Generation Interconnection

Feasibility Study Report

for

Queue Project AE2-276

SULLIVAN 345KV

50 MW Capacity / 50 MW Energy

November, 2019

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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

2 General

The Interconnection Customer has proposed a Storage generating facility located in Sullivan County, Indiana. The installed facilities will have a total capability of 50 MW with 50 MW of this output being recognized by PJM as Capacity. The Point of Interconnection is at direct connection to Sullivan 345kV substation. In addition, the Interconnection Customer has indicated that at times they will charge the batteries from the grid. The AE2-276 project will share the same generator lead with AC2-157 (see figure 1).The proposed in-service date for this project is 12/31/2020. This study does not imply a TO commitment to this in-service date.

The Feasibility Study includes Short Circuit and Peak Load steady state power flow analyses. The conduct of power flow studies at other load levels, stability analysis, and coordination with non-PJM Transmission Planners, as required under the PJM planning process, is not performed during the Generation Interconnection Feasibility Study phase of the PJM study process. Additional reinforcement requirements for this Interconnection Request may be defined during the conduct of these additional analyses which shall be performed following execution of the System Impact Study agreement.

The objective of this Feasibility Study is to determine budgetary cost estimates and approximate construction timelines for identified transmission facilities required to connect the proposed generating facilities to the AEP transmission system. These reinforcements include the Attachment Facilities, Local Upgrades, and Network Upgrades required maintaining the reliability of the AEP transmission system. Stability analysis is not included as part of this study.

Queue Number	AE2-276
Project Name	SULLIVAN 345KV
State	Indiana
County	Sullivan
Transmission Owner	AEP
MFO	50
MWE	50
MWC	50
Fuel	Storage
Basecase Study Year	2022

2.1 Point of Interconnection

AE2-276 will interconnect with the AEP transmission system at the Sullivan 345kV station. This project taps on the #AC2-157, a 200MW solar generator lead line.

Note: It is assumed that the 345 kV revenue metering system, gen lead and Protection & Control Equipment installed for #AC2-157 will be adequate for the additional storage facility connection requested at the AE2-276 generator lead line. Depending on the timing of the completion of the AE2-276 interconnection construction relative to the AE2-276 completion, there may (or may not) be a need to review and revise relay settings for the increased generation of AE2-276.

2.2 Cost Summary

The AE2-276 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$0
Direct Connection Network Upgrade	$0
Non Direct Connection Network Upgrades	$0
Total Costs	$0

In addition, the AE2-276 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 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.

None

4 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.

None

5 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.

None

6 Incremental Capacity Transfer Rights (ICTRs)

Will be determined at a later study phase

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 signing 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 Sullivan 345kV circuit are not included in this report; these are assumed to be the Interconnection Customer 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.

Requirement from the PJM Open Access Transmission Tariff:

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.

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

The Queue Project AE2-276 was evaluated as a 50 MW (Capacity 50 MW) injection at Sullivan 345kV in the AEP area. Project AE2-276 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-276 was studied with a commercial probability of 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)

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
8927646	937160	AD2-153 TAP	CE	924040	AB2-047 TAP	CE	1	COMED_P1-2_345-L2102___-S_W4-005-FSA-A	single	1528.0	99.82	100.01	DC	2.94

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)

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
7334851	247712	05SULLIVAN	AEP	346809	7CASEY	AMIL	1	AEP_P4_#8648_05JEFRSO 765_B	breaker	1466.0	208.13	209.38	DC	18.29
7335712	247712	05SULLIVAN	AEP	346809	7CASEY	AMIL	1	AEP_P1-2_#363	single	1466.0	135.53	136.78	DC	18.28
7335713	247712	05SULLIVAN	AEP	346809	7CASEY	AMIL	1	AEP_P1-2_#10136	single	1466.0	104.07	105.32	DC	18.41

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.

