

***Generation Interconnection
Feasibility Study Report***

For

***PJM Generation Interconnection Request
Queue Position AC1-085***

Hillsboro 138 kV

February 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

Hecate Energy Highland, LLC (Hecate) proposes to install PJM Project #AC1-085, a 400.0 MW (152.0 MW Capacity) solar generating facility in Hillsboro, Ohio (see Figure 2). The primary point of interconnection will be a direct connection to AEP's Hillsboro 138 kV substation (see Figure 1). The secondary point of interconnection is to Dayton Power and Light's Stuart – Clinton 345 kV line.

The requested in service date is January 31, 2018.

Attachment Facilities

Primary Point of Interconnection (Hillsboro 138 kV Substation)

To accommodate the interconnection at the Hillsboro 138 kV substation, the substation will have to be expanded requiring the installation of two (2) 138 kV circuit breakers, extending the two 138 kV buses, and starting a new string (see Figure 1). Installation of associated protection and control equipment, 138 kV line risers, SCADA, and 138 kV revenue metering will also be required.

Note: Two 138 kV circuit breakers are recommended for this interconnection to allow for breaker maintenance and inspections.

Station Work:

- Expand the Hillsboro 138 kV substation, start a new string, extend the two 138 kV buses and install two (2) 138 kV circuit breakers (see Figure 1). Installation of associated protection and control equipment, 138 kV line risers, SCADA, and 138 kV revenue metering will also be required.
- **Estimated Station Cost: \$3,000,000**

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	Estimated Cost
138 kV Revenue Metering	\$300,000
Upgrade line protection and controls at the expanded Hillsboro 138 kV substation.	\$300,000
Upgrade line protection and control settings at the Millbrook Park 138 kV substation to coordinate with the expanded Hillsboro 138 kV substation.	\$25,000

Upgrade line protection and control settings at the Highland 138 kV substation to coordinate with the expanded Hillsboro 138 kV substation.	\$25,000
Upgrade line protection and control settings at the Clinton County 138 kV substation to coordinate with the expanded Hillsboro 138 kV substation.	\$25,000
Upgrade line protection and control settings at the Wildcat 138 kV substation to coordinate with the expanded Hillsboro 138 kV substation.	\$25,000
Upgrade line protection and control settings at the O.H. Hutchings (DP&L) 138 kV substation to coordinate with the expanded Hillsboro 138 kV substation.	\$25,000
Total	\$725,000

Table 1

Secondary Point of Interconnection (Stuart – Clinton 138 kV)

This is a DP&L line and DP&L will have to provide the interconnection plan for the secondary point of interconnection.

It is understood that Hecate is responsible for all costs associated with this interconnection. The costs above are reimbursable to AEP. The cost of Hecate's generating plant and the costs for the line connecting the generating plant to Hecate's switching station are not included in this report; these are assumed to be Hecate'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>

Network Impacts

The Queue Project AC1-085 was evaluated as a 400.0 MW (Capacity 152.0 MW) injection at the Hillsboro 138kV substation in the AEP area. Project AC1-085 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC1-085 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Base Case Used

Summer Peak Analysis – 2020 Case

Contingency Descriptions

The following contingencies resulted in overloads:

Option 1	
Contingency Name	Description
7981	CONTINGENCY '7981' OPEN BRANCH FROM BUS 243019 TO BUS 249995 CKT 1 / 243019 05HILLSB 138 249995 08CLINCO 138 1 OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB 138 253111 09MIDDLE 138 1 OPEN BRANCH FROM BUS 249995 TO BUS 250122 CKT 1 / 249995 08CLINCO 138 250122 08WARRN1 138 1 OPEN BRANCH FROM BUS 253111 TO BUS 253057 CKT 1 / 253111 09MIDDLE 138 253057 09OHH 138 1 END
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
363_B2_TOR1682	CONTINGENCY '363_B2_TOR1682' OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1 END
4812_B2_TOR8931	CONTINGENCY '4812_B2_TOR8931' OPEN BRANCH FROM BUS 242921 TO BUS 242924 CKT 1 / 242921 05CORN 765 242924 05HANG R 765 1 END
4839_B1_05ROCKPT 765-1	CONTINGENCY '4839_B1_05ROCKPT 765-1' OPEN BRANCH FROM BUS 243209 TO BUS 243442 CKT 1 / 243209 05ROCKPT 765 243442 05RKG1 26.0 1 REMOVE UNIT 1H FROM BUS 243442 / 243442 05RKG1 26.0 REMOVE UNIT 1L FROM BUS 243442 / 243442 05RKG1 26.0

Option 1	
Contingency Name	Description
	END
6190_B3_05SPORN 345-4_WOMOAB	CONTINGENCY '6190_B3_05SPORN 345-4_WOMOAB' OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 1 / 242528 05SPORN 345 248005 06KYGER 345 1 OPEN BRANCH FROM BUS 242528 TO BUS 242808 CKT 4 / 242528 05SPORN 345 242808 05SPORNS 138 4 END
7342_B2_TOR7202268	CONTINGENCY '7342_B2_TOR7202268' OPEN BRANCH FROM BUS 246911 TO BUS 243019 CKT 1 / 246911 05HIGHLA 138 243019 05HILLSB 138 1 END
7350_C2_05HIGHLA 138-_WOMOAB	CONTINGENCY '7350_C2_05HIGHLA 138-_WOMOAB' OPEN BRANCH FROM BUS 246911 TO BUS 243019 CKT 1 / 246911 05HIGHLA 138 243019 05HILLSB 138 1 OPEN BRANCH FROM BUS 246911 TO BUS 247035 CKT 1 / 246911 05HIGHLA 138 247035 05NMARSS 138 1 OPEN BRANCH FROM BUS 246912 TO BUS 247035 CKT 1 / 246912 05N MKT8 138 247035 05NMARSS 138 1 OPEN BRANCH FROM BUS 247035 TO BUS 243571 CKT 1 / 247035 05NMARSS 138 243571 05SEAMAN 138 1 OPEN BRANCH FROM BUS 246911 TO BUS 243606 CKT 3 / 246911 05HIGHLA 138 243606 05HIGHLA 69.0 3 END
8107_C2_05HILLSB 138-C_A	CONTINGENCY '8107_C2_05HILLSB 138-C_A' OPEN BRANCH FROM BUS 246911 TO BUS 243019 CKT 1 / 246911 05HIGHLA 138 243019 05HILLSB 138 1 OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB 138 253111 09MIDDLE 138 1 END
8107_C2_05HILLSB 138-C_B	CONTINGENCY '8107_C2_05HILLSB 138-C_B' OPEN BRANCH FROM BUS 246911 TO BUS 243019 CKT 1 / 246911 05HIGHLA 138 243019 05HILLSB 138 1 OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB 138 253111 09MIDDLE 138 1 OPEN BRANCH FROM BUS 253111 TO BUS 253057 CKT 1 / 253111 09MIDDLE 138 253057 09OHH 138 1 END

Option 1		
Contingency Name	Description	
8108_C2_05HILLSB 138-D	CONTINGENCY '8108_C2_05HILLSB 138-D' OPEN BRANCH FROM BUS 243019 TO BUS 249995 CKT 1 / 243019 05HILLSB 138 249995 08CLINCO 138 1 OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB 138 253111 09MIDDLE 138 1 OPEN BRANCH FROM BUS 249995 TO BUS 250122 CKT 1 / 249995 08CLINCO 138 250122 08WARRN1 138 1 OPEN BRANCH FROM BUS 253111 TO BUS 253057 CKT 1 / 253111 09MIDDLE 138 253057 09OHH 138 1 END	
8109_C2_05HILLSB 138-A	CONTINGENCY '8109_C2_05HILLSB 138-A' OPEN BRANCH FROM BUS 243019 TO BUS 243102 CKT 1 / 243019 05HILLSB 138 243102 05SINKG8 138 1 OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB 138 253111 09MIDDLE 138 1 OPEN BRANCH FROM BUS 243042 TO BUS 243102 CKT 1 / 243042 05MILLBR 138 243102 05SINKG8 138 1 OPEN BRANCH FROM BUS 253111 TO BUS 253057 CKT 1 / 253111 09MIDDLE 138 253057 09OHH 138 1 END	
8115_C2_05HIGHLA 138-_MOAB	CONTINGENCY '8115_C2_05HIGHLA 138-_MOAB' OPEN BRANCH FROM BUS 246911 TO BUS 243019 CKT 1 / 246911 05HIGHLA 138 243019 05HILLSB 138 1 OPEN BRANCH FROM BUS 246911 TO BUS 247035 CKT 1 / 246911 05HIGHLA 138 247035 05NMARSS 138 1 OPEN BRANCH FROM BUS 246911 TO BUS 243606 CKT 3 / 246911 05HIGHLA 138 243606 05HIGHLA 69.0 3 END	
8468_B2	CONTINGENCY '8468_B2' OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 2 / 242528 05SPORN 345 248005 06KYGER 345 2 END	
H1TH3	CONTINGENCY 'H1TH3' /* BATH CO. REMOVE MACHINE 5 FROM BUS 315205 /*BATH UNIT #5 REMOVE MACHINE 6 FROM BUS 315206 /*BATH UNIT #6 REMOVE MACHINE 1 FROM BUS 315201 /*BATH UNIT #1 REMOVE MACHINE 2 FROM BUS 315202 /*BATH UNIT #2 END	

