Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AD1-043

Makahoy 138kV Substation

April 2018

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. 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 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 (IC) proposes to install PJM Project #AD1-043, a 120.0 MW (45.6 MW Capacity) solar generating facility in Madison County, Indiana. The primary point of interconnection is to AEP's Makahoy 138kV Substation (see Figure 1). The secondary point of interconnection is to AEP's Strawton - Aladdin 138kV section of the Strawton – Arnold Hogan 138 kV circuit (see Figure 3).

The requested in backfeed date is June 30, 2020.

The requested in service date is September 30, 2020.

Attachment Facilities

Primary Point of Interconnection (Makahoy 138kV Substation)

To accommodate the interconnection on the Makahoy Substation 138kV, the installation of a new 138 kV circuit breaker will be required (see 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.

New Switching Station Work:

- Install one (1) 138 kV circuit breaker at Makahoy 138 kV substation. Installation of associated protection and control equipment, 138 kV line risers, SCADA, and 138 kV revenue metering will also be required (see Figure 1).
    - **Estimated Station Cost: $1,000,000**

Non-Direct Connection Cost Estimate

The total preliminary cost estimate for Non-Direct Connection work is given in the following tables below.

For AEP building Direct Connection cost estimates:

Description	Total Cost
138 kV Revenue Metering	**$250,000**
Upgrade line protection and controls at the Makahoy 138 kV substation.	**$250,000**
Total	**$500,000**

Table 1

Secondary Point of Interconnection (Strawton - Aladdin 138kV)

To accommodate the interconnection on the Strawton - Aladdin 138kV section of the Strawton – Arnold Hogan 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 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.

Interconnection Customer Requirements

It is understood that the IC's Solar Development North America is responsible for all costs associated with this interconnection. The cost of IC's generating plant and the costs for the line connecting the generating plant to the new 138 kV switching station are not included in this report; these are assumed to be IC'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 Sections 24.1 and 24.2.

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

Option 1

Network Impacts

The Queue Project AD1-043 was evaluated as a 120.0 MW (Capacity 45.6 MW) injection at Makahoy 138kV substation in the AEP area. Project AD1-043 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD1-043 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis – 2021

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
AEP_P1-2_#2811	CONTINGENCY 'AEP_P1-2_#2811' OPEN BRANCH FROM BUS 243233 TO BUS 248001 CKT Z1 / 243233 05TANNER 345 248001 06DEARB1 345 Z1 OPEN BRANCH FROM BUS 243233 TO BUS 249565 CKT 1 / 243233 05TANNER 345 249565 08EBEND 345 1 OPEN BRANCH FROM BUS 248000 TO BUS 248001 CKT 1 / 248000 06CLIFTY 345 248001 06DEARB1 345 1 OPEN BRANCH FROM BUS 248001 TO BUS 248013 CKT 1 / 248001 06DEARB1 345 248013 06PIERCE 345 1 END
AEP_P1-2_#673-A	CONTINGENCY 'AEP_P1-2_#673-A' OPEN BRANCH FROM BUS 243218 TO BUS 923880 CKT 1 / 243218 05DESOTO 345 923880 AB2-028 TAP 345 1 END
AEP_P1-2_#6964	CONTINGENCY 'AEP_P1-2_#6964' OPEN BRANCH FROM BUS 246763 TO BUS 246988 CKT 1 / 246763 05PIPECK 138 246988 05STRWTN 138 1 END
AEP_P1-2_#8702	CONTINGENCY 'AEP_P1-2_#8702' OPEN BRANCH FROM BUS 243218 TO BUS 243232 CKT 2 / 243218 05DESOTO 345 243232 05SORENS 345 2 END

Contingency Name	Description
AEP_P4_#2965_05 DESOTO 345	CONTINGENCY 'AEP_P4_#2965_05DESOTO 345' OPEN BRANCH FROM BUS 243218 TO BUS 923880 CKT 1 / 243218 05DESOTO 345 923880 AB2-028 TAP 345 1 OPEN BRANCH FROM BUS 243218 TO BUS 243278 CKT 1 / 243218 05DESOTO 345 243278 05DESOTO 138 1 END
AEP_P7-1_#3206_B	CONTINGENCY 'AEP_P7-1_#3206_B' OPEN BRANCH FROM BUS 243218 TO BUS 923880 CKT 1 / 243218 05DESOTO 345 923880 AB2-028 TAP C 345 1 OPEN BRANCH FROM BUS 243222 TO BUS 254535 CKT 1 / 243222 05FALL C 345 254535 16SUNNYS 345 1 END

Table 2

Generator 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)

