



**Generation Interconnection  
Feasibility Study Report  
for  
Queue Project AE1-227  
SOUTH CUMBERLAND 69 KV  
30.69 MW Capacity / 49.5 MW Energy**

July, 2019

## 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.

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.

## General

The Interconnection Customer has proposed to install PJM project # AE1-227, a Solar generating facility located in Guernsey County, Ohio (See Figure 2). The installed facilities will have a total capability of 49.5 MW with 30.69 MW of this output being recognized by PJM as Capacity. The Primary Point of Interconnection will be a direct connection to the South Cumberland 69 kV substation (See Figure 1). The secondary Point of Interconnection will be a direct connection to the South Cumberland 138 kV substation (See Figure 3).

The proposed in-service date for this project is September 30, 2021. This study does not imply a TO commitment to this in-service date.

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 for maintaining the reliability of the AEP transmission system.

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.

<b>Queue Number</b>	<b>AE1-227</b>
<b>Project Name</b>	<b>SOUTH CUMBERLAND 69 KV</b>
<b>State</b>	Ohio
<b>County</b>	Guernsey
<b>Transmission Owner</b>	AEP
<b>MFO</b>	49.5
<b>MWE</b>	49.5
<b>MWC</b>	30.69
<b>Fuel</b>	Solar
<b>Basecase Study Year</b>	2022

## Primary Point of Interconnection

AE1-227 will interconnect with the AEP transmission system at the South Cumberland 69 kV substation.

To accommodate the interconnection at the South Cumberland 69 kV substation, the substation will have to be expanded requiring the installation of one (1) 69 kV circuit breaker (see Figure 1). Installation of associated protection and control equipment, 69 kV line risers, SCADA, and 69 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.

Note: The Interconnection Customer may be required to go offline for routine circuit breaker maintenance.

## Cost Summary

The AE1-227 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	\$800,000
Direct Connection Network Upgrade	\$0
Non Direct Connection Network Upgrades	\$200,000
<b>Total Costs</b>	<b>\$1,000,000</b>

In addition, the AE1-227 project may be responsible for a contribution to the following costs

Description	Total Cost
<b>System Upgrades</b>	<b>\$8,100,000</b>

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

## Transmission Owner Scope of Work

### 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
Expand South Cumberland 69 kV Substation	\$800,000
<b>Total Attachment Facility Costs</b>	<b>\$800,000</b>

### 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
	\$0
<b>Total Direct Connection Facility Costs</b>	<b>\$0</b>

### 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
69 kV Revenue Metering	\$200,000
<b>Total Non-Direct Connection Facility Costs</b>	<b>\$200,000</b>

## 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.



## 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 South Cumberland 69 kV substation 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.

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.

## Revenue Metering and SCADA Requirements

### 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.

### 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>

## Network Impacts – Option 1

The Queue Project AE1-227 was evaluated as a 49.5 MW (Capacity 30.69 MW) injection at the South Cumberland 69 kV substation in the AEP area. Project AE1-227 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE1-227 was studied with a commercial probability of 53%. Potential network impacts were as follows:

## Summer Peak Load Flow

## Generation Deliverability

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

None

## Multiple Facility Contingency

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

None

## 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
881272	242977	05CALDWE	AEP	242956	05BALLHL	AEP	1	AEP_P7-1_#11152	tower	284.0	114.17	114.66	DC	3.09
881273	242977	05CALDWE	AEP	242956	05BALLHL	AEP	1	AEP_P7-1_#11150	tower	284.0	114.08	114.58	DC	3.12

## 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

## System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
881272,881273	1	05CALDWE 138.0 kV - 05BALLHL 138.0 kV Ckt 1	<u>AEP</u> Description: Replace 5.4 miles of ACSR ~ 556.5 ~ 26/7 ~ DOVE - Conductor Section 1. Estimated cost: \$8.1 million. Time Estimate : 24-36 Months Cost : \$8,100,000	\$8,100,000
			<b>TOTAL COST</b>	<b>\$8,100,000</b>

## Flow Gate Details

The following appendices contain additional information about each flow gate presented in the body of the report. For each appendix, a description of the flow gate 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 flow gate 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.