Option 1	
Contingency Name	Description
P04	CONTINGENCY 'P04'
	DISCONNECT BUS 200122 /*
	DISCONNECT BUS 200192 /*
	DISCONNECT BUS 200193 /*
	DISCONNECT BUS 200194 /*
	DISCONNECT BUS 200195 /*
	END
P2-1..LOE BRKR OPEN AT HILLSBORO AEP 2381	CONTINGENCY 'P2-1..LOE BRKR OPEN AT HILLSBORO AEP 2381'
	OPEN BRANCH FROM BUS 249995 TO BUS 243019 CKT 1
	END
P7-1..C5 4524FOSTRUGRCRK34598FOSTERBATH	CONTINGENCY 'P7-1..C5 4524FOSTRUGRCRK34598FOSTERBATH'
	OPEN BRANCH FROM BUS 253079 TO BUS 249566 CKT 1
	OPEN BRANCH FROM BUS 253006 TO BUS 249566 CKT 1
	END

Table 2

Generator Deliverability

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

Option 1														
AC1-085 Generator Deliverability														
Contingency				Bus					Loading		Rating		MW	FG
#	Type	Name	Affected Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
1	N-1	8468_B2	OVEC - AEP	06KYGER-05SPORN 345 kV line	248005	242528	1	DC	98.37	98.94	NR	1017	12.85	1

Table 3

Multiple Facility Contingency

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

AC1-085 Multiple Facility Contingency														
Contingency				Bus					Loading		Rating		MW	FG
#	Type	Name	Affected Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
1	LFFB	8107_C2_05HILLSB 138-C_A	AEP - AEP	05HILLSB-05SINKG8 138 kV line	243019	243102	1	DC	0.15	76.58	ER	185	141.74	2

AC1-085 Multiple Facility Contingency

#	Contingency		Affected Area	Facility Description	Bus		Cir.	PF	Loading		Rating		MW Con.	FG App.
	Type	Name			From	To			Initial	Final	Type	MVA		
1	LFFB	8107_C2_05HILLSB 138-C_B	AEP - AEP	05HILLSB-05SINKG8 138 kV line	243019	243102	1	DC	0.15	76.58	ER	185	141.74	
2	LFFB	8108_C2_05HILLSB 138-D	AEP - AEP	05HILLSB-05SINKG8 138 kV line	243019	243102	1	DC	0.74	76.17	ER	185	139.55	
3	DCTL	7981	AEP - AEP	05HILLSB-05SINKG8 138 kV line	243019	243102	1	DC	0.74	76.17	ER	185	139.55	
4	LFFB	8107_C2_05HILLSB 138-C_A	AEP - DEO&K	05HILLSB-08CLINCO 138 kV line	243019	249995	1	DC	29.11	108.17	ER	184	145.47	3
5	LFFB	8107_C2_05HILLSB 138-C_B	AEP - DEO&K	05HILLSB-08CLINCO 138 kV line	243019	249995	1	DC	29.11	108.17	ER	184	145.47	
6	LFFB	8109_C2_05HILLSB 138-A	AEP - DEO&K	05HILLSB-08CLINCO 138 kV line	243019	249995	1	DC	21.07	98.59	ER	184	142.64	
7	LFFB	8115_C2_05HIGHLA 138-_MOAB	AEP - DEO&K	05HILLSB-08CLINCO 138 kV line	243019	249995	1	DC	16.85	80.07	ER	184	116.33	
8	LFFB	7350_C2_05HIGHLA 138-_WOMOAB	AEP - DEO&K	05HILLSB-08CLINCO 138 kV line	243019	249995	1	DC	16.85	80.07	ER	184	116.33	
9	DCTL	P7-1..C5 4524FOSTRSUGRCRK34598FOSTERBATH	AEP - DAY	05HILLSB-09MIDDLE 138 kV line	243019	253111	1	DC	54.28	86.69	ER	185	59.96	4
10	LFFB	8107_C2_05HILLSB 138-C_B	AEP - AEP	05SINKG8-05MILLBR 138 kV line	243102	243042	1	DC	2.11	78.63	ER	179	141.74	5
11	LFFB	8107_C2_05HILLSB 138-C_A	AEP - AEP	05SINKG8-05MILLBR 138 kV line	243102	243042	1	DC	2.16	78.62	ER	179	141.74	
12	LFFB	8108_C2_05HILLSB 138-D	AEP - AEP	05SINKG8-05MILLBR 138 kV line	243102	243042	1	DC	1.19	77.65	ER	179	139.55	
13	DCTL	7981	AEP - AEP	05SINKG8-05MILLBR 138 kV line	243102	243042	1	DC	1.19	77.65	ER	179	139.55	
14	LFFB	8108_C2_05HILLSB 138-D	AEP - AEP	05HIGHLA 138/69 kV transformer	246911	243606	3	DC	61.2	110.19	ER	122	59.77	6
15	DCTL	7981	AEP - AEP	05HIGHLA 138/69 kV transformer	246911	243606	3	DC	61.2	110.19	ER	122	59.77	
16	LFFB	8109_C2_05HILLSB 138-A	AEP - AEP	05HIGHLA 138/69 kV transformer	246911	243606	3	DC	55.11	102.97	ER	122	58.39	

ACI-085 Multiple Facility Contingency

Contingency					Bus		Loading		Rating		MW	FG		
#	Type	Name	Affected Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
17	LFFB	8107_C2_05HILLSB 138-C_B	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	249995	250122	1	DC	13.5	86.97	ER	198	145.47	7
18	LFFB	8107_C2_05HILLSB 138-C_A	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	249995	250122	1	DC	13.5	86.97	ER	198	145.47	
19	LFFB	8109_C2_05HILLSB 138-A	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	249995	250122	1	DC	6.01	78.05	ER	198	142.64	
20	DCTL	P7-1..C5 4524FOSTRSUGRCRK34598FOSTERBATH	DAY - DAY	09MIDDLE-09OHH 138 kV line	253111	253057	1	DC	52.01	84.42	ER	185	59.96	8

Table 4

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)

Note: Please see Appendices for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper table in the Appendix.

ACI-085 Contribution to Previously Identified Overloads

Contingency				Bus				Loading		Rating		MW Con.	FG App.	
#	Type	Name	Affected Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type			MVA
1	N-1	349_B2_TOR21	OVEC - AEP	06KYGER-05SPORN 345 kV line	248005	242528	2	DC	103.03	103.62	NR	971	12.85	9
2	N-1	6190_B3_05SPORN 345-4_WOMOAB	OVEC - AEP	06KYGER-05SPORN 345 kV line	248005	242528	2	DC	102.22	102.83	NR	971	12.96	
3	N-1	363_B2_TOR1682	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	DC	174.06	174.06	ER	1370	0	10
4	Non	Non	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	DC	120.55	120.55	NR	1134	0	
5	N-1	4812_B2_TOR8931	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	DC	106.48	106.48	ER	1370	0	
6	Non	Non	MISO AMIL - MISO AMIL	7NEWTON-7CASEY 345 kV line	347830	346809	1	DC	110.79	110.79	NR	1200	0	11

ACI-085 Contribution to Previously Identified Overloads														
		Contingency		Affected Area	Facility Description	Bus			Loading		Rating		MW Con.	FG App.
#	Type	Name				From	To	Cir.	PF	Initial	Final	Type	MVA	
7	LFFB	H1TH3		MISO AMIL - MISO AMIL	7NEWTON-7CASEY 345 kV line	347830	346809	1	DC	106.49	106.49	ER	1319	0
8	N-1	P04		MISO AMIL - MISO AMIL	7NEWTON-7CASEY 345 kV line	347830	346809	1	DC	106.32	106.32	ER	1319	0
9	N-1	4839_B1_05ROCKPT 765-1		MISO AMIL - MISO AMIL	7NEWTON-7CASEY 345 kV line	347830	346809	1	DC	106.13	106.13	ER	1319	0

Table 5

Steady-State Voltage Requirements

None

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

None

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.