AD1-043 Contribution to Previously Identified Overloads															
	Contingency		Affected	Facility	Bus				Loading		Rating		MW	FG
#	Type	Name	Area	Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
1	LFFB	AEP_P4_#2965_ 05DESOTO 345	AEP - AEP	05HOGAN-05DELAWR 138 kV line	243311	243275	1	DC	102.82	113.78	ER	231	25.29	1
2	DCTL	AEP_P7-1_#3206_B	AEP - AEP	05HOGAN-05DELAWR 138 kV line	243311	243275	1	DC	101.56	113.12	ER	231	26.69	

Table 3

Steady-State Voltage Requirements

(Results of the steady-state voltage studies should be inserted here)

None

Short Circuit
(Summary of impacted circuit breakers)
New circuit breakers found to be over-duty:

None

Affected System Analysis & Mitigation

LGEE Impacts:

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

MISO Impacts:

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

Duke, Progress & TVA Impacts:

Duke Carolina, Progress, & TVA Impacts to be determined during later study phases (as applicable).

OVEC Impacts:

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

Delivery of Energy Portion of Interconnection Request
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.
Only the most severely overloaded conditions are listed. 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 will study all overload conditions associated with the overloaded element(s) identified.

AD1-043 Delivery of Energy Portion of Interconnection Request															
	Contingency		Affected	Facility	Bus				Loading		Rating		MW	FG
#	Type	Name	Area	Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
1	N-1	AEP_P1-2_#8702	AEP - AEP	05KEYSTN-05SORENS 345 kV line	243225	243232	1	DC	121.33	122.91	NR	897	13.65	
2	N-1	AEP_P1-2_#2811	AEP - DEO&K	05TANNER-08M.FORT 345 kV line	243233	249567	1	DC	98.09	99.55	NR	1409	18.48	
3	N-1	AEP_P1-2_#673-A	AEP - AEP	05HOGAN-05DELAWR 138 kV line	243311	243275	1	DC	101.33	112.54	ER	231	25.87	

AD1-043 Delivery of Energy Portion of Interconnection Request															
	Contingency		Affected	Facility	Bus				Loading		Rating		MW	FG	
#	Type	Name	Area	Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.	
4	Non	Non	AEP - AEP	05HOGAN-05DELAWR 138 kV line	243311	243275	1	DC	91.84	106.83	NR	167	25		
5	N-1	AEP_P1-2_#6964	AEP - AEP	05STRWTN-05ALEXAN 138 kV line	246988	247116	1	DC	87.21	120.01	ER	150	49.14		
6	N-1	AEP_P1-2_#6964	AEP - AEP	05ALEXAN-05JONES 138 kV line	247116	246913	1	DC	74.95	107.74	ER	150	49.14		

Table 4

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)

None

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)
(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

Violation #	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
#1 and #2	HOGAN-DELAWARE 138 kV line	(1) An Engineering study will need to be conducted to determine if the CT Thermal limits settings can be adjusted to mitigate the overload. (2) Upgrade bus work – Delaware Bus (3) 5.21 miles of AEP owned conductor will need to be rebuilt/reconductored (4) Replace line risers – Delaware CB/Line Risers **Note:** All of the upgrades identified above are being handled by various projects in the area. One of the projects is S0738 and the others are still going through the RTEP process for approval.	An approximate construction time would be 24 to 36 months after signing an interconnection agreement.	$8,135,000
			Total Previous Network Upgrades	**$8,135,000**

Table 5

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 be between 24 to 36 months after signing an interconnection agreement.

Note: The time provided between anticipated normal completion of System Impact, Facilities Studies, subsequent execution of ISA and ICSA documents, and the proposed Backfeed Date is shorter than usual and may be difficult to achieve.

Conclusion

Based upon the results of this Feasibility Study, the construction of the 120.0 MW (45.6 MW Capacity) solar generating facility of The Interconnection Customer(PJM Project #AD1-043) will require the following additional interconnection charges. This plan of service will interconnect the proposed generating facility in a manner that will provide operational reliability and flexibility to both the AEP system and the Invenergy Solar Development North America LLC's generating facility.

Cost Breakdown for Primary Point of Interconnection (Makahoy 138 kV Substation)		
Attachment Cost	Expand Makahoy 138 kV Substation	**$1,000,000**
Non-Direct Connection Cost Estimate	138 kV Revenue Metering	**$250,000**
	Upgrade line protection and controls at the Makahoy 138 kV station.	**$250,000**
	Contribution to Previously Identified System Reinforcements *(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study) (Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)* **Note:** All of the upgrades identified are being handled by various projects in the area. One of the projects is S0738 and the others are still going through the RTEP process for approval. PJM will determine cost allocation if any in the System Impact study.	**$8,135,000**
	Total Estimated Cost for Project AD1-043	**$9,635,000**

Table 6

The estimates are preliminary in nature, as they were determined without the benefit of detailed engineering studies. Final estimates will require an on-site review and coordination to determine final construction requirements.

