239605	926010	AC1-078 TAP	138.0	AEP	243469	05BEATTY	138.0	AEP	1	ATSI-P7-1-OES-138-071-B	tower	242.0	86.62	102.85	DC	39.27

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	CONTNAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
52239326	926010	AC1-078 TAP	138.0	AEP	243469	05BEATTY	138.0	AEP	1	ATSI-P1-2-OES-138-022A-B	operation	242.0	80.03	101.86	DC	52.83

23 Flow Gate Details

The following indices contain additional information about each flowgate presented in the body of the report. For each index, 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
43816567	926010	AC1-078 TAP	AEP	243469	05BEATTY	AEP	1	ATSI-P2-3-OES-138-010A	breaker	242.0	90.16	112.92	DC	55.08

Bus #	Bus	MW Impact
926011	AC1-078 C O1	45.2549
926012	AC1-078 E O1	75.4248
934561	AD1-081 C	9.0510
934562	AD1-081 E	4.6626
935041	AD1-140 C O1	11.7374
935042	AD1-140 E O1	9.7036
937241	AD2-163 C	28.8883
937242	AD2-163 E	14.1929
942051	AE2-217 C	48.3635
942052	AE2-217 E	32.2423
942621	AE2-278 C	16.7285
942622	AE2-278 E	11.1585
942861	AE2-305 C O1	7.1066
942862	AE2-305 E O1	4.7377
943131	AE2-342 C	1.9345
943132	AE2-342 E	0.9528
943861	AF1-054 C	5.9373
943862	AF1-054 E	5.9829
944791	AF1-144 C O2	36.8479
944792	AF1-144 E O2	18.2311
LGEE	LGEE	0.2453
CPLE	CPLE	0.0007
WEC	WEC	0.0693
CBM-W2	CBM-W2	1.9574
NY	NY	0.0747
CBM-W1	CBM-W1	2.4144
TVA	TVA	0.2506
O-066	O-066	0.9072
CBM-S2	CBM-S2	0.1907
CBM-S1	CBM-S1	1.9170
G-007	G-007	0.1404
MEC	MEC	0.3575

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).

Contingency Name	Contingency Definition
ATSI-P2-3-OES-138-010A	CONTINGENCY 'ATSI-P2-3-OES-138-010A' /* TANGY B-155 FAILURE TO TRIP DISCONNECT BRANCH FROM BUS 239134 TO BUS 239264 CKT 1 /* 02TANGY 138 02DBP 138 DISCONNECT BRANCH FROM BUS 239134 TO BUS 239218 CKT 1 /* 02TANGY 138 02SSCIOT 138 DISCONNECT BRANCH FROM BUS 239134 TO BUS 238574 CKT 1 /* 02TANGY 138 02BELPT+ 138 DISCONNECT BRANCH FROM BUS 238964 TO BUS 238574 CKT 1 /* 02MLCRK+ 138 02BELPT+ 138 DISCONNECT BRANCH FROM BUS 239134 TO BUS 944790 CKT 1 /* 02TANGY 138 AF1-144 TAP 138 DISCONNECT BRANCH FROM BUS 239133 TO BUS 239134 CKT 3 /* 02TANGY 345 02TANGY 138 DISCONNECT BRANCH FROM BUS 239133 TO BUS 239134 CKT 4 /* 02TANGY 345 02TANGY 138 DISCONNECT BRANCH FROM BUS 239133 TO BUS 239134 CKT 5 /* 02TANGY 345 02TANGY 138 DISCONNECT BRANCH FROM BUS 239134 TO BUS 239135 CKT 1 /* 02TANGY 138 02TANGY 69 DISCONNECT BRANCH FROM BUS 239134 TO BUS 239135 CKT 2 /* 02TANGY 138 02TANGY 69 DISCONNECT BRANCH FROM BUS 937240 TO BUS 238964 CKT 1 /* AD2-163 TAP 138 02MLCRK+ 138 REMOVE LOAD O FROM BUS 238574 /* 02BELPT+ 138 REMOVE LOAD O FROM BUS 238964 /* 02MLCRK+ 138 DISCONNECT BUS 239134 /* 02TANGY 138 DISCONNECT BUS 238964 /* 02MLCRK+ 138 DISCONNECT BUS 238574 /* 02BELPT+ 138 END
ATSI-P2-3-OES-138-011	CONTINGENCY 'ATSI-P2-3-OES-138-011' /* TANGY B-2 FAILURE TO TRIP DISCONNECT BRANCH FROM BUS 239134 TO BUS 239264 CKT 1 /* 02TANGY 138 02DBP 138 DISCONNECT BRANCH FROM BUS 239134 TO BUS 239218 CKT 1 /* 02TANGY 138 02SSCIOT 138 DISCONNECT BRANCH FROM BUS 239134 TO BUS 238574 CKT 1 /* 02TANGY 138 02BELPT+ 138 DISCONNECT BRANCH FROM BUS 239264 TO BUS 238640 CKT 1 /* 02DBP 138 02CRISS 138 DISCONNECT BRANCH FROM BUS 239134 TO BUS 944790 CKT 1 /* 02TANGY 138 AF1-144 TAP 138 DISCONNECT BRANCH FROM BUS 239133 TO BUS 239134 CKT 3 /* 02TANGY 345 02TANGY 138 DISCONNECT BRANCH FROM BUS 239133 TO BUS 239134 CKT 4 /* 02TANGY 345 02TANGY 138 DISCONNECT BRANCH FROM BUS 239133 TO BUS 239134 CKT 5 /* 02TANGY 345 02TANGY 138 DISCONNECT BRANCH FROM BUS 239134 TO BUS 239135 CKT 1 /* 02TANGY 138 02TANGY 69 DISCONNECT BRANCH FROM BUS 239134 TO BUS 239135 CKT 2 /* 02TANGY 138 02TANGY 69 REMOVE LOAD R FROM BUS 239264 /* 02DBP 138 DISCONNECT BUS 239134 /* 02TANGY 138 DISCONNECT BUS 239264 /* 02DBP 138 END
ATSI-P1-2-OES-138-022A-B	CONTINGENCY 'ATSI-P1-2-OES-138-022A-B' /* LONDON - TANGY 138KV LINE FAULT DISCONNECT BRANCH FROM BUS 944790 TO BUS 239134 CKT 1 /* AF1-144 TAP 138 02TANGY 138 END
ATSI-P7-1-OES-138-071-B	CONTINGENCY 'ATSI-P7-1-OES-138-071-B' /* E. SPFD-LONDON 1 & N TITUS-LONDON COMMON TOWER DISCONNECT BRANCH FROM BUS 942050 TO BUS 238703 CKT 1 /* AE2-217 TAP 138 02ESPRNG 138 DISCONNECT BRANCH FROM BUS 240709 TO BUS 238908 CKT 1 /* 02N TITUS 138 02LONDON 138 END

Short Circuit

25 Short Circuit

The following Breakers are overduty

Bus Number	Bus Name	BREAKER	Type	Capacity (Amps)	Duty Percentage Post Queue	Duty Percentage Pre Queue