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.

#	Contingency		Affected Area	Facility Description	Bus		Cir.	PF	Loading		Rating		MW Con.
	Type	Name			From	To			Initial	Final	Type	MVA	
1	N-1	7342_B2_TOR7202268	AEP - DEO&K	05HILLSB-08CLINCO 138 kV line	243019	249995	1	DC	16.8	80.02	ER	184	116.33
2	Non	Non	AEP - DEO&K	05HILLSB-08CLINCO 138 kV line	243019	249995	1	DC	17.27	73.82	NR	159	89.92
3	N-1	P2-1..LOE BRKR OPEN AT HILLSBORO AEP 2381	AEP - DAY	05HILLSB-09MIDDLE 138 kV line	243019	253111	1	DC	34.25	76.5	ER	185	78.17
4	N-1	P2-1..LOE BRKR OPEN AT HILLSBORO AEP 2381	AEP - AEP	05HIGHLA 138/69 kV transformer	246911	243606	3	DC	52.24	91.11	ER	122	47.42
5	N-1	363_B2_TOR1682	OVEC - AEP	06CLIFTY-05JEFRS 345 kV line	248000	242865	Z1	DC	94.18	94.94	NR	1756	29.74
6	N-1	8468_B2	OVEC - AEP	06KYGER-05SPORN 345 kV line	248005	242528	1	DC	106.14	107.64	NR	1017	33.81
7	N-1	349_B2_TOR21	OVEC - AEP	06KYGER-05SPORN 345 kV line	248005	242528	2	DC	111.17	112.74	NR	971	33.81
8	N-1	363_B2_TOR1682	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	DC	185.09	185.09	ER	1370	0
9	Non	Non	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	DC	117.28	117.28	NR	1134	0
10	Non	Non	MISO AMIL - MISO AMIL	7NEWTON-7CASEY 345 kV line	347830	346809	1	DC	110.79	110.79	NR	1200	0
11	N-1	4839_B1_05ROCKPT 765-1	MISO AMIL - MISO AMIL	7NEWTON-7CASEY 345 kV line	347830	346809	1	DC	106.13	106.13	ER	1319	0

Table 6

New System Reinforcements

#	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
#1	06KYGER-05SPORN 345 kV line	Six Wire the Kyger-Sporn 345 kV No 1 and No 2 Circuits together	The standard time required for construction differs from state to state. An approximate construction time would be 24 to 36 months after signing an interconnection agreement.	\$300,000
#2	05HILLSB-05SINKG8 138 kV line	A sag check will be required for the Hillsboro – Sinking Spring 138 kV section of the Hillsboro – Millbrook Park 138 kV circuit (ACSR ~ 477 ~ 26/7 ~ HAWK - Conductor Section 1) to determine if the line section can be operated above its emergency rating of 185 MVA. The result could prove that no additional upgrades are necessary, that some upgrades on the circuit are necessary, or that the entire 3.29 mile section of line would need to be rebuilt.	An approximate time for the sag study is 6 to 12 months after signing an interconnection agreement.	\$15,000
#3	05HILLSB-08CLINCO 138 kV line	AEP owns 17.5 miles of line between Hillsboro and Clinton County. This line will have to be reconducted or rebuilt because a Sag Study will only increase the capability of this line to 257 MVA which is not sufficient. This is an AEP-Duke tie line therefore; PJM is going to have to coordinate this upgrade with Duke as well to make sure that their equipment will not set a limit lower than what is required.	The standard time required for construction differs from state to state. An approximate construction time would be 24 to 36 months after signing an interconnection agreement.	\$26,250,000
#4	05HILLSB-09MIDDLE 138 kV line	A sag check will be required for the Hillsboro – Middleboro 138 kV section of the Hillsboro – Hutchings 138 kV circuit (ACSR ~ 477 ~ 26/7 ~ HAWK - Conductor Section 1) to determine if the line section can be operated above its emergency rating of 185 MVA. The result could prove that no additional upgrades are necessary, that some upgrades on the circuit are necessary, or that the entire 22.3 mile section of line would need to be rebuilt. This is an AEP-Dayton Power & Light tie line therefore; PJM is going to have to coordinate this upgrade with Dayton Power & Light as well to make sure that their equipment will not set a limit lower than what is required	An approximate time for the sag study is 6 to 12 months after signing an interconnection agreement.	\$89,200
#5	05SINKG8-05MILLBR 138 kV line	A sag check will be required for the ACSR ~ 477 ~ 26/7 ~ HAWK - Conductor Section 3 to determine if the line section can be operated above its emergency rating of 185 MVA. The result could prove that no additional upgrades are necessary, that some upgrades on the circuit are necessary, or that the entire 8.7 mile section of line would need to be rebuilt. An engineering study will need to be conducted to determine if the Relay Compliance Trip limits settings can be adjusted at Millbrook Park to mitigate the overload.	An approximate time for the sag study is 6 to 12 months after signing an interconnection agreement.	\$35,000
#6	05HIGHLA 138/69 kV transformer	Replace the 138/69 kV Transformer #3 at Highland	An approximate construction time will be 12 months after signing of an interconnection agreement.	\$1,500,000
Total New Network Upgrades				\$28,179,200

Table 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 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 400.0 MW (152.0 MW Capacity) solar generating facility of Hecate (PJM Project #AC1-085) will require the following additional interconnection charges. This plan of service will interconnect the proposed solar generating facility in a manner that will provide operational reliability and flexibility to both the AEP system and the Hecate generating facility.

Cost Breakdown for Primary Point of Interconnection (Hillsboro 138 kV Substation)		
Attachment Cost	Expand Hillsboro 138 kV Substation	\$3,000,000
Non-Direct Connection Cost Estimate	138 kV Revenue Metering	\$300,000
	Upgrade line protection and controls at the expanded Hillsboro 138 kV substation.	\$300,000
	Upgrade line protection and control settings at the Millbrook Park 138 kV substation to coordinate with the expanded Hillsboro 138 kV substation.	\$25,000
	Upgrade line protection and control settings at the Highland 138 kV substation to coordinate with the expanded Hillsboro 138 kV substation.	\$25,000
	Upgrade line protection and control settings at the Clinton County 138 kV substation to coordinate with the expanded Hillsboro 138 kV substation.	\$25,000
	Upgrade line protection and control settings at the Wildcat 138 kV substation to coordinate with the expanded Hillsboro 138 kV substation.	\$25,000
	Upgrade line protection and control settings at the O.H. Hutchings (DP&L) 138 kV substation to coordinate with the expanded Hillsboro 138 kV substation.	\$25,000
	A sag check will be required for the Hillsboro – Sinking Spring 138 kV section of the Hillsboro – Millbrook Park 138 kV circuit (ACSR ~ 477 ~ 26/7 ~ HAWK - Conductor Section 1) to determine if the line section can be operated above its emergency rating of 185 MVA. The result could prove that no additional upgrades are necessary, that some upgrades on the circuit are necessary, or that the	\$15,000

	entire 3.29 mile section of line would need to be rebuilt.	
	<p>AEP owns 17.5 miles of line between Hillsboro and Clinton County.</p> <p>This line will have to be reconducted or rebuilt because a Sag Study will only increase the capability of this line to 257 MVA which is not sufficient.</p> <p>This is an AEP-Duke tie line therefore; PJM is going to have to coordinate this upgrade with Duke as well to make sure that their equipment will not set a limit lower than what is required.</p>	\$26,250,000
	<p>A sag check will be required for the Hillsboro – Middleboro 138 kV section of the Hillsboro – Hutchings 138 kV circuit (ACSR ~ 477 ~ 26/7 ~ HAWK - Conductor Section 1) to determine if the line section can be operated above its emergency rating of 185 MVA. The result could prove that no additional upgrades are necessary, that some upgrades on the circuit are necessary, or that the entire 22.3 mile section of line would need to be rebuilt.</p> <p>This is an AEP-Dayton Power & Light tie line therefore; PJM is going to have to coordinate this upgrade with Dayton Power & Light as well to make sure that their equipment will not set a limit lower than what is required</p>	\$89,200
	<p>A sag check will be required for the Millbrook Park – Sinking Spring 138 kV section of the Hillsboro – Millbrook Park 138 kV circuit (ACSR ~ 477 ~ 26/7 ~ HAWK - Conductor Section 3) to determine if the line section can be operated above its emergency rating of 185 MVA. The result could prove that no additional upgrades are necessary, that some upgrades on the circuit are necessary, or that the entire 8.7 mile section of line would need to be rebuilt.</p> <p>An engineering study will need to be conducted to determine if the Relay Compliance Trip limits settings can be adjusted at Millbrook Park to mitigate the overload.</p>	\$35,000
	Replace the 138/69 kV Transformer #3 at Highland	\$1,500,000
	Six Wire the Kyger-Sporn 345 kV No 1 and No 2 Circuits together	\$25,000
	Total Estimated Cost for Project AC1-085	\$31,604,200

Table 8

The estimates are preliminary in nature, as they were determined without the benefit of detailed engineering studies. The cost of remediation for sag limited conductors is not included in this

estimate. Final estimates will require an on-site review and coordination to determine final construction requirements.

