Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AC2-176

Jay-Bluff Point 138kV

September 2017

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 #AC2-176, a 150.0 MW (19.50 MW Capacity) wind generating facility in Rush County, Indiana (see Figure 3). The primary point of interconnection is to AEP's Bluff Point – Jay 138 kV section of the College Corner – Jay 138 kV circuit (see Figure 1). The secondary point of interconnection is a direct connection to AEP's Jay 138 kV via a 5.50 mile 138 kV attachment line (see Figure 2).

The requested in service date is 10/1/2020.

Attachment Facilities

Primary Point of Interconnection (Bluff Point - Jay 138 kV substation)

To accommodate the interconnection on the Bluff Point – Jay 138 kV section of the College Corner – Jay 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 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.

<u>New Switching Station Work:</u>

- Construct 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. 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: $6,300,000**

Direct Connection Cost Estimate

The total preliminary cost estimate for 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**
Total	**$250,000**

Table 1

Non-Direct Connection Cost Estimate

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

For AEP building Non-Direct Connection cost estimates:

Description	Estimated Cost
Bluff Point – Jay 138 kV T-Line Cut In	**$1,500,000**
138 kV Revenue Metering	**$250,000**
Upgrade line protection and controls at the Bluff Point 138 kV substation.	**$250,000**
Upgrade line protection and controls at the Jay 138 kV substation.	**$250,000**
Total	**$2,250,000**

Table 2

Secondary Point of Interconnection (Jay 138 kV Substation)

To accommodate the interconnection at the Jay 138 kV substation, 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.

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

Interconnection Customer Requirements

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 AC2-176 was evaluated as a 150.0 MW (Capacity 19.5 MW) injection tapping the Bluff Point – Jay 138 kV line in the AEP area. Project AC2-176 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC2-176 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis – 2020

Contingency Descriptions

The following contingencies resulted in overloads:

Option 1	
Contingency Name	**Description**
349_B2_TOR21	CONTINGENCY '349_B2_TOR21' OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 1 / 242528 05SPORN 345 248005 06KYGER 345 1 END
6856_B2_TOR6201747	CONTINGENCY '6856_B2_TOR6201747' OPEN BRANCH FROM BUS 243253 TO BUS 243362 CKT 1 / 243253 05BLUFFP 138 243362 05RANDOL 138 1 END

Option 1	
Contingency Name	**Description**
786_B3_05JAY 138-1_WOMOAB_B	CONTINGENCY '786_B3_05JAY 138-1_WOMOAB_B' OPEN BRANCH FROM BUS 246018 TO BUS 243319 CKT 1 / 246018 05JAY EQ 999 243319 05JAY 138 1 OPEN BRANCH FROM BUS 246018 TO BUS 246016 CKT 1 / 246018 05JAY EQ 999 246016 05JAY 69.0 1 OPEN BRANCH FROM BUS 246018 TO BUS 246015 CKT 1 / 246018 05JAY EQ 999 246015 05JAY 34.5 1 OPEN BRANCH FROM BUS 932590 TO BUS 243319 CKT 1 / 932590 AC2-176 TAP 138 243319 05JAY 138 1 OPEN BRANCH FROM BUS 243278 TO BUS 243319 CKT 1 / 243278 05DESOTO 138 243319 05JAY 138 1 OPEN BRANCH FROM BUS 243319 TO BUS 243358 CKT 1 / 243319 05JAY 138 243358 05PENNVI 138 1 OPEN BRANCH FROM BUS 246013 TO BUS 246016 CKT 1 / 246013 05ARMSTRON 69.0 246016 05JAY 69.0 1 OPEN BRANCH FROM BUS 246024 TO BUS 246016 CKT 1 / 246024 05GREEN SW 69.0 246016 05JAY 69.0 1 OPEN BRANCH FROM BUS 246025 TO BUS 246026 CKT 1 / 246025 05ALBANY 34.5 246026 05BARLEY 34.5 1 OPEN BRANCH FROM BUS 246026 TO BUS 246015 CKT 1 / 246026 05BARLEY 34.5 246015 05JAY 34.5 1 END
8468_B2	CONTINGENCY '8468_B2' OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 2 / 242528 05SPORN 345 248005 06KYGER 345 2 END
8702_B2_TOR2543	CONTINGENCY '8702_B2_TOR2543' OPEN BRANCH FROM BUS 243218 TO BUS 243232 CKT 2 / 243218 05DESOTO 345 243232 05SORENS 345 2 END
994_B3_05BLUFFP 138-1_WOMOAB_B	CONTINGENCY '994_B3_05BLUFFP 138-1_WOMOAB_B' OPEN BRANCH FROM BUS 932590 TO BUS 243319 CKT 1 / 932590 AC2-176 TAP 138 243319 05JAY 138 1 END
P1-#..B2 TERMINAL-EAST BEND 4516	CONTINGENCY 'P1-#..B2 TERMINAL-EAST BEND 4516' OPEN BRANCH FROM BUS 249575 TO BUS 249565 CKT 1 END