Option 2

Network Impacts

The Queue Project AD1-043 was evaluated as a 120.0 MW (Capacity 45.6 MW) injection tapping Strawton to Aladdin 138kV line in the AEP area. Project AD1-043 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD1-043 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis – 2021

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
844_B3_05HOGAN 138-1_WOMOAB	CONTINGENCY '844_B3_05HOGAN 138-1_WOMOAB' OPEN BRANCH FROM BUS 247420 TO BUS 243311 CKT 1 / 247420 05CROSS ST Z 138 243311 05HOGAN 138 1 OPEN BRANCH FROM BUS 243275 TO BUS 243311 CKT 1 / 243275 05DELAWR 138 243311 05HOGAN 138 1 OPEN BRANCH FROM BUS 243311 TO BUS 246913 CKT 1 / 243311 05HOGAN 138 246913 05JONES 138 1 OPEN BRANCH FROM BUS 243311 TO BUS 246046 CKT 1 / 243311 05HOGAN 138 246046 05HOGAN 34.5 1 OPEN BRANCH FROM BUS 243311 TO BUS 246047 CKT 1 / 243311 05HOGAN 138 246047 05HOGAN L 12.0 1 END
AEP_P1-2_#2811	CONTINGENCY 'AEP_P1-2_#2811' OPEN BRANCH FROM BUS 243233 TO BUS 248001 CKT Z1 / 243233 05TANNER 345 248001 06DEARB1 345 Z1 OPEN BRANCH FROM BUS 243233 TO BUS 249565 CKT 1 / 243233 05TANNER 345 249565 08EBEND 345 1 OPEN BRANCH FROM BUS 248000 TO BUS 248001 CKT 1 / 248000 06CLIFTY 345 248001 06DEARB1 345 1 OPEN BRANCH FROM BUS 248001 TO BUS 248013 CKT 1 / 248001 06DEARB1 345 248013 06PIERCE 345 1 END

Contingency Name	Description
AEP_P1-2_#673-A	CONTINGENCY 'AEP_P1-2_#673-A' OPEN BRANCH FROM BUS 243218 TO BUS 923880 CKT 1 / 243218 05DESOTO 345 923880 AB2-028 TAP 345 1 END
AEP_P1-2_#6964	CONTINGENCY 'AEP_P1-2_#6964' OPEN BRANCH FROM BUS 246763 TO BUS 246988 CKT 1 / 246763 05PIPECK 138 246988 05STRWTN 138 1 END
AEP_P1-2_#8702	CONTINGENCY 'AEP_P1-2_#8702' OPEN BRANCH FROM BUS 243218 TO BUS 243232 CKT 2 / 243218 05DESOTO 345 243232 05SORENS 345 2 END
AEP_P4_#2965_05DESOTO 345	CONTINGENCY 'AEP_P4_#2965_05DESOTO 345' OPEN BRANCH FROM BUS 243218 TO BUS 923880 CKT 1 / 243218 05DESOTO 345 923880 AB2-028 TAP 345 1 OPEN BRANCH FROM BUS 243218 TO BUS 243278 CKT 1 / 243218 05DESOTO 345 243278 05DESOTO 138 1 END
AEP_P7-1_#3206_B	CONTINGENCY 'AEP_P7-1_#3206_B' OPEN BRANCH FROM BUS 243218 TO BUS 923880 CKT 1 / 243218 05DESOTO 345 923880 AB2-028 TAP C 345 1 OPEN BRANCH FROM BUS 243222 TO BUS 254535 CKT 1 / 243222 05FALL C 345 254535 16SUNNYS 345 1 END
AEP_P7-1_#6872-B	CONTINGENCY 'AEP_P7-1_#6872-B' OPEN BRANCH FROM BUS 243218 TO BUS 243225 CKT 1 / 243218 05DESOTO 345 243225 05KEYSTN 345 1 OPEN BRANCH FROM BUS 925800 TO BUS 243233 CKT 1 / 2925800 AC1-059 TAP 345 243233 05TANNER 345 1 OPEN BRANCH FROM BUS 243218 TO BUS 243232 CKT 2 / 243218 05DESOTO 345 243232 05SORENS 345 2 END

Table 7

Generator 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)