Option 2

Network Impacts

The Queue Project AC1-085 was evaluated as a 400.0 MW (Capacity 152.0 MW) injection tapping the Stuart-Clinton 345kV line in the DP&L area. Project AC1-085 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC1-085 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Base Case Used

Summer Peak Analysis – 2020 Case

Contingency Descriptions

The following contingencies resulted in overloads:

Option 2	
Contingency Name	Description
160_B3	CONTINGENCY '160_B3' OPEN BRANCH FROM BUS 253110 TO BUS 253100 CKT 1 / 253110 09ADKINS 345 253100 09ATLNTA 345 1 OPEN BRANCH FROM BUS 253100 TO BUS 253099 CKT 1 / 253100 09ATLNTA 345 253099 09ATLNTA 69.0 1 END
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
363_B2_TOR1682	CONTINGENCY '363_B2_TOR1682' OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1 END
4812_B2_TOR8931	CONTINGENCY '4812_B2_TOR8931' OPEN BRANCH FROM BUS 242921 TO BUS 242924 CKT 1 / 242921 05CORN 765 242924 05HANG R 765 1 END
4839_B1_05ROCKPT 765-1	CONTINGENCY '4839_B1_05ROCKPT 765-1' OPEN BRANCH FROM BUS 243209 TO BUS 243442 CKT 1 / 243209 05ROCKPT 765 243442 05RKG1 26.0 1 REMOVE UNIT 1H FROM BUS 243442 / 243442 05RKG1 26.0 REMOVE UNIT 1L FROM BUS 243442 / 243442 05RKG1 26.0 END

Option 2	
Contingency Name	Description
6190_B3_05SPORN 345-4_WOMOAB	CONTINGENCY '6190_B3_05SPORN 345-4_WOMOAB' OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 1 / 242528 05SPORN 345 248005 06KYGER 345 1 OPEN BRANCH FROM BUS 242528 TO BUS 242808 CKT 4 / 242528 05SPORN 345 242808 05SPORNS 138 4 END
762_B2_TOR8072	CONTINGENCY '762_B2_TOR8072' OPEN BRANCH FROM BUS 243453 TO BUS 253110 CKT 1 / 243453 05BEATTY 345 253110 09ADKINS 345 1 END
764_B2_TOR9237	CONTINGENCY '764_B2_TOR9237' OPEN BRANCH FROM BUS 242938 TO BUS 253038 CKT 1 / 242938 05MARQUI 345 253038 09KILLEN 345 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
892_B2_A	CONTINGENCY '892_B2_A' OPEN BRANCH FROM BUS 253014 TO BUS 926060 CKT 1 / 253014 09CLINTO 345 926060 AC1-085 TAP 345 1 END
H1TH3	CONTINGENCY 'H1TH3' /* BATH CO. REMOVE MACHINE 5 FROM BUS 315205 /*BATH UNIT #5 REMOVE MACHINE 6 FROM BUS 315206 /*BATH UNIT #6 REMOVE MACHINE 1 FROM BUS 315201 /*BATH UNIT #1 REMOVE MACHINE 2 FROM BUS 315202 /*BATH UNIT #2 END
P04	CONTINGENCY 'P04' DISCONNECT BUS 200122 /* DISCONNECT BUS 200192 /* DISCONNECT BUS 200193 /* DISCONNECT BUS 200194 /* DISCONNECT BUS 200195 /* END

Table 9

Generator Deliverability

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

Option 2														
AC1-085 Generator Deliverability														
#	Contingency		Affected Area	Facility Description	Bus		Cir.	PF	Loading		Type	Rating MVA	MW Con.	FG App.
	Type	Name			From	To			Initial	Final				
1	N-1	8468_B2	OVEC - AEP	06KYGER-05SPORN 345 kV line	248005	242528	1	DC	97.47	98.14	NR	1017	15.14	1
2	N-1	160_B3	DAY - AEP	09KILLEN-05MARQUI 345 kV line	253038	242938	1	DC	97.72	98.79	NR	1233	29.33	

Table 10

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)

AC1-085 Contribution to Previously Identified Overloads														
#	Contingency		Affected Area	Facility Description	Bus		Cir.	PF	Loading		Type	Rating MVA	MW Con.	FG App.
	Type	Name			From	To			Initial	Final				
1	N-1	349_B2_TOR21	OVEC - AEP	06KYGER-05SPORN 345 kV line	248005	242528	2	DC	102.09	102.79	NR	971	15.14	2
2	N-1	6190_B3_05SPORN 345-4_WOMOAB	OVEC - AEP	06KYGER-05SPORN 345 kV line	248005	242528	2	DC	101.28	101.98	NR	971	15.17	
3	N-1	762_B2_TOR8072	DAY - AEP	09KILLEN-05MARQUI 345 kV line	253038	242938	1	DC	103.65	104.71	NR	1233	29.1	3
4	N-1	892_B2_A	DAY - AEP	09ADKINS-05BEATTY 345 kV line	253110	243453	1	DC	112.89	114.61	NR	1233	21.25	4
5	N-1	764_B2_TOR9237	DAY - AEP	09ADKINS-05BEATTY 345 kV line	253110	243453	1	DC	113.69	114.33	NR	1233	17.7	
6	N-1	363_B2_TOR1682	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	DC	171.64	171.64	ER	1370	0	5
7	Non	Non	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	DC	118.34	118.34	NR	1134	0	
8	N-1	4812_B2_TOR8931	LGEE -	7TRIMBLE-06CLIFTY	324114	248000	1	DC	104.65	104.65	ER	1370	0	

AC1-085 Contribution to Previously Identified Overloads															
Contingency			Affected Area	Facility Description	Bus				Loading		Rating		MW Con.	FG App.	
#	Type	Name			From	To	Cir.	PF	Initial	Final	Type	MVA			
			OVEC	345 kV line											
9	Non	Non	MISO AMIL - MISO AMIL	7NEWTON-7CASEY 345 kV line	347830	346809	1	DC	108.77	108.77	NR	1200	0	6	
10	LFFB	H1TH3	MISO AMIL - MISO AMIL	7NEWTON-7CASEY 345 kV line	347830	346809	1	DC	104.67	104.67	ER	1319	0		
11	N-1	P04	MISO AMIL - MISO AMIL	7NEWTON-7CASEY 345 kV line	347830	346809	1	DC	104.48	104.48	ER	1319	0		
12	N-1	4839_B1_05ROCKPT 765-1	MISO AMIL - MISO AMIL	7NEWTON-7CASEY 345 kV line	347830	346809	1	DC	104.31	104.31	ER	1319	0		

Table 11

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

None

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.

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.

Contingency					Bus		Loading			Rating		MW	
#	Type	Name	Affected Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.
1	N-1	363_B2_TOR1682	OVEC - AEP	06CLIFTY-05JEFRSO 345 kV line	248000	242865	Z1	DC	93.58	94.49	NR	1756	35.46
2	N-1	8468_B2	OVEC - AEP	06KYGER-05SPORN 345 kV line	248005	242528	1	DC	105.58	107.35	NR	1017	39.84
3	N-1	349_B2_TOR21	OVEC - AEP	06KYGER-05SPORN 345 kV line	248005	242528	2	DC	110.59	112.43	NR	971	39.84

Contingency			Affected Area	Facility Description	Bus		Cir.	PF	Loading		Rating		MW Con.
#	Type	Name			From	To			Initial	Final	Type	MVA	
4	N-1	764_B2_TOR9237	DAY - AEP	09ADKINS-05BEATTY 345 kV line	253110	243453	1	DC	107.65	109.35	NR	1233	46.57
5	N-1	363_B2_TOR1682	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	DC	182.68	182.68	ER	1370	0
6	Non	Non	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	DC	115.08	115.08	NR	1134	0
7	Non	Non	MISO AMIL - MISO AMIL	7NEWTON-7CASEY 345 kV line	347830	346809	1	DC	108.77	108.77	NR	1200	0
8	N-1	4839_B1_05ROCKPT 765-1	MISO AMIL - MISO AMIL	7NEWTON-7CASEY 345 kV line	347830	346809	1	DC	104.31	104.31	ER	1319	0