Table 3

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)

None

Steady-State Voltage Requirements

None

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

Bus Number	Bus Name	BREAKER	Rating Type	Breaker Capacity (Amps)	Duty Percent With AC2-176_AEP_opt1	Duty Percent Without AC2-176_AEP_opt1	Duty Percent Difference	Duty Amps With AC2-176_AEP_opt1	Duty Amps Without AC2-176_AEP_opt1
0	05DELAWR 138.kV	P	T	19999.8	100.24%	99.84%	0.40%	20048.6	19968.7

Note: Circuit Breaker "P" is schedule to be replaced the 3rd quarter of 2018

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.

AC2-176 Delivery of Energy Portion of Interconnection Request - Option 1														
		Contingency	Affected		Bus				Loading		Rating		MW
#	Type	Name	Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.
1	N-1	8702_B2_TOR2543	AEP - AEP	05KEYSTN-05SORENS 345 kV line	243225	243232	1	DC	99.25	101.32	NR	897	18.55
2	N-1	P1-#..B2 TERMINAL-EAST BEND 4516	AEP - DEO&K	05TANNER-08M.FORT 345 kV line	243233	249567	1	DC	133.03	133.51	NR	1409	15.06
3	N-1	994_B3_05BLUFFP 138-1_WOMOAB_B	AEP - AEP	05BLUFFP 138/69 kV transformer	243253	246014	1	DC	87.5	150.71	ER	77	48.43
4	N-1	994_B3_05BLUFFP 138-1_WOMOAB_B	AEP - AEP	05BLUFFPNT-05PORTLAND 69 kV line	246014	246022	1	DC	82.38	136.18	ER	90	48.43
5	N-1	786_B3_05JAY 138-1_WOMOAB_B	AEP - AEP	05PORTLAND-05N PORTLN 69 kV line	246022	246020	1	DC	75.14	124.26	ER	69	33.89
6	N-1	8468_B2	OVEC - AEP	06KYGER-05SPORN 345 kV line	248005	242528	1	DC	124.57	125.03	NR	1017	10.18
7	N-1	349_B2_TOR21	OVEC - AEP	06KYGER-05SPORN 345 kV line	248005	242528	2	DC	130.48	130.95	NR	971	10.18
8	N-1	786_B3_05JAY 138-1_WOMOAB_B	AEP - AEP	AC2-176 TAP-05BLUFFP 138 kV line	932590	243253	1	DC	0	104.9	ER	143	150
9	N-1	6856_B2_TOR6201747	AEP - AEP	AC2-176 TAP-05JAY 138 kV line	932590	243319	1	DC	57.37	153.3	ER	143	137.19

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)

None

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 In-Service Date is shorter than usual and may be difficult to achieve.

Conclusion

Based upon the results of this Feasibility Study, the construction of the 150.0 MW (19.5 MW Capacity) the IC's wind generating facility (PJM Project #AC2-176) 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 IC generating facility.