AD1-043 Contribution to Previously Identified Overloads															
		Contingency	Affected	Facility	Bus				Loading		Rating		MW	FG
#	Type	Name	Area	Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
1	DCTL	AEP_P7-1_#6872-B	AEP - AEP	05DESOTO-05JAY 138 kV line	243278	243319	1	DC	102.59	103.28	ER	393	6.04	1
2	LFFB	AEP_P4_#2965_05DESOTO 345	AEP - AEP	05HOGAN-05DELAWR 138 kV line	243311	243275	1	DC	102.98	116.98	ER	231	32.33	1
3	DCTL	AEP_P7-1_#3206_B	AEP - AEP	The 05HOGAN-05DELAWR 138 kV line	243311	243275	1	DC	101.72	116.31	ER	231	33.67	1

Table 8

Steady-State Voltage Requirements
(Results of the steady-state voltage studies should be inserted here)

None

Short Circuit
(Summary of impacted circuit breakers)

None

Affected System Analysis & Mitigation

LGEE Impacts:

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

MISO Impacts:

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

Duke, Progress & TVA Impacts:

Duke Carolina, Progress, & TVA Impacts to be determined during later study phases (as applicable).

OVEC Impacts:

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

Delivery of Energy Portion of Interconnection Request

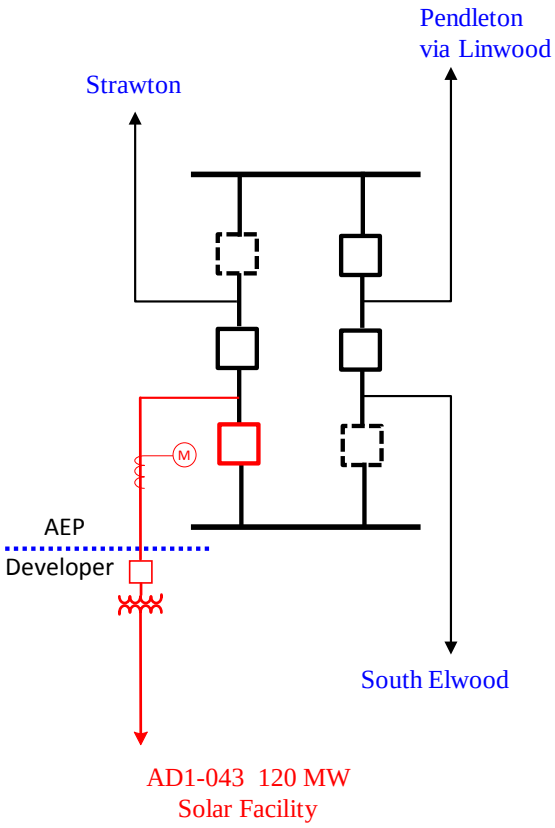
PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.
Only the most severely overloaded conditions are listed. 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 will study all overload conditions associated with the overloaded element(s) identified.

AD1-043 Delivery of Energy Portion of Interconnection Request															
		Contingency	Affected		Bus				Loading		Rating		MW	FG
#	Type	Name	Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
1	N-1	AEP_P1-2_#8702	AEP - AEP	05KEYSTN-05SORENS 345 kV line	243225	243232	1	DC	121.54	123.12	NR	897	13.63	
2	N-1	AEP_P1-2_#2811	AEP - DEO&K	05TANNER-08M.FORT 345 kV line	243233	249567	1	DC	98.09	98.73	NR	1409	18.03	
3	N-1	AEP_P1-2_#673-A	AEP - AEP	05HOGAN-05DELAWR 138 kV line	243311	243275	1	DC	101.49	115.77	ER	231	32.97	
4	N-1	None	AEP - AEP	05HOGAN-05DELAWR 138 kV line	243311	243275	1	DC	91.9	111.36	NR	167	32.48	
5	N-1	844_B3_05HOGAN 138-1_WOMOAB	AEP - AEP	05STRWTN-05PIPECK 138 kV line	246988	246763	1	DC	70.71	100.53	ER	205	61.12	
6	N-1	AEP_P1-2_#6964	AEP - AEP	05ALEXAN-05JONES 138 kV line	247116	246913	1	DC	75.01	119.31	ER	150	66.4	
7	N-1	AEP_P1-2_#6964	AEP - AEP	AD1-043 TAP-05ALEXAN 138 kV line	934160	247116	1	DC	87.21	131.51	ER	150	66.4	

Table 9

Figure 1: Primary Point of Interconnection (Makahoy 138kV Substation)

Single Line Diagram



Legend

Existing

To be constructed for AD1-043

Figure 2: Primary Point of Interconnection (Makahoy 138kV Substation)