Table 12

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

Single-Line Diagram

**AC1-085 Primary Point of Interconnection
Hillsboro 138 kV Substation**

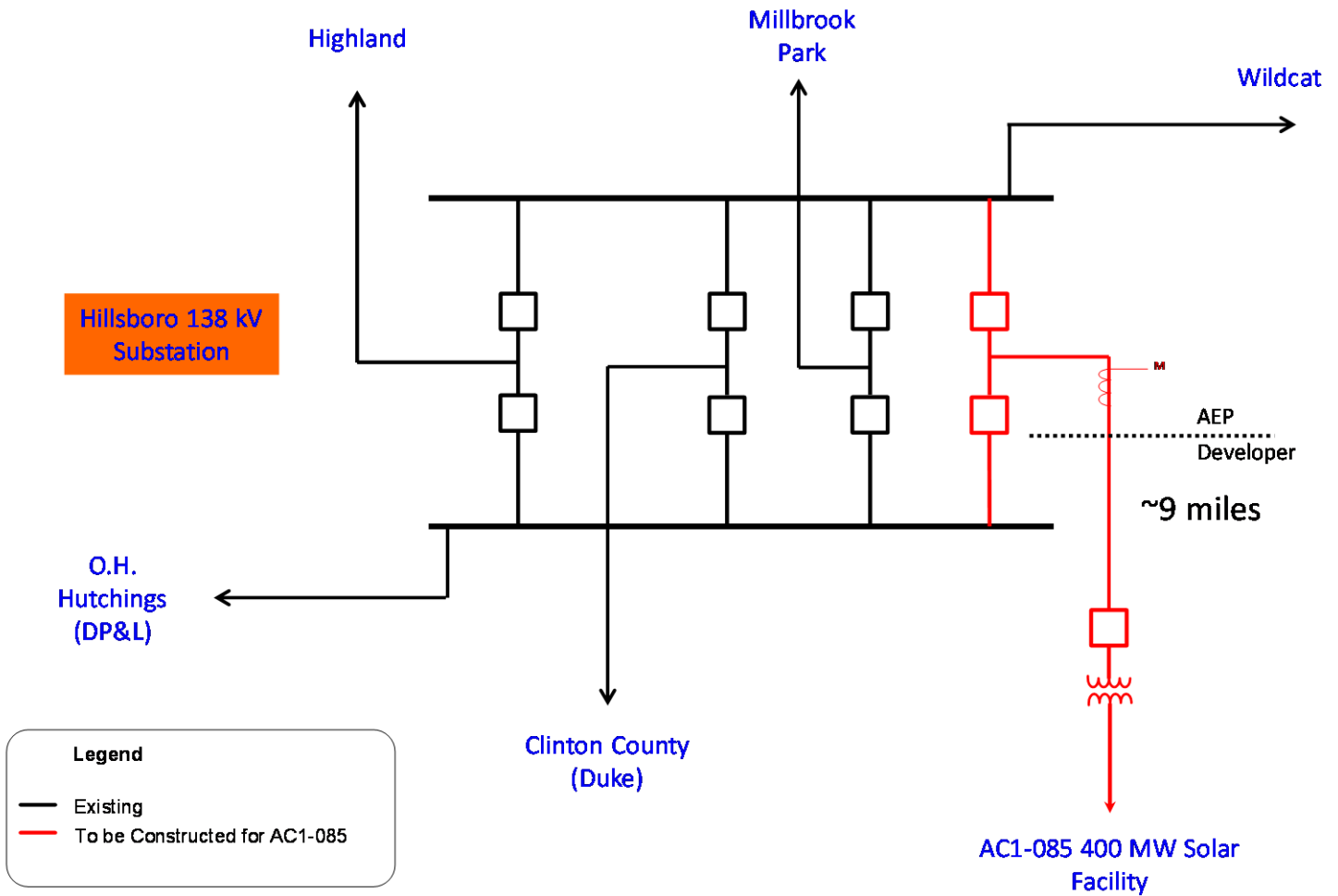
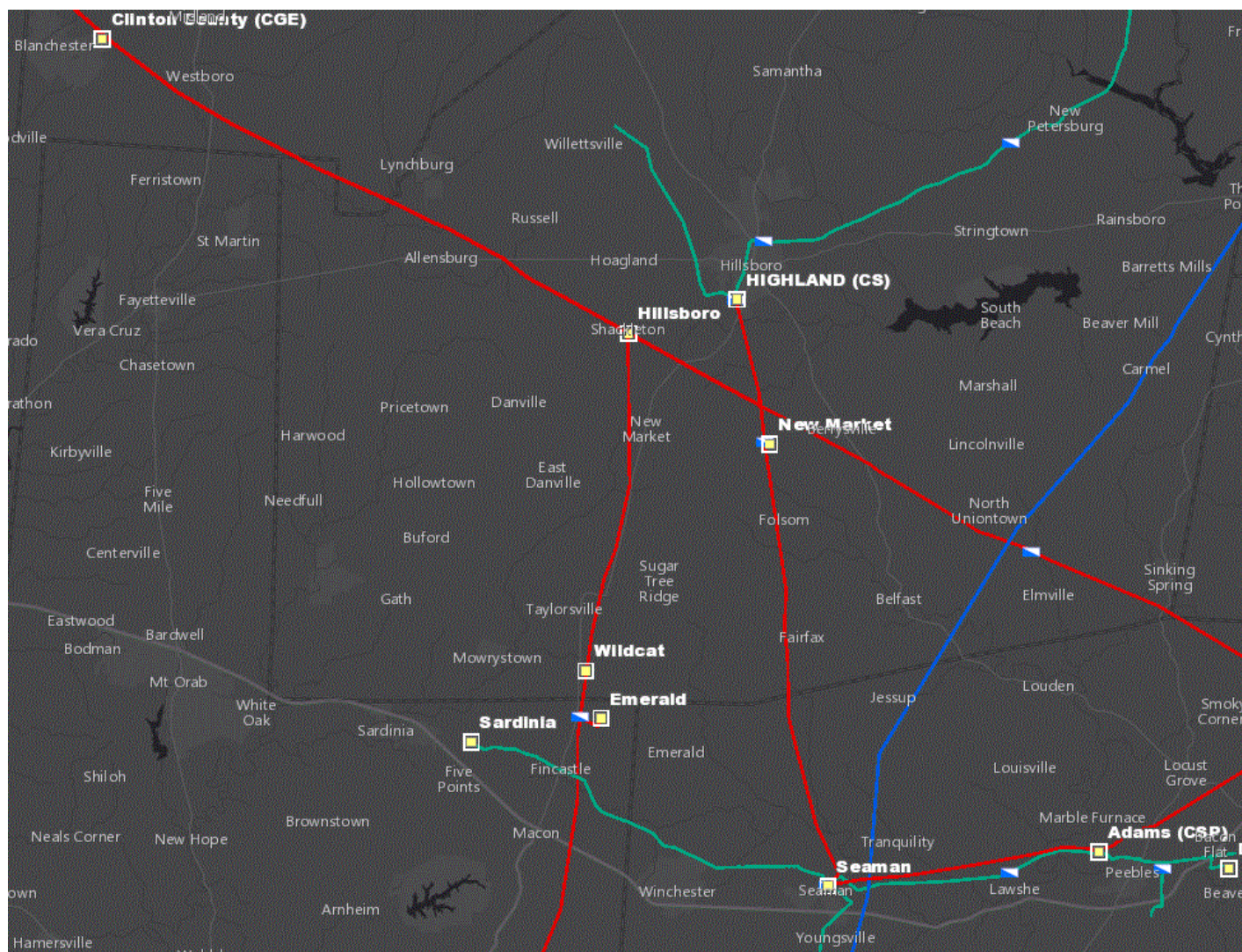


Figure 2: Primary Point of Interconnection (Hillsboro 138 kV Substation)



Appendices Option 1

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

(OVEC - AEP) The 06KYGER-05SPORN 345 kV line (from bus 248005 to bus 242528 ckt 1) loads from 98.37% to 98.94% (**DC power flow**) of its normal rating (1017 MVA) for the single line contingency outage of '8468_B2'. This project contributes approximately 12.85 MW to the thermal violation.