---

## 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
881273	242977	05CALDWE	AEP	242956	05BALLHL	AEP	1	AEP_P7-1_#11150	tower	284.0	114.08	114.58	DC	3.12

Bus #	Bus	MW Impact
934631	AD1-090 O1	62.36
939911	AE1-227 C O1	1.94
939912	AE1-227 E O1	1.19
CARR	CARR	0.32
CBM-S1	CBM-S1	3.45
CBM-S2	CBM-S2	1.06
CBM-W1	CBM-W1	5.91
CBM-W2	CBM-W2	25.61
CIN	CIN	3.01
CPL	CPL	0.33
G-007	G-007	0.82
IPL	IPL	1.97
LGEE	LGEE	0.92
MEC	MEC	5.12
MECS	MECS	2.71
O-066	O-066	2.77
RENSSELAER	RENSSELAER	0.25
WEC	WEC	0.74



## Affected Systems

## **LG&E**

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

## **MISO**

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

## **TVA**

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

## **Duke Energy Progress**

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

## **NYISO**

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

Contingency Name	Contingency Definition
<b>AEP_P7-1_#11150</b>	CONTINGENCY 'AEP_P7-1_#11150' OPEN BRANCH FROM BUS 242931 TO BUS 247130 CKT 1 / 242931 05BEVERL 345 247130 05HOLLOW 345 1 OPEN BRANCH FROM BUS 242937 TO BUS 247832 CKT 1 / 242937 05KAMMER 345 247832 05LAMPING 345 1 END
<b>AEP_P7-1_#11152</b>	CONTINGENCY 'AEP_P7-1_#11152' OPEN BRANCH FROM BUS 242931 TO BUS 247130 CKT 1 / 242931 05BEVERL 345 247130 05HOLLOW 345 1 OPEN BRANCH FROM BUS 247832 TO BUS 242940 CKT 1 / 247832 05LAMPING 345 242940 05MUSKNG 345 1 END

## Short Circuit

## Short Circuit

The following Breakers are over duty

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

None

## Secondary Point of Interconnection

AE1-227 will interconnect with the AEP transmission system at the South Cumberland 138 kV substation.

To accommodate the interconnection at the South Cumberland 138 kV substation, the substation will have to be expanded requiring the installation of one (1) 138 kV circuit breaker (see 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.

### Notes:

1. The Interconnection Customer may be required to go offline for routine circuit breaker maintenance.
2. The switching configuration shown in Figure 3 is allowed under the requirements documented at <http://www.pjm.com/~media/planning/plan-standards/private-aep/aep-interconnection-requirements.ashx> as an expansion at an existing “straight bus” station. However, the analysis performed in a Feasibility Study does not include evaluation by Protection and Control Engineering to determine whether the resulting protection schemes will provide acceptable performance. A preliminary review may take place during the System Impact Study stage, but final evaluation usually occurs during the Facilities Study. Additional protection equipment, not included in the description provided above, may be required to provide adequate protection system performance.

## Network Impacts – Option 2

The Queue Project AE1-227 was evaluated as a 49.5 MW (Capacity 30.69 MW) injection at the South Cumberland 138 kV substation in the AEP area. Project AE1-227 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE1-227 was studied with a commercial probability of 53%. Potential network impacts were as follows:

## Summer Peak Load Flow



## Generation Deliverability

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

None

## Multiple Facility Contingency

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

None

## 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
854738	242977	05CALDWE	AEP	242956	05BALLHL	AEP	1	AEP_P7-1_#11152	tower	284.0	114.17	114.85	DC	4.27
854739	242977	05CALDWE	AEP	242956	05BALLHL	AEP	1	AEP_P7-1_#11150	tower	284.0	114.09	114.77	DC	4.31
854691	243091	05SCALDW	AEP	242977	05CALDWE	AEP	1	AEP_P7-1_#11152	tower	284.0	118.91	119.5	DC	3.71
854692	243091	05SCALDW	AEP	242977	05CALDWE	AEP	1	AEP_P7-1_#11150	tower	284.0	118.82	119.41	DC	3.75