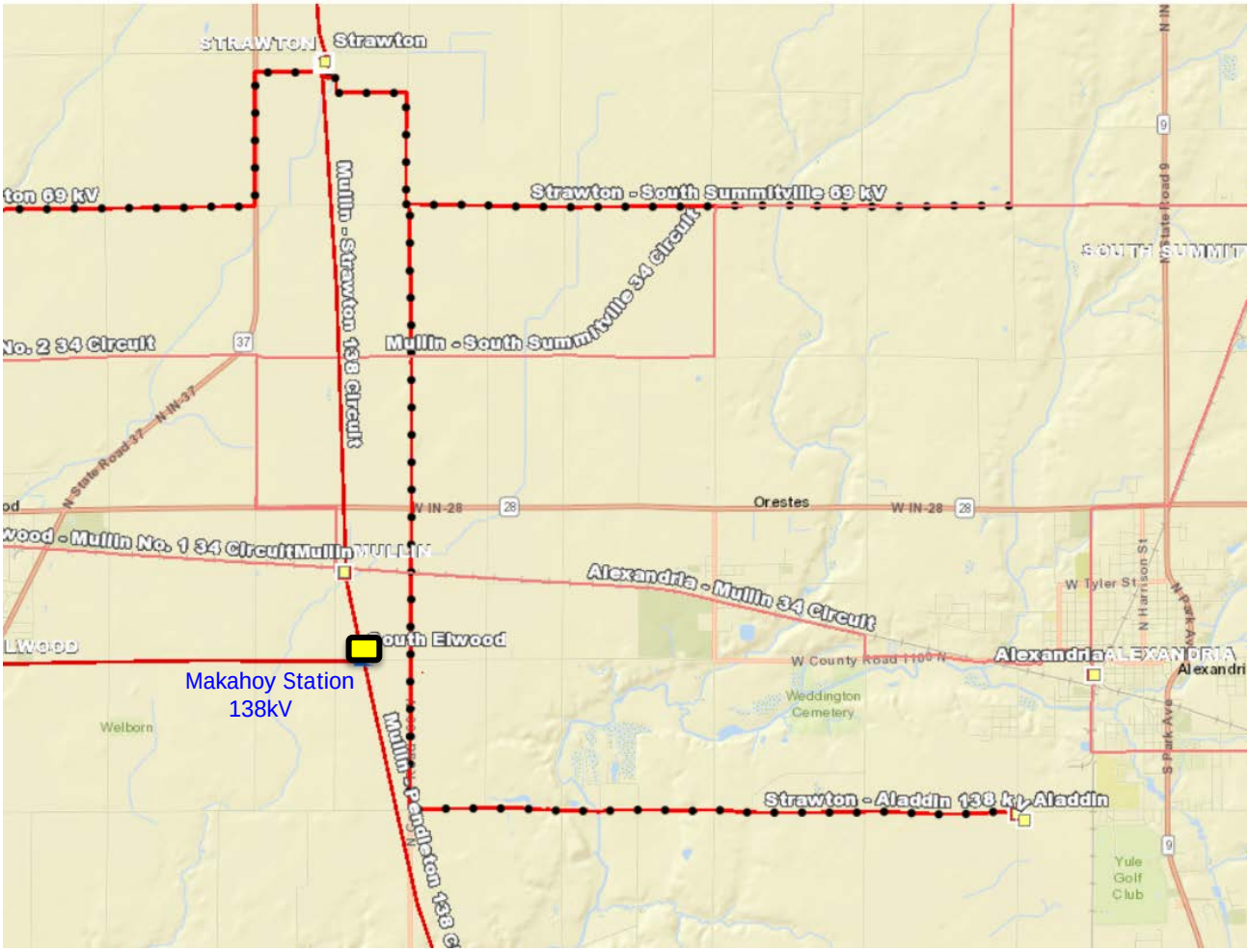


Figure 3: Secondary Point of Interconnection (Strawton – Aladdin 138kV)