CONTINGENCY '8468_B2'

OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 2

/ 242528 05SPORN

345 248005 06KYGER 345 2

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
251936	08BCKJD4	20.19
251937	08BCKJD5	31.13
251964	08WSDLE3	1.75
251965	08WSDLE4	1.75
251966	08WSDLE5	1.75
251967	08WSDLE6	1.75
253038	09KILLEN	15.45
253058	09OHH C.	5.23
342910	1DALE 3G	5.65
342911	1DALE 4G	5.83
247536	S-071 C	1.63
247543	V3-007 C	1.9
916261	Z1-079	11.06
922002	AA2-100	0.53
922372	AA2-148 C	1.8
922612	AB1-014 C	5.3
923522	AB1-169 C OP	118.36
923881	AB2-028 C	1.77

<i>924101</i>	<i>AB2-054</i>	<i>40.06</i>
<i>924211</i>	<i>AB2-065 C</i>	<i>1.26</i>
<i>924351</i>	<i>AB2-083 C OP</i>	<i>2.</i>
<i>924371</i>	<i>AB2-085 C OP</i>	<i>5.58</i>
<i>924541</i>	<i>AB2-103 C OP</i>	<i>2.68</i>
<i>925341</i>	<i>AC1-001 C</i>	<i>4.</i>
<i>927331</i>	<i>AC1-040 C</i>	<i>3.56</i>
<i>925801</i>	<i>AC1-059 C</i>	<i>2.85</i>
<i>925921</i>	<i>AC1-068 C</i>	<i>2.34</i>
<i>925931</i>	<i>AC1-069 C</i>	<i>2.34</i>
<i>925981</i>	<i>AC1-074 C OP</i>	<i>5.1</i>
<i>926061</i>	<i>AC1-085 C</i>	<i>12.85</i>
<i>926101</i>	<i>AC1-089 C</i>	<i>4.88</i>
<i>926631</i>	<i>AC1-144 C</i>	<i>5.69</i>
<i>926691</i>	<i>AC1-152 C</i>	<i>65.53</i>
<i>926791</i>	<i>AC1-165 C</i>	<i>2.16</i>
<i>926801</i>	<i>AC1-166 C</i>	<i>2.16</i>
<i>926851</i>	<i>AC1-172 C</i>	<i>65.53</i>
<i>926871</i>	<i>AC1-174 C</i>	<i>2.78</i>
<i>926881</i>	<i>AC1-175 C</i>	<i>2.78</i>
<i>926951</i>	<i>AC1-182</i>	<i>2.23</i>

Appendix 2

(AEP - AEP) The 05HILLSB-05SINKG8 138 kV line (from bus 243019 to bus 243102 ckt 1) loads from .15% to 76.58% (**DC power flow**) of its emergency rating (185 MVA) for the line fault with failed breaker contingency outage of '8107_C2_05HILLSB 138-C_A'. This project contributes approximately 141.74 MW to the thermal violation.

CONTINGENCY '8107_C2_05HILLSB 138-C_A'

OPEN BRANCH FROM BUS 246911 TO BUS 243019 CKT 1 / 246911

05HIGHLA 138 243019 05HILLSB 138 1

OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB

138 253111 09MIDDLE 138 1

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
916272	Z1-080 E	1.23
926061	AC1-085 C	53.86
926062	AC1-085 E	87.88
926101	AC1-089 C	18.17
926102	AC1-089 E	29.64
926631	AC1-144 C	23.85
926632	AC1-144 E	11.59

Appendix 3

(AEP - DEO&K) The 05HILLSB-08CLINCO 138 kV line (from bus 243019 to bus 249995 ckt 1) loads from 29.11% to 108.17% (**DC power flow**) of its emergency rating (184 MVA) for the line fault with failed breaker contingency outage of '8107_C2_05HILLSB 138-C_A'. This project contributes approximately 145.47 MW to the thermal violation.

CONTINGENCY '8107_C2_05HILLSB 138-C_A'

OPEN BRANCH FROM BUS 246911 TO BUS 243019 CKT 1 / 246911

05HIGHLA 138 243019 05HILLSB 138 1

OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB

138 253111 09MIDDLE 138 1

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
916272	Z1-080 E	2.17
926061	AC1-085 C	55.28
926062	AC1-085 E	90.19
926101	AC1-089 C	18.57
926102	AC1-089 E	30.29
926631	AC1-144 C	24.48
926632	AC1-144 E	11.89

Appendix 4

(AEP - DAY) The 05HILLSB-09MIDDLE 138 kV line (from bus 243019 to bus 253111 ckt 1) loads from 54.28% to 86.69% (**DC power flow**) of its emergency rating (185 MVA) for the tower line contingency outage of 'P7-1..C5 4524FOSTRSUGRCRK34598FOSTERBATH'. This project contributes approximately 59.96 MW to the thermal violation.

CONTINGENCY 'P7-1..C5 4524FOSTRSUGRCRK34598FOSTERBATH'
OPEN BRANCH FROM BUS 253079 TO BUS 249566 CKT 1
OPEN BRANCH FROM BUS 253006 TO BUS 249566 CKT 1
END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
914372	Y2-111 E	0.75
915582	Y3-080 E	0.5
916272	Z1-080 E	0.51
924371	AB2-085 C OP	3.74
924372	AB2-085 E OP	1.76
924541	AB2-103 C OP	2.26
924542	AB2-103 E OP	1.06
926061	AC1-085 C	22.78
926062	AC1-085 E	37.18
926101	AC1-089 C	7.68
926102	AC1-089 E	12.52
926631	AC1-144 C	10.09
926632	AC1-144 E	4.9

Appendix 5

(AEP - AEP) The 05SINKG8-05MILLBR 138 kV line (from bus 243102 to bus 243042 ckt 1) loads from 2.11% to 78.63% (**DC power flow**) of its emergency rating (179 MVA) for the line fault with failed breaker contingency outage of '8107_C2_05HILLSB 138-C_B'. This project contributes approximately 141.74 MW to the thermal violation.

CONTINGENCY '8107_C2_05HILLSB 138-C_B'

OPEN BRANCH FROM BUS 246911 TO BUS 243019 CKT 1 / 246911

05HIGHLA 138 243019 05HILLSB 138 1

OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB

138 253111 09MIDDLE 138 1

OPEN BRANCH FROM BUS 253111 TO BUS 253057 CKT 1 / 253111

09MIDDLE 138 253057 09OHH 138 1

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
916272	Z1-080 E	1.23
926061	AC1-085 C	53.86
926062	AC1-085 E	87.88
926101	AC1-089 C	18.17
926102	AC1-089 E	29.64
926631	AC1-144 C	23.85
926632	AC1-144 E	11.59

Appendix 6

(AEP - AEP) The 05HIGHLA 138/69 kV transformer (from bus 246911 to bus 243606 ckt 3) loads from 61.2% to 110.19% (**DC power flow**) of its emergency rating (122 MVA) for the line fault with failed breaker contingency outage of '8108_C2_05HILLSB 138-D'. This project contributes approximately 59.77 MW to the thermal violation.

CONTINGENCY '8108_C2_05HILLSB 138-D'

OPEN BRANCH FROM BUS 243019 TO BUS 249995 CKT 1 / 243019 05HILLSB
138 249995 08CLINCO 138 1

OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB
138 253111 09MIDDLE 138 1

OPEN BRANCH FROM BUS 249995 TO BUS 250122 CKT 1 / 249995
08CLINCO 138 250122 08WARRN1 138 1

OPEN BRANCH FROM BUS 253111 TO BUS 253057 CKT 1 / 253111
09MIDDLE 138 253057 09OHH 138 1

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
924371	AB2-085 C OP	5.85
924372	AB2-085 E OP	2.75
924541	AB2-103 C OP	3.58
924542	AB2-103 E OP	1.68
926061	AC1-085 C	22.71
926062	AC1-085 E	37.06
926101	AC1-089 C	7.63
926102	AC1-089 E	12.45
926631	AC1-144 C	10.06
926632	AC1-144 E	4.89

Appendix 7

(DEO&K - DEO&K) The 08CLINCO-08WARRN1 138 kV line (from bus 249995 to bus 250122 ckt 1) loads from 13.5% to 86.97% (**DC power flow**) of its emergency rating (198 MVA) for the line fault with failed breaker contingency outage of '8107_C2_05HILLSB 138-C_B'. This project contributes approximately 145.47 MW to the thermal violation.