## 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
854398	243091	05SCALDW	AEP	242977	05CALDWE	AEP	1	Base Case	operation	205.0	104.54	105.22	DC	3.06
854400	243091	05SCALDW	AEP	242977	05CALDWE	AEP	1	AEP_P1-2_#9135	operation	284.0	102.44	103.1	DC	4.21

## Flow Gate Details

The following appendices contain additional information about each flow gate presented in the body of the report. For each appendix, a description of the flow gate 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 flow gate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gauge 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.

---

## 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
854739	242977	05CALDWE	AEP	242956	05BALLHL	AEP	1	AEP_P7-1_#11150	tower	284.0	114.09	114.77	DC	4.31

Bus #	Bus	MW Impact
934631	AD1-090 O1	62.37
939911	AE1-227 C O2	2.67
939912	AE1-227 E O2	1.64
CARR	CARR	0.32
CBM-S1	CBM-S1	3.45
CBM-S2	CBM-S2	1.06
CBM-W1	CBM-W1	5.91
CBM-W2	CBM-W2	25.61
CIN	CIN	3.01
CPL	CPL	0.32
G-007	G-007	0.82
IPL	IPL	1.97
LGEE	LGEE	0.92
MEC	MEC	5.12
MECS	MECS	2.71
O-066	O-066	2.77
RENSSELAER	RENSSELAER	0.25
WEC	WEC	0.74

## 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
854692	243091	05SCALDW	AEP	242977	05CALDWE	AEP	1	AEP_P7-1_#11150	tower	284.0	118.82	119.41	DC	3.75

Bus #	Bus	MW Impact
934631	AD1-090 O1	62.39
939911	AE1-227 C O2	2.32
939912	AE1-227 E O2	1.42
CARR	CARR	0.32
CBM-S1	CBM-S1	3.45
CBM-S2	CBM-S2	1.06
CBM-W1	CBM-W1	5.89
CBM-W2	CBM-W2	25.58
CIN	CIN	3.01
CPL	CPL	0.32
G-007	G-007	0.82
IPL	IPL	1.96
LGEE	LGEE	0.92
MEC	MEC	5.11
MECS	MECS	2.7
O-066	O-066	2.77
RENSSELAER	RENSSELAER	0.25
WEC	WEC	0.74

## Affected Systems

## **LG&E**

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

## **MISO**

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

## **TVA**

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

## **Duke Energy Progress**

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

## **NYISO**

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

Contingency Name	Contingency Definition
Base Case	
AEP_P7-1_#11150	CONTINGENCY 'AEP_P7-1_#11150' OPEN BRANCH FROM BUS 242931 TO BUS 247130 CKT 1 / 242931 05BEVERL 345 247130 05HOLLOW 345 1 OPEN BRANCH FROM BUS 242937 TO BUS 247832 CKT 1 / 242937 05KAMMER 345 247832 05LAMPING 345 1 END
AEP_P7-1_#11152	CONTINGENCY 'AEP_P7-1_#11152' OPEN BRANCH FROM BUS 242931 TO BUS 247130 CKT 1 / 242931 05BEVERL 345 247130 05HOLLOW 345 1 OPEN BRANCH FROM BUS 247832 TO BUS 242940 CKT 1 / 247832 05LAMPING 345 242940 05MUSKNG 345 1 END
AEP_P1-2_#9135	CONTINGENCY 'AEP_P1-2_#9135' OPEN BRANCH FROM BUS 243091 TO BUS 247156 CKT 1 / 243091 05SCALDW 138 247156 05STEAMT 138 1 END

## Short Circuit



## Short Circuit

The following Breakers are overduty

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

None