Cost Breakdown for Primary Point of Interconnection (Bluff Point – Jay 138 kV)		
Attachment Cost	New 138 kV Switching Station	**$6,300,000**
Direct Connection Cost Estimate	Bluff Point - Jay 138 kV T-Line Cut In	**$1,500,000**
Non-Direct Connection Cost Estimate	138 kV Revenue Metering	**$250,000**
	Upgrade line protection and controls at the Bluff Point 138 kV substation.	**$250,000**
	Upgrade line protection and controls at the Jay 138 kV substation.	**$250,000**
	Total Estimated Cost for Project AC2-176	**$8,550,000**

Table 5

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 AC2-176 was evaluated as a 150.0 MW (Capacity 19.5 MW) injection at the Jay 138 kV substation in the AEP area. Project AC2-176 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC2-176 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis - 2020

Contingency Descriptions

The following contingencies resulted in overloads:

Option 2	
Contingency Name	**Description**
8702_B2_TOR2543	CONTINGENCY '8702_B2_TOR2543' OPEN BRANCH FROM BUS 243218 TO BUS 243232 CKT 2 / 243218 05DESOTO 345 243232 05SORENS 345 2 END
P1-#..B2 TERMINAL-EAST BEND 4516	CONTINGENCY 'P1-#..B2 TERMINAL-EAST BEND 4516' OPEN BRANCH FROM BUS 249575 TO BUS 249565 CKT 1 END

Table 6

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)

None

Steady-State Voltage Requirements

None

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

Bus Number	Bus Name	BREAKER	Rating Type	Breaker Capacity (Amps)	Duty Percent With AC2-176_AEP_opt2	Duty Percent Without AC2-176_AEP_opt2	Duty Percent Difference	Duty Amps With AC2-176_AEP_opt2	Duty Amps Without AC2-176_AEP_opt2
0	05DELAWR 138.kV	P	T	19999.8	100.32%	99.84%	0.48%	20064.6	19968.7

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.

AC2-176 Delivery of Energy Portion of Interconnection Request – Option 2														
		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	8702_B2_TOR2543	AEP - AEP	05KEYSTN-05SORENS 345 kV line	243225	243232	1	DC	99.28	101.46	NR	897	19.53	
2	N-1	P1-#..B2 TERMINAL-EAST BEND 4516	AEP - DEO&K	05TANNER-08M.FORT 345 kV line	243233	249567	1	DC	133.07	133.57	NR	1409	15.5	

Table 7

Figure 1: Primary Point of Interconnection (Bluff Point – Jay 138kV)