CONTINGENCY '8107_C2_05HILLSB 138-C_B'

OPEN BRANCH FROM BUS 246911 TO BUS 243019 CKT 1 / 246911

05HIGHLA 138 243019 05HILLSB 138 1

OPEN BRANCH FROM BUS 243019 TO BUS 253111 CKT 1 / 243019 05HILLSB
138 253111 09MIDDLE 138 1

OPEN BRANCH FROM BUS 253111 TO BUS 253057 CKT 1 / 253111

09MIDDLE 138 253057 09OHH 138 1

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
916272	Z1-080 E	3.83
926061	AC1-085 C	55.28
926062	AC1-085 E	90.19
926101	AC1-089 C	18.57
926102	AC1-089 E	30.29
926631	AC1-144 C	24.48
926632	AC1-144 E	11.89

Appendix 8

(DAY - DAY) The 09MIDDLE-09OHH 138 kV line (from bus 253111 to bus 253057 ckt 1) loads from 52.01% to 84.42% (**DC power flow**) of its emergency rating (185 MVA) for the tower line contingency outage of 'P7-1..C5 4524FOSTRSUGRCRK34598FOSTERBATH'. This project contributes approximately 59.96 MW to the thermal violation.

CONTINGENCY 'P7-1..C5 4524FOSTRSUGRCRK34598FOSTERBATH'
 OPEN BRANCH FROM BUS 253079 TO BUS 249566 CKT 1
 OPEN BRANCH FROM BUS 253006 TO BUS 249566 CKT 1
 END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
914372	Y2-111 E	0.75
915582	Y3-080 E	0.5
916272	Z1-080 E	0.51
924371	AB2-085 C OP	3.74
924372	AB2-085 E OP	1.76
924541	AB2-103 C OP	2.26
924542	AB2-103 E OP	1.06
926061	AC1-085 C	22.78
926062	AC1-085 E	37.18
926101	AC1-089 C	7.68
926102	AC1-089 E	12.52
926631	AC1-144 C	10.09
926632	AC1-144 E	4.9

Appendix 9

(OVEC - AEP) The 06KYGER-05SPORN 345 kV line (from bus 248005 to bus 242528 ckt 2) loads from 103.03% to 103.62% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '349_B2_TOR21'. This project contributes approximately 12.85 MW to the thermal violation.

CONTINGENCY '349_B2_TOR21'

OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 1

/ 242528 05SPORN

345 248005 06KYGER 345 1

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
251936	08BCKJD4	20.19
251937	08BCKJD5	31.13
251964	08WSDLE3	1.75
251965	08WSDLE4	1.75
251966	08WSDLE5	1.75
251967	08WSDLE6	1.75
253038	09KILLEN	15.45
253058	09OHH C.	5.23
342910	1DALE 3G	5.65
342911	1DALE 4G	5.83
247536	S-071 C	1.63
247543	V3-007 C	1.9
916261	Z1-079	11.06
922002	AA2-100	0.53
922372	AA2-148 C	1.8
922612	AB1-014 C	5.3
923522	AB1-169 C OP	118.36
923881	AB2-028 C	1.77

<i>924101</i>	<i>AB2-054</i>	<i>40.06</i>
<i>924211</i>	<i>AB2-065 C</i>	<i>1.26</i>
<i>924351</i>	<i>AB2-083 C OP</i>	<i>2.</i>
<i>924371</i>	<i>AB2-085 C OP</i>	<i>5.58</i>
<i>924541</i>	<i>AB2-103 C OP</i>	<i>2.68</i>
<i>925341</i>	<i>AC1-001 C</i>	<i>4.</i>
<i>927331</i>	<i>AC1-040 C</i>	<i>3.56</i>
<i>925801</i>	<i>AC1-059 C</i>	<i>2.85</i>
<i>925921</i>	<i>AC1-068 C</i>	<i>2.34</i>
<i>925931</i>	<i>AC1-069 C</i>	<i>2.34</i>
<i>925981</i>	<i>AC1-074 C OP</i>	<i>5.1</i>
<i>926061</i>	<i>AC1-085 C</i>	<i>12.85</i>
<i>926101</i>	<i>AC1-089 C</i>	<i>4.88</i>
<i>926631</i>	<i>AC1-144 C</i>	<i>5.69</i>
<i>926691</i>	<i>AC1-152 C</i>	<i>65.53</i>
<i>926791</i>	<i>AC1-165 C</i>	<i>2.16</i>
<i>926801</i>	<i>AC1-166 C</i>	<i>2.16</i>
<i>926851</i>	<i>AC1-172 C</i>	<i>65.53</i>
<i>926871</i>	<i>AC1-174 C</i>	<i>2.78</i>
<i>926881</i>	<i>AC1-175 C</i>	<i>2.78</i>
<i>926951</i>	<i>AC1-182</i>	<i>2.23</i>

Appendix 10

(LGEE - OVEC) The 7TRIMBLE-06CLIFTY 345 kV line (from bus 324114 to bus 248000 ckt 1) loads from 174.06% to 174.06% (**DC power flow**) of its emergency rating (1370 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 0.0 MW to the thermal violation.

CONTINGENCY '363_B2_TOR1682'

OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1

/ 243208 05JEFRSO

765 243209 05ROCKPT 765 1

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
243442	05RKG1	38.66
243443	05RKG2	38.08
342900	1COOPER1 G	3.1
342903	1COOPER2 G	6.02
342910	1DALE 3G	9.18
342911	1DALE 4G	8.89
342918	1JKCT 1G	2.44
342921	1JKCT 2G	2.44
342924	1JKCT 3G	2.44
342927	1JKCT 4G	1.62
342930	1JKCT 5G	1.62
342933	1JKCT 6G	1.62
342936	1JKCT 7G	1.62
342939	1JKCT 9G	1.66
342942	1JKCT 10G	1.66
342945	1LAUREL 1G	1.75
900405	X3-028 E	217.86
LTF	Y2-006	16.25

<i>247629</i>	<i>Y3-038</i>	<i>5.5</i>
<i>LTF</i>	<i>Z1-046</i>	<i>18.63</i>
<i>LTF</i>	<i>AA1-001</i>	<i>6.08</i>
<i>LTF</i>	<i>AA1-004</i>	<i>15.42</i>
<i>922982</i>	<i>AB1-087 C OP</i>	<i>59.91</i>
<i>922992</i>	<i>AB1-088 C OP</i>	<i>59.91</i>
<i>LTF</i>	<i>AB2-005</i>	<i>10.3</i>
<i>924101</i>	<i>AB2-054</i>	<i>57.43</i>
<i>924261</i>	<i>AB2-070 C OP</i>	<i>1.33</i>
<i>LTF</i>	<i>AB2-075</i>	<i>2.42</i>
<i>LTF</i>	<i>AB2-076</i>	<i>3.07</i>
<i>LTF</i>	<i>AC1-002</i>	<i>42.48</i>
<i>927331</i>	<i>AC1-040 C</i>	<i>9.5</i>
<i>925771</i>	<i>AC1-053 C</i>	<i>1.33</i>
<i>925981</i>	<i>AC1-074 C OP</i>	<i>4.67</i>

Appendix 11

(MISO AMIL - MISO AMIL) The 7NEWTON-7CASEY 345 kV line (from bus 347830 to bus 346809 ckt 1) loads from 110.79% to 110.79% (**DC power flow**) of its normal rating (1200 MVA) for non-contingency condition. This project contributes approximately 0.0 MW to the thermal violation.

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
<i>LTF</i>	<i>Y2-006</i>	<i>12.9</i>
<i>LTF</i>	<i>Z1-046</i>	<i>12.12</i>
<i>LTF</i>	<i>AA1-001</i>	<i>11.88</i>
<i>LTF</i>	<i>AA1-004</i>	<i>12.25</i>
<i>LTF</i>	<i>AB2-005</i>	<i>7.69</i>
<i>LTF</i>	<i>AC1-002</i>	<i>76.7</i>

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

(OVEC - AEP) The 06KYGER-05SPORN 345 kV line (from bus 248005 to bus 242528 ckt 1) loads from 97.47% to 98.14% (**DC power flow**) of its normal rating (1017 MVA) for the single line contingency outage of '8468_B2'. This project contributes approximately 15.14 MW to the thermal violation.