Single Line Diagram

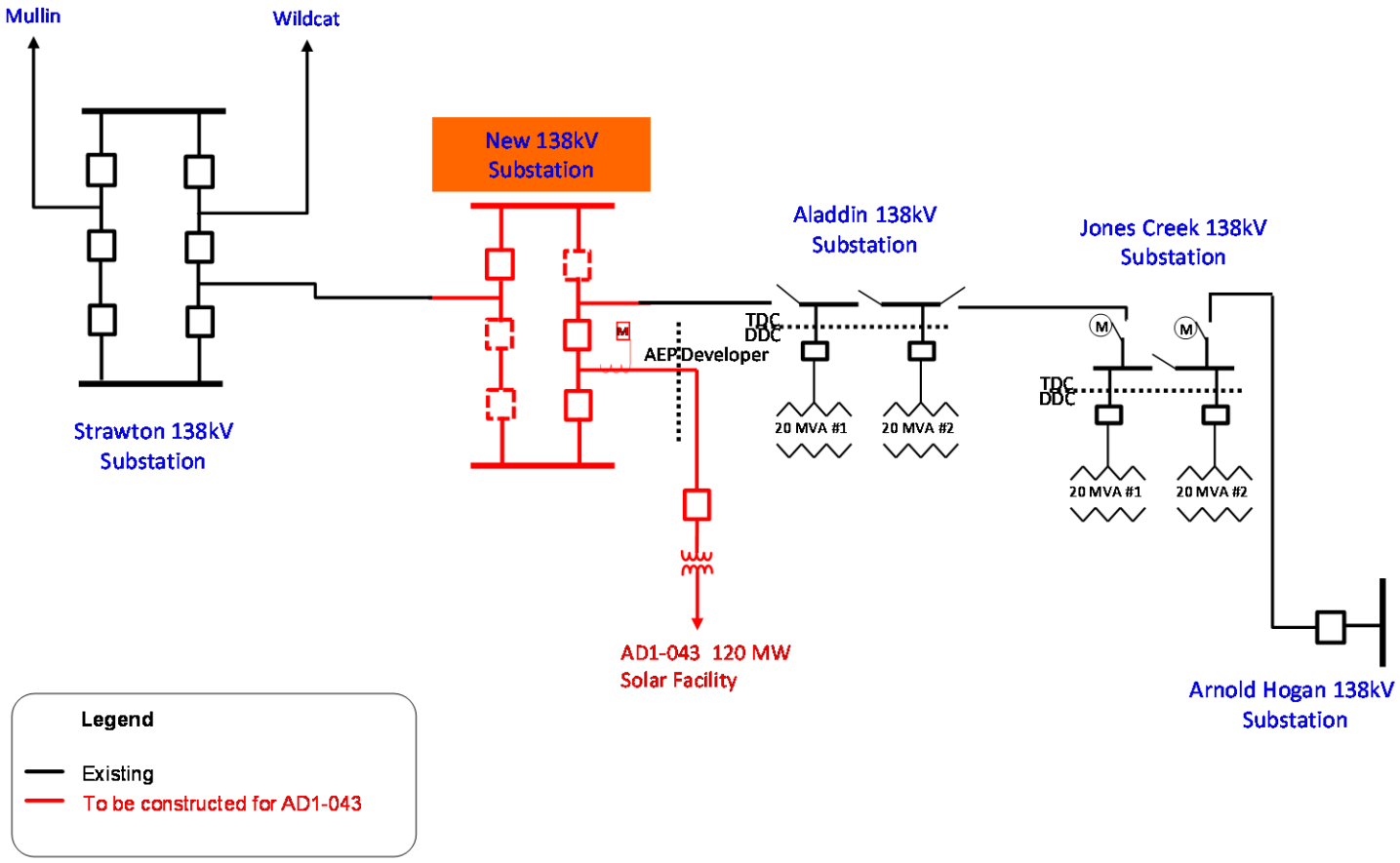
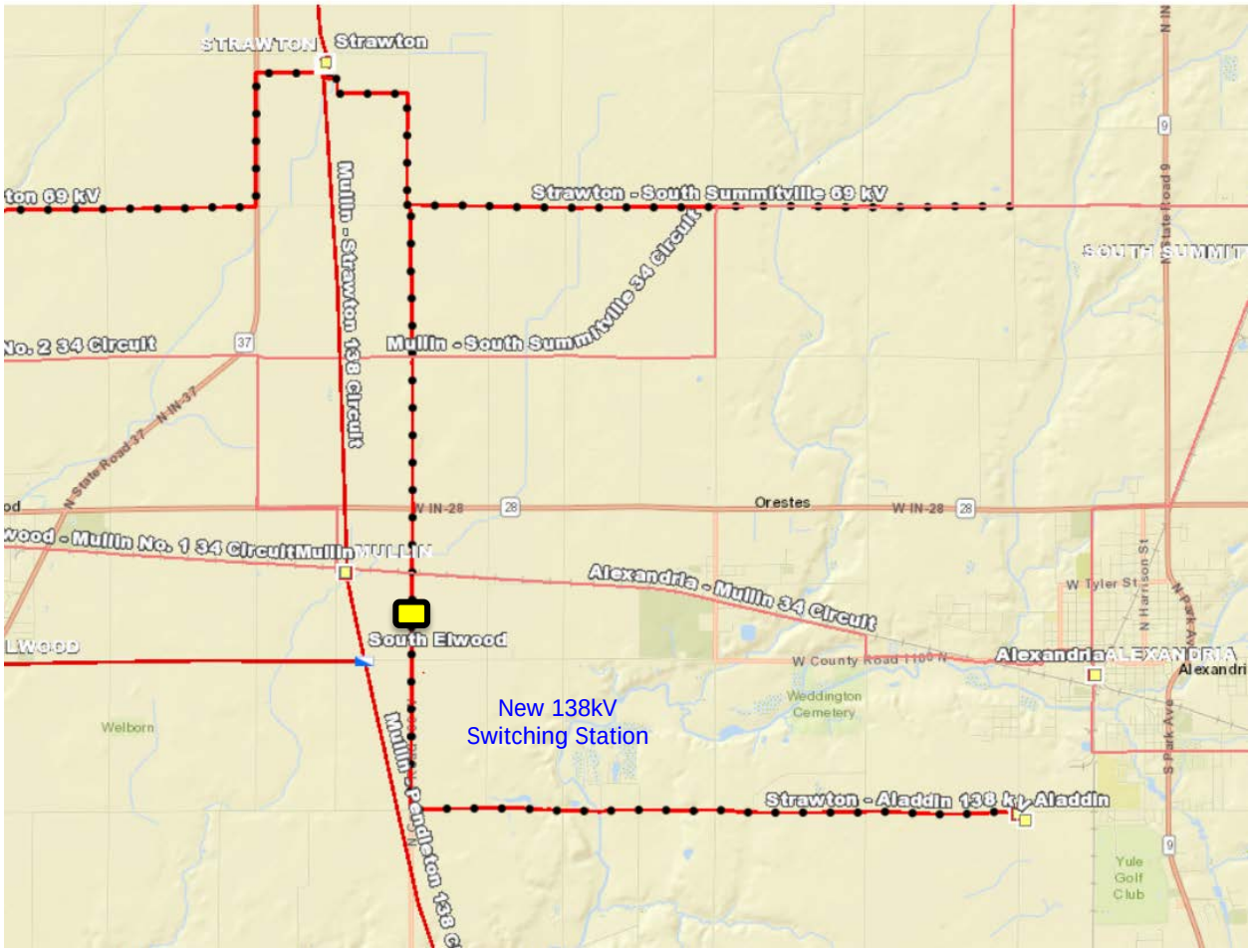