Single Line Diagram

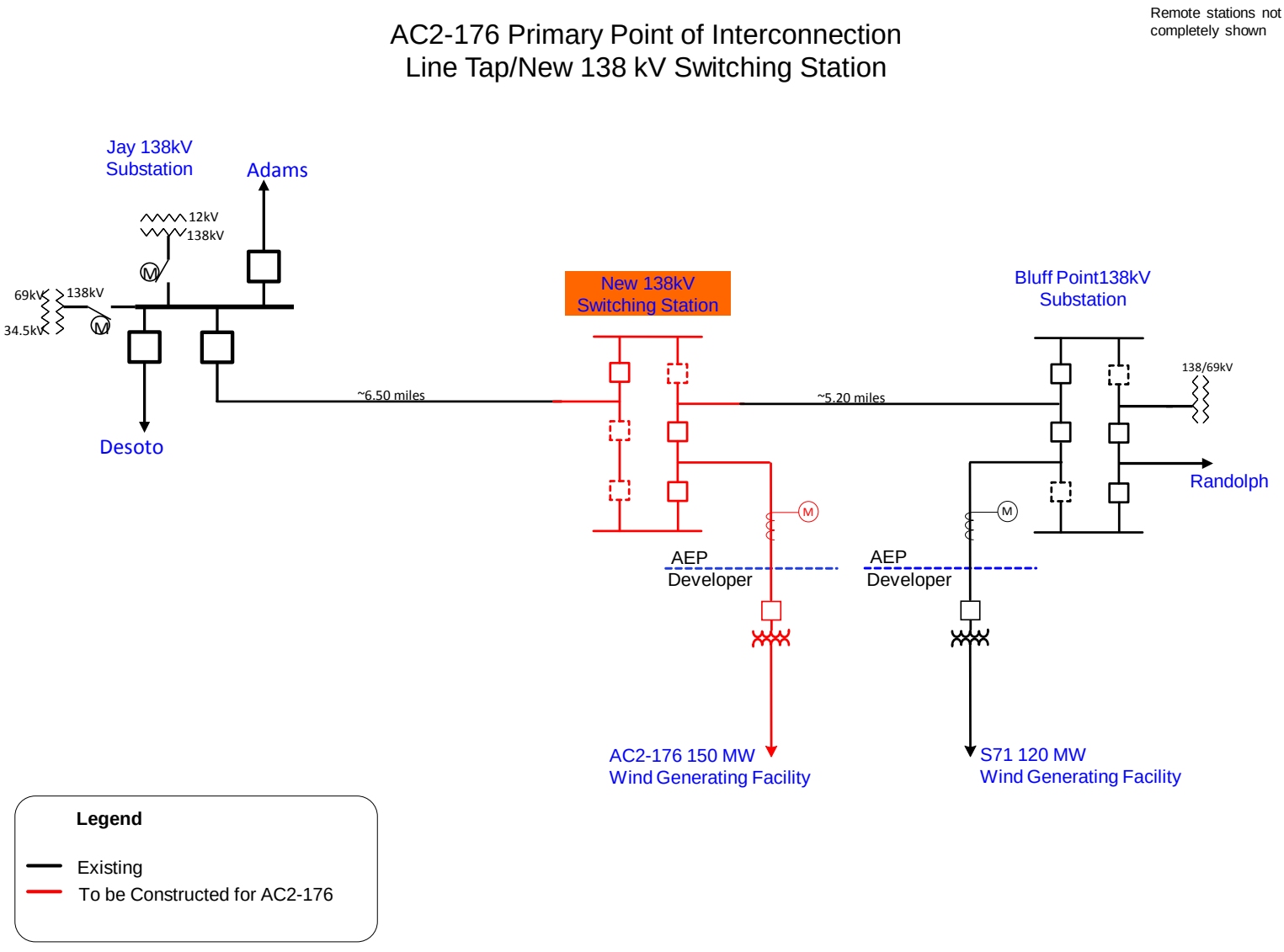


Figure 2: Primary Point of Interconnection (Bluff Point – Jay 138kV)