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
7335709	247712	05SULLIVAN	AEP	346809	7CASEY	AMIL	1	AEP_P1-2_#363	operation	1466.0	207.78	209.02	DC	18.28

15 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
7334851,7335713,7335712	2	05SULLIVAN 345.0 kV - 7CASEY 345.0 kV Ckt 1	**7335713** Non AEP Reinforcement. This is an AEP-Ameren tie line therefore, PJM is going to have to coordinate this upgrade with Ameren as well to make sure that their equipment will not set a limit lower than what is specified here. AEP End Ratings: [Rate A: 1443 MVA; Rate B: 1685 MVA] **n5034 (196)** : Rebuilding a new Sullivan - Reynolds 765kV line which is driven by X3-028 MTX project will mitigate the identified overloads. **Project Type** : FAC **Cost** : $0 **Time Estimate** : N/A Months **NonPJMArea (197)** : The external (i.e. Non-PJM) Transmission Owner, AMIL, will not evaluate this violation until the impact study phase. **Project Type** : FAC **Cost** : $0 **Time Estimate** : N/A Months	$0
8927646	1	AD2-153 TAP 345.0 kV - AB2-047 TAP 345.0 kV Ckt 1	**8927646** No violation. L8001 SSTE rating is 1837 MVA.	$0
			TOTAL COST	**$0**

16 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.

16.1 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
8927646	937160	AD2-153 TAP	CE	924040	AB2-047 TAP	CE	1	COMED_P1-2_345-L2102___-S_W4-005-FSA-A	single	1528.0	99.82	100.01	DC	2.94

Bus #	Bus	MW Impact
274650	KINCAID ;1U	11.96
274651	KINCAID ;2U	11.96
900404	X3-028 C	88.09
924261	AB2-070 C O1	9.03
925771	AC1-053 C	8.75
926841	AC1-171 C O1	1.03
930461	AB1-087	32.3
930471	AB1-088	32.3
933441	AC2-157 C	4.46
935141	AD1-148	15.38
936771	AD2-100 C O1	22.2
937161	AD2-153 C O1	14.16
937171	AD2-154 C O1	14.16
942481	AE2-261 C	31.35
942601	AE2-276	2.94
942913	AE2-310 BAT	3.8
950291	J291	3.76
950701	J196 C	1.33
951001	J339	15.62
951741	J474 C	5.96
952251	J641	11.91
952271	J644	12.1
952321	J734	13.11
952651	J756 C	4.86
952871	J757 C	5.05
953401	J811	10.4
953651	J815	34.47
953741	J826 C	3.85
953801	J835 C	3.33
953851	J845 C	3.77
953881	J848 C	5.32
954181	J884	33.24
954411	J912	13.32
954681	J949	19.25
954721	J750 C	3.44
954761	J468 C	4.45
AD2-098	AD2-098	0.42
CBM-N	CBM-N	0.72
CBM-S1	CBM-S1	10.93
CBM-S2	CBM-S2	3.47
CBM-W2	CBM-W2	127.07

Bus #	Bus	MW Impact
CIN	CIN	12.36
CPLE	CPLE	1.24
G-007A	G-007A	2.4
IPL	IPL	6.69
LGEE	LGEE	1.85
MEC	MEC	5.36
NYISO	NYISO	3.14
TATANKA	TATANKA	0.08
VFT	VFT	6.44

16.2 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
7334851	247712	05SULLIVAN	AEP	346809	7CASEY	AMIL	1	AEP_P4_#8648_05JEFRSO 765_B	breaker	1466.0	208.13	209.38	DC	18.29

Bus #	Bus	MW Impact
243442	05RKG1	60.33
243443	05RKG2	57.84
247900	05FR-11G E	4.0
247901	05FR-12G E	3.93
247902	05FR-21G E	4.2
247903	05FR-22G E	4.03
247904	05FR-3G E	8.15
247905	05FR-4G E	6.13
900404	X3-028 C	547.58
900405	X3-028 E	730.1
930461	AB1-087	200.78
930471	AB1-088	200.78
933441	AC2-157 C	27.74
933442	AC2-157 E	45.27
935271	AD1-137 C	3.32
935272	AD1-137 E	22.22
936972	AD2-131 E O1	2.62
939683	AE1-198 BAT	2.43
941341	AE2-130 C	175.26
941342	AE2-130 E	116.84
941732	AE2-173 BAT	1.44
942601	AE2-276	18.29
950161	J401	1.53
951731	J446 C	1.78
951732	J446 E	9.64
951811	J513 C	0.95
951812	J513 E	5.13
952471	J708	22.71
952801	J754 C	3.01
952802	J754 E	16.29
952811	J759	4.28
952861	J783 C	4.12
952862	J783 E	0.17
953101	J714 C	1.89
953102	J714 E	10.2
953161	J837 C	2.14
953162	J837 E	11.55
953171	J838 C	2.14
953172	J838 E	11.55
953351	J805	14.18
953501	J478 C	1.69
953502	J478 E	9.15
953831	J842 C	2.24