Figure 4: Secondary Point of Interconnection (Strawton – Aladdin 138kV)



Appendices

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.

Appendix 1

(AEP - AEP) The 05HOGAN-05DELAWR 138 kV line (from bus 243311 to bus 243275 ckt 1) loads from 102.82% to 113.78% (**DC power flow**) of its emergency rating (231 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#2965_05DESOTO 345'. This project contributes approximately 25.29 MW to the thermal violation.

CONTINGENCY 'AEP_P4_#2965_05DESOTO 345'
OPEN BRANCH FROM BUS 243218 TO BUS 923880 CKT 1 / 243218 05DESOTO 345 923880 AB2-028 TAP 345 1
OPEN BRANCH FROM BUS 243218 TO BUS 243278 CKT 1 / 243218 05DESOTO 345 243278 05DESOTO 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
246991	*05WLD G1 C*	*0.57*
247914	*05WLD G1 E*	*19.42*
247255	*05WLD G2 C*	*0.6*
247958	*05WLD G2 E*	*20.38*
934161	*AD1-043 C O1*	*9.61*
934162	*AD1-043 E O1*	*15.68*
247588	*W4-004 C*	*1.21*
247946	*W4-004 E*	*8.1*
247589	*W4-008 C*	*1.21*
247953	*W4-008 E*	*8.1*
917722	*Z2-115 E*	*0.08*
920102	*AA2-106 E*	*1.29*
920501	*AA2-148 C*	*2.35*
920502	*AA2-148 E*	*15.75*
923881	*AB2-028 C*	*1.67*
923882	*AB2-028 E*	*11.17*
924211	*AB2-065 C*	*1.66*
924212	*AB2-065 E*	*11.19*
926091	*AC1-088*	*4.57*

Appendices - Option 2

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.

Appendix 1

(AEP - AEP) The 05DESOTO-05JAY 138 kV line (from bus 243278 to bus 243319 ckt 1) loads from 102.59% to 103.28% (**DC power flow**) of its emergency rating (393 MVA) for the tower line contingency outage of 'AEP_P7-1_#6872-B'. This project contributes approximately 6.04 MW to the thermal violation.