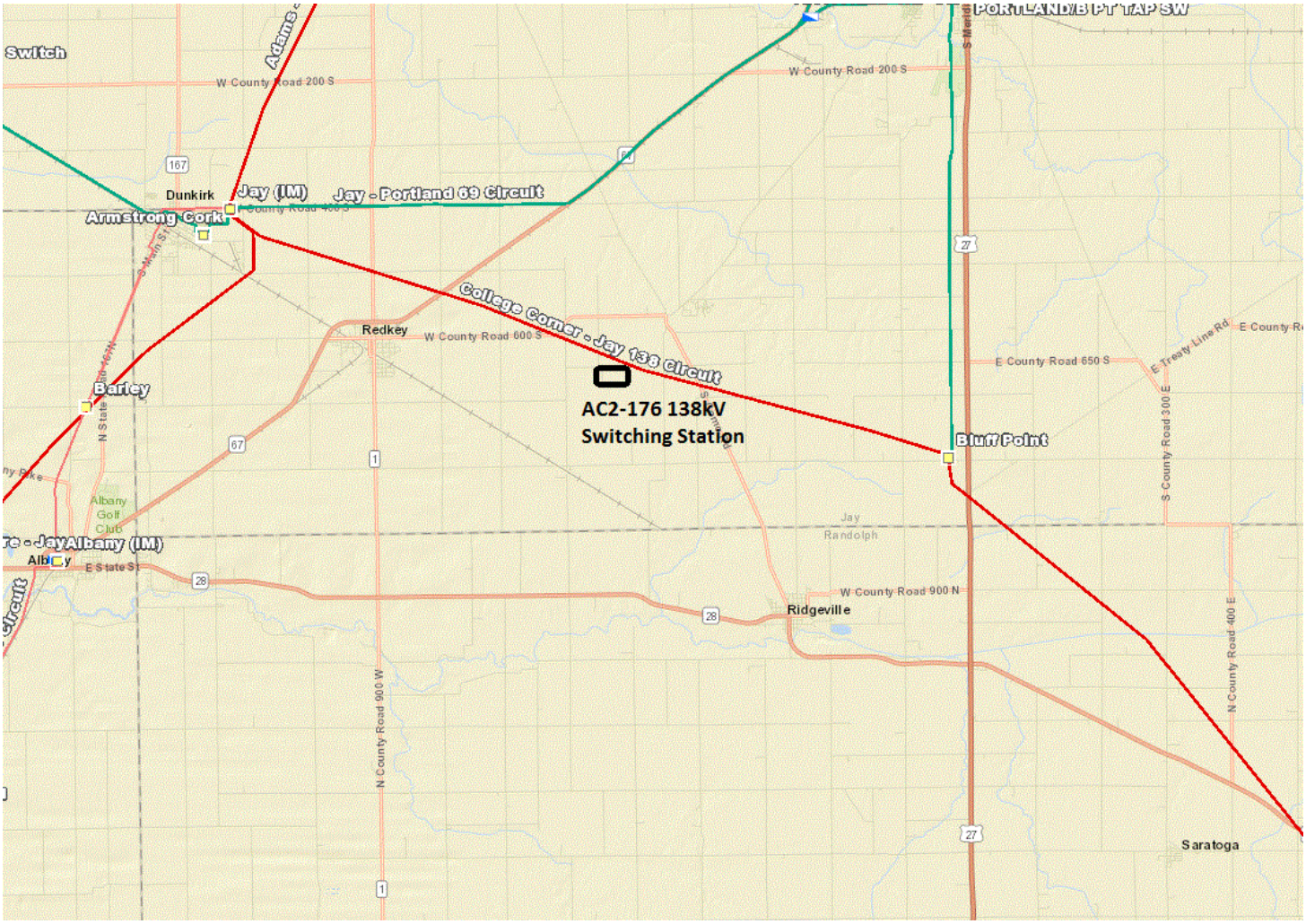


Figure 3: Secondary Point of Interconnection (Jay 138kV Substation)