Bus #	Bus	MW Impact
953832	J842 E	12.13
953841	J843 C	2.37
953842	J843 E	12.84
953931	J856	5.42
954171	J883 C	0.69
954172	J883 E	3.74
954351	J903	6.77
954421	J913	13.68
954772	J515 E	26.69
AC1-056	AC1-056	12.08
CALDERWOOD	CALDERWOOD	1.23
CARR	CARR	0.01
CATAWBA	CATAWBA	0.49
CHEOAH	CHEOAH	1.11
CHILHOWEE	CHILHOWEE	0.4
CIN	CIN	8.3
COFFEEN	COFFEEN	8.31
COTTONWOOD	COTTONWOOD	10.75
DUCKCREEK	DUCKCREEK	7.21
EDWARDS	EDWARDS	2.8
FARMERCITY	FARMERCITY	2.39
G-007	G-007	0.07
HAMLET	HAMLET	0.71
IPL	IPL	11.83
LGEE	LGEE	0.92
MECS	MECS	1.17
NEWTON	NEWTON	34.02
O-066	O-066	0.45
PRAIRIE	PRAIRIE	31.39
RENSSELAER	RENSSELAER	0.01
SANTEETLA	SANTEETLA	0.32
SMITHLAND	SMITHLAND	1.22
TATANKA	TATANKA	3.69
TILTON	TILTON	1.7
TVA	TVA	6.59
UNIONPOWER	UNIONPOWER	3.59

Affected Systems

17 Affected Systems

17.1 LG&E

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

17.2 MISO

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

17.3 TVA

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

17.4 Duke Energy Progress

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

17.5 NYISO

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

18 Contingency Descriptions

Contingency Name	Contingency Definition
COMED_P1-2_345-L2102___-S_W4-005-FSA-A	CONTINGENCY 'COMED_P1-2_345-L2102___-S_W4-005-FSA-A' TRIP BRANCH FROM BUS 270804 TO BUS 905080 CKT 1 / LATHAM TAP W4-005 TRIP BRANCH FROM BUS 270804 TO BUS 936770 CKT 1 / LATHA; T 345 AD2-100 TAP 345 TRIP BRANCH FROM BUS 270804 TO BUS 348856 CKT 1 / LATHA; T 345 7LATHAM 345 TRIP BRANCH FROM BUS 270668 TO BUS 905080 CKT 1 / BLUEM; B 345 W4-005 END
AEP_P1-2_#10136	CONTINGENCY 'AEP_P1-2_#10136' OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1 OPEN BRANCH FROM BUS 243209 TO BUS 243443 CKT 2 / 243209 05ROCKPT 765 243443 05RKG2 26.0 2 REMOVE UNIT 2H FROM BUS 243443 / 243443 05RKG2 26.0 REMOVE UNIT 2L FROM BUS 243443 / 243443 05RKG2 26.0 END
AEP_P4_#8648_05JEFRSO 765_B	CONTINGENCY 'AEP_P4_#8648_05JEFRSO 765_B' OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1 OPEN BRANCH FROM BUS 243208 TO BUS 242865 CKT 2 / 243208 05JEFRSO 765 242865 05JEFRSO 345 2 OPEN BRANCH FROM BUS 242865 TO BUS 248000 CKT Z1 / 242865 05JEFRSO 345 248000 06CLIFTY 345 Z1 END
AEP_P1-2_#363	CONTINGENCY 'AEP_P1-2_#363' OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1 END

Short Circuit

19 Short Circuit

The following Breakers are overduty

None