CONTINGENCY 'AEP_P7-1_#6872-B'
OPEN BRANCH FROM BUS 243218 TO BUS 243225 CKT 1 / 243218 05DESOTO 345 243225 05KEYSTN 345 1
OPEN BRANCH FROM BUS 925800 TO BUS 243233 CKT 1 / 2925800 AC1-059 TAP 345 243233 05TANNER 345 1
OPEN BRANCH FROM BUS 243218 TO BUS 243232 CKT 2 / 243218 05DESOTO 345 243232 05SORENS 345 2
END

Bus Number	*Bus Name*	*Full Contribution*
247963	*05HDWTR1G E*	*5.51*
932681	*AC2-090 C*	*3.34*
932682	*AC2-090 E*	*5.45*
933601	*AC2-177 C*	*2.29*
933602	*AC2-177 E*	*15.3*
934161	*AD1-043 C O2*	*2.3*
934162	*AD1-043 E O2*	*3.75*
LTF	*CARR*	*0.05*
LTF	*CBM-S1*	*2.16*
LTF	*CBM-S2*	*0.77*
LTF	*CBM-W1*	*0.75*
LTF	*CBM-W2*	*16.65*
LTF	*CIN*	*4.52*
LTF	*CPLE*	*0.15*
LTF	*DEARBORN*	*0.56*
LTF	*G-007*	*0.08*
LTF	*IPL*	*4.14*
LTF	*LGEE*	*0.55*
LTF	*MEC*	*2.2*
LTF	*O-066*	*0.26*
LTF	*RENSSELAER*	*0.04*
LTF	*ROSETON*	*0.29*
247543	*V3-007 C*	*2.29*
247935	*V3-007 E*	*15.3*
LTF	*WEC*	*0.14*
920102	*AA2-106 E*	*7.96*
923881	*AB2-028 C*	*1.92*
923882	*AB2-028 E*	*12.87*
925801	*AC1-059 C*	*3.97*

925802	*AC1-059 E*	*26.54*
926871	*AC1-174 C*	*3.34*
926872	*AC1-174 E*	*5.45*
926881	*AC1-175 C*	*3.34*
926882	*AC1-175 E*	*5.45*
927181	*AC1-212 C*	*1.26*
927182	*AC1-212 E*	*0.21*

Appendix 2

(AEP - AEP) The 05HOGAN-05DELAWR 138 kV line (from bus 243311 to bus 243275 ckt 1) loads from 102.98% to 116.98% (**DC power flow**) of its emergency rating (231 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#2965_05DESOTO 345'. This project contributes approximately 32.33 MW to the thermal violation.

CONTINGENCY 'AEP_P4_#2965_05DESOTO 345'
OPEN BRANCH FROM BUS 243218 TO BUS 923880 CKT 1 / 243218 05DESOTO 345 923880 AB2-028 TAP 345 1
OPEN BRANCH FROM BUS 243218 TO BUS 243278 CKT 1 / 243218 05DESOTO 345 243278 05DESOTO 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
246991	*05WLD G1 C*	*0.57*
247914	*05WLD G1 E*	*19.42*
247255	*05WLD G2 C*	*0.6*
247958	*05WLD G2 E*	*20.38*
934161	*AD1-043 C O2*	*12.28*
934162	*AD1-043 E O2*	*20.04*
LTF	*CARR*	*0.04*
LTF	*CBM-S1*	*1.73*
LTF	*CBM-S2*	*0.56*
LTF	*CBM-W1*	*2.78*
LTF	*CBM-W2*	*16.4*
LTF	*CIN*	*4.57*
LTF	*CPLE*	*0.1*
LTF	*DEARBORN*	*0.25*
LTF	*G-007*	*0.07*
LTF	*IPL*	*4.09*
LTF	*LGEE*	*0.35*
LTF	*MEC*	*2.64*
LTF	*O-066*	*0.24*
LTF	*RENSSELAER*	*0.03*
LTF	*ROSETON*	*0.22*
247588	*W4-004 C*	*1.21*
247946	*W4-004 E*	*8.1*
247589	*W4-008 C*	*1.21*
247953	*W4-008 E*	*8.1*
LTF	*WEC*	*0.25*
917722	*Z2-115 E*	*0.08*
920102	*AA2-106 E*	*1.29*
920501	*AA2-148 C*	*2.35*
920502	*AA2-148 E*	*15.75*
923881	*AB2-028 C*	*1.67*

923882	*AB2-028 E*	*11.17*
924211	*AB2-065 C*	*1.66*
924212	*AB2-065 E*	*11.19*
926091	*AC1-088*	*4.58*