Single Line Diagram

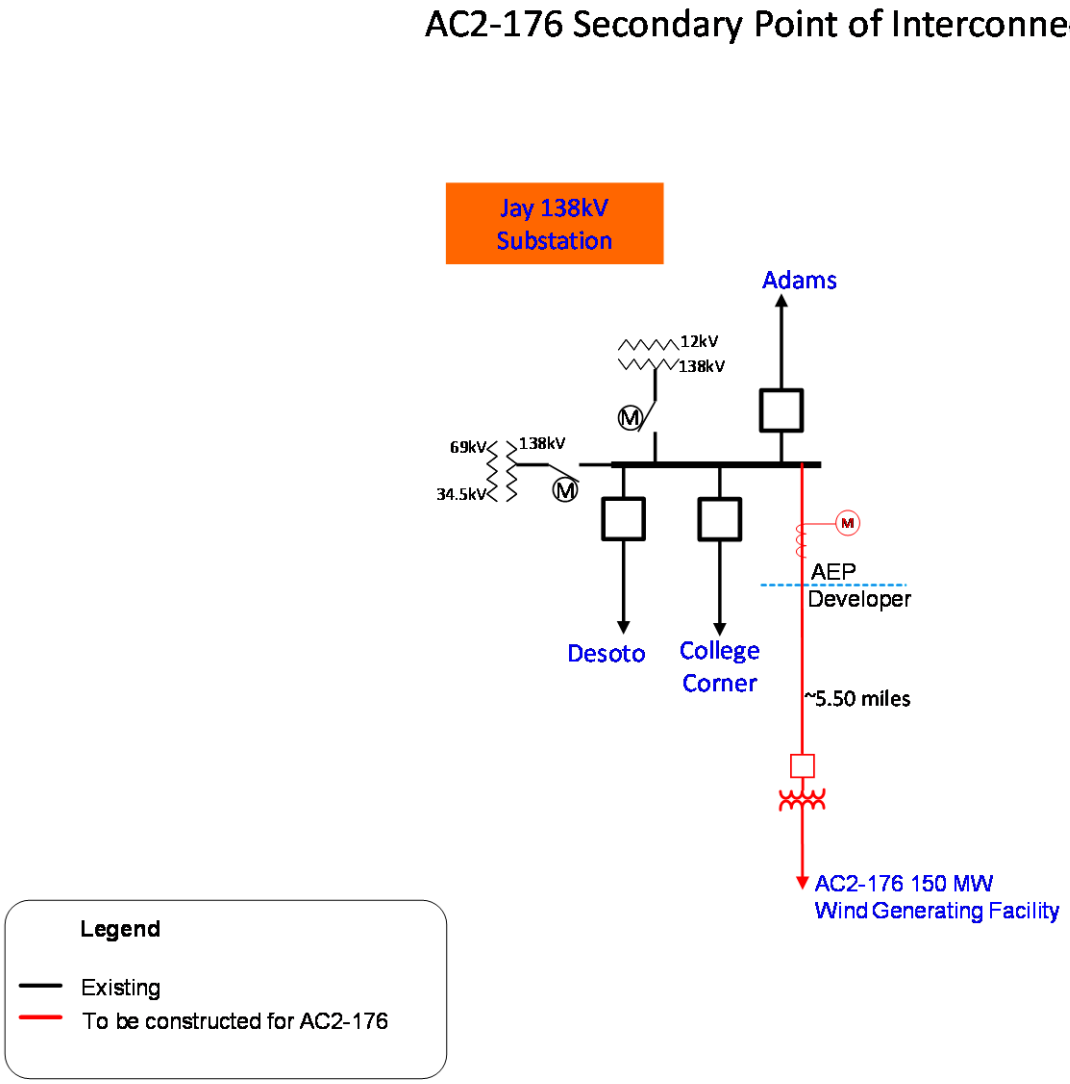
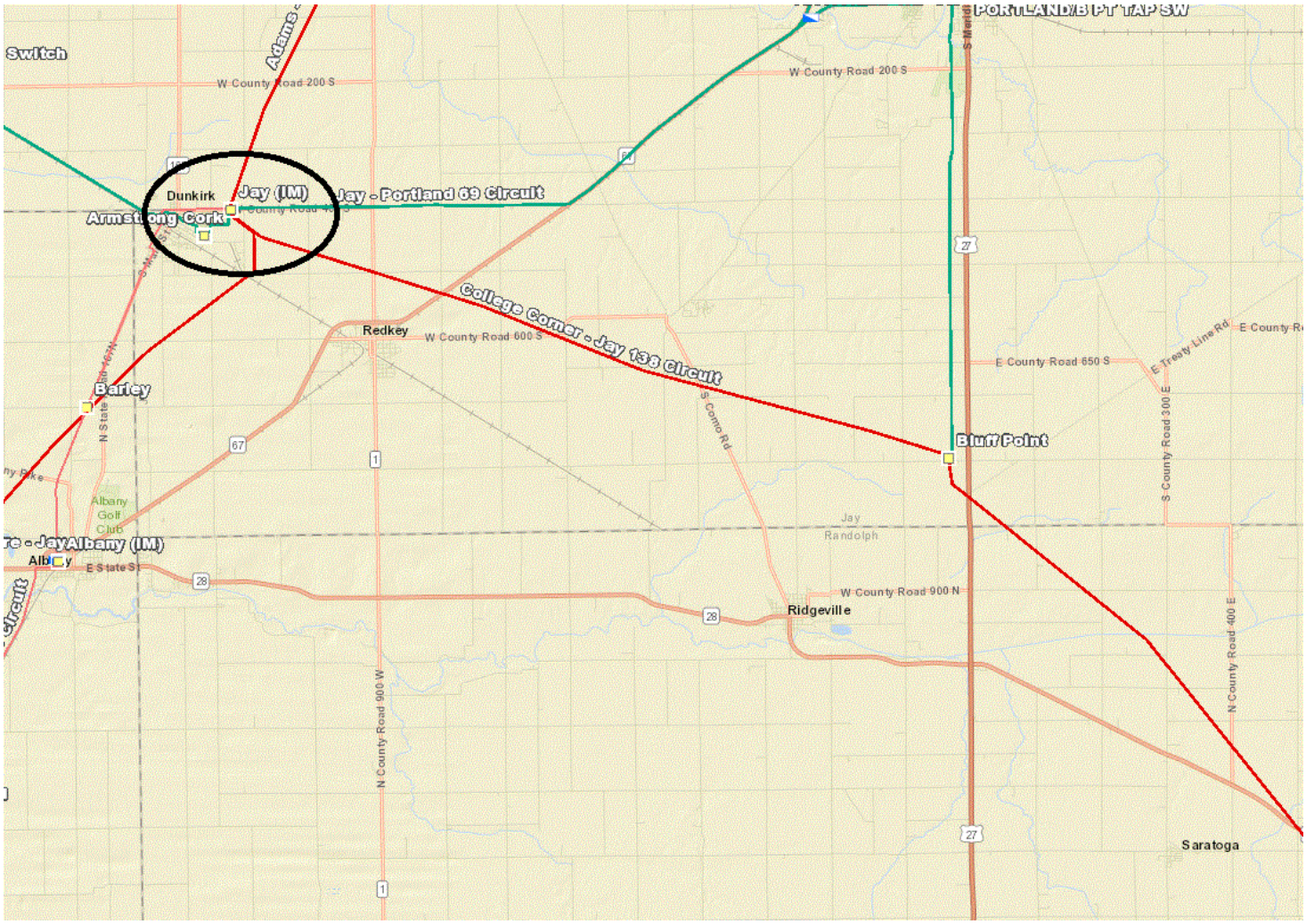


Figure 4: Secondary Point of Interconnection (Jay 138kV Substation)



Appendices – Primary POI

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 AC2-176 TAP-05JAY 138 kV line (from bus 932590 to bus 243319 ckt 1) loads from 83.92% to 188.81% (**DC power flow**) of its emergency rating (143 MVA) for the line fault with failed breaker contingency outage of '7005_C2_05BLUFFP 138-'. This project contributes approximately 150.0 MW to the thermal violation.

CONTINGENCY '7005_C2_05BLUFFP 138-'
OPEN BRANCH FROM BUS 243253 TO BUS 243362 CKT 1 / 243253 05BLUFFP 138 243362 05RANDOL 138 1
OPEN BRANCH FROM BUS 243253 TO BUS 246014 CKT 1 / 243253 05BLUFFP 138 246014 05BLUFFPNT 69.0 1
OPEN BRANCH FROM BUS 246014 TO BUS 246022 CKT 1 / 246014 05BLUFFPNT 69.0 246022 05PORTLAND 69.0 1
END

Bus Number	*Bus Name*	*Full Contribution*
932591	*AC2-176 C OP*	*19.5*
932592	*AC2-176 E OP*	*130.5*
247536	*S-071 C*	*24.*
247929	*S-071 E*	*96.*