CONTINGENCY '8468_B2'

OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 2

/ 242528 05SPORN

345 248005 06KYGER 345 2

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
251936	08BCKJD4	20.18
251937	08BCKJD5	31.13
251964	08WSDLE3	1.73
251965	08WSDLE4	1.73
251966	08WSDLE5	1.73
251967	08WSDLE6	1.73
253038	09KILLEN	15.29
253058	09OHH C.	5.23
342910	1DALE 3G	5.65
342911	1DALE 4G	5.83
247536	S-071 C	1.63
247543	V3-007 C	1.9
916261	Z1-079	10.94
922002	AA2-100	0.53
922372	AA2-148 C	1.8
922612	AB1-014 C	5.3
923522	AB1-169 C OP	118.34
923881	AB2-028 C	1.77

924101	AB2-054	40.05
924211	AB2-065 C	1.26
924351	AB2-083 C OP	2.
924371	AB2-085 C OP	5.58
924541	AB2-103 C OP	2.68
925341	AC1-001 C	3.99
927331	AC1-040 C	3.56
925801	AC1-059 C	2.85
925921	AC1-068 C	2.34
925931	AC1-069 C	2.34
925981	AC1-074 C OP	5.08
926011	AC1-078 C OP	4.08
926061	AC1-085 C	15.14
926101	AC1-089 C	4.88
926181	AC1-096 OP	84.41
926631	AC1-144 C	5.23
926691	AC1-152 C	65.52
926791	AC1-165 C	2.16
926801	AC1-166 C	2.16
926851	AC1-172 C	65.52
926871	AC1-174 C	2.78
926881	AC1-175 C	2.78
926951	AC1-182	2.23

Appendix 2

(OVEC - AEP) The 06KYGER-05SPORN 345 kV line (from bus 248005 to bus 242528 ckt 2) loads from 102.09% to 102.79% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '349_B2_TOR21'. This project contributes approximately 15.14 MW to the thermal violation.

CONTINGENCY '349_B2_TOR21'

OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 1

/ 242528 05SPORN

345 248005 06KYGER 345 1

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
251936	08BCKJD4	20.18
251937	08BCKJD5	31.13
251964	08WSDLE3	1.73
251965	08WSDLE4	1.73
251966	08WSDLE5	1.73
251967	08WSDLE6	1.73
253038	09KILLEN	15.29
253058	09OHH C.	5.23
342910	1DALE 3G	5.65
342911	1DALE 4G	5.83
247536	S-071 C	1.63
247543	V3-007 C	1.9
916261	Z1-079	10.94
922002	AA2-100	0.53
922372	AA2-148 C	1.8
922612	AB1-014 C	5.3
923522	AB1-169 C OP	118.34
923881	AB2-028 C	1.77

924101	AB2-054	40.05
924211	AB2-065 C	1.26
924351	AB2-083 C OP	2.
924371	AB2-085 C OP	5.58
924541	AB2-103 C OP	2.68
925341	AC1-001 C	3.99
927331	AC1-040 C	3.56
925801	AC1-059 C	2.85
925921	AC1-068 C	2.34
925931	AC1-069 C	2.34
925981	AC1-074 C OP	5.08
926011	AC1-078 C OP	4.08
926061	AC1-085 C	15.14
926101	AC1-089 C	4.88
926181	AC1-096 OP	84.41
926631	AC1-144 C	5.23
926691	AC1-152 C	65.52
926791	AC1-165 C	2.16
926801	AC1-166 C	2.16
926851	AC1-172 C	65.52
926871	AC1-174 C	2.78
926881	AC1-175 C	2.78
926951	AC1-182	2.23

Appendix 3

(DAY - AEP) The 09KILLEN-05MARQUI 345 kV line (from bus 253038 to bus 242938 ckt 1) loads from 103.65% to 104.71% (**DC power flow**) of its normal rating (1233 MVA) for the single line contingency outage of '762_B2_TOR8072'. This project contributes approximately 29.1 MW to the thermal violation.

CONTINGENCY '762_B2_TOR8072'

OPEN BRANCH FROM BUS 243453 TO BUS 253110 CKT 1

/ 243453

05BEATTY 345 253110 09ADKINS 345 1

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
251936	08BCKJD4	9.61
251937	08BCKJD5	14.51
253038	09KILLEN	54.1
253058	09OHH C.	4.06
253077	09STUART	111.68
342910	1DALE 3G	6.72
342911	1DALE 4G	7.22
920662	Z2-029	0.98
922002	AA2-100	0.85
922612	AB1-014 C	7.36
923522	AB1-169 C OP	278.49
924101	AB2-054	52.68
925921	AC1-068 C	7.63
925931	AC1-069 C	7.63
925981	AC1-074 C OP	6.25
926061	AC1-085 C	29.1
926101	AC1-089 C	3.29
926691	AC1-152 C	34.5

<i>926791</i>	<i>ACI-165 C</i>	<i>7.04</i>
<i>926801</i>	<i>ACI-166 C</i>	<i>7.04</i>
<i>926851</i>	<i>ACI-172 C</i>	<i>34.5</i>
<i>926951</i>	<i>ACI-182</i>	<i>2.42</i>

Appendix 4

(DAY - AEP) The 09ADKINS-05BEATTY 345 kV line (from bus 253110 to bus 243453 ckt 1) loads from 112.89% to 114.61% (**DC power flow**) of its normal rating (1233 MVA) for the single line contingency outage of '892_B2_A'. This project contributes approximately 21.25 MW to the thermal violation.

CONTINGENCY '892_B2_A'

OPEN BRANCH FROM BUS 253014 TO BUS 926060 CKT 1 / 253014

09CLINTO 345 926060 AC1-085 TAP 345 1

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
253110	09ADKINS	66.62
253077	09STUART	61.66
342960	1SPURLK2G	10.48
342963	1SPURLK3G	5.51
342966	1SPURLK4G	5.51
916411	Z1-097	4.11
920662	Z2-029	0.54
922002	AA2-100	0.46
922612	AB1-014 C	3.83
923522	AB1-169 C OP	153.77
925921	AC1-068 C	19.6
925931	AC1-069 C	19.6
926061	AC1-085 C	21.25
926791	AC1-165 C	18.09
926801	AC1-166 C	18.09

Appendix 5

(LGEE - OVEC) The 7TRIMBLE-06CLIFTY 345 kV line (from bus 324114 to bus 248000 ckt 1) loads from 171.64% to 171.64% (**DC power flow**) of its emergency rating (1370 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 0.0 MW to the thermal violation.

CONTINGENCY '363_B2_TOR1682'

OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1

/ 243208 05JEFRSO

765 243209 05ROCKPT 765 1

END

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
243442	05RKG1	38.24
243443	05RKG2	37.66
342900	1COOPER1 G	3.07
342903	1COOPER2 G	5.95
342910	1DALE 3G	9.17
342911	1DALE 4G	8.89
342918	1JKCT 1G	2.41
342921	1JKCT 2G	2.41
342924	1JKCT 3G	2.41
342927	1JKCT 4G	1.6
342930	1JKCT 5G	1.6
342933	1JKCT 6G	1.6
342936	1JKCT 7G	1.6
342939	1JKCT 9G	1.64
342942	1JKCT 10G	1.64
342945	1LAUREL 1G	1.73
900405	X3-028 E	217.76
LTF	Y2-006	16.23

<i>247629</i>	<i>Y3-038</i>	<i>5.5</i>
<i>LTF</i>	<i>Z1-046</i>	<i>18.63</i>
<i>LTF</i>	<i>AA1-001</i>	<i>6.07</i>
<i>LTF</i>	<i>AA1-004</i>	<i>15.41</i>
<i>922982</i>	<i>AB1-087 C OP</i>	<i>59.88</i>
<i>922992</i>	<i>AB1-088 C OP</i>	<i>59.88</i>
<i>LTF</i>	<i>AB2-005</i>	<i>10.29</i>
<i>924101</i>	<i>AB2-054</i>	<i>57.42</i>
<i>924261</i>	<i>AB2-070 C OP</i>	<i>1.33</i>
<i>LTF</i>	<i>AB2-075</i>	<i>2.42</i>
<i>LTF</i>	<i>AB2-076</i>	<i>3.07</i>
<i>LTF</i>	<i>AC1-002</i>	<i>42.44</i>
<i>927331</i>	<i>AC1-040 C</i>	<i>9.49</i>
<i>925771</i>	<i>AC1-053 C</i>	<i>1.33</i>
<i>925981</i>	<i>AC1-074 C OP</i>	<i>4.73</i>

Appendix 6

(MISO AMIL - MISO AMIL) The 7NEWTON-7CASEY 345 kV line (from bus 347830 to bus 346809 ckt 1) loads from 108.77% to 108.77% (**DC power flow**) of its normal rating (1200 MVA) for non-contingency condition. This project contributes approximately 0.0 MW to the thermal violation.

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
<i>LTF</i>	<i>Y2-006</i>	<i>12.9</i>
<i>LTF</i>	<i>Z1-046</i>	<i>12.11</i>
<i>LTF</i>	<i>AA1-001</i>	<i>11.87</i>
<i>LTF</i>	<i>AA1-004</i>	<i>12.24</i>
<i>LTF</i>	<i>AB2-005</i>	<i>7.68</i>
<i>LTF</i>	<i>AC1-002</i>	<i>76.68</i>

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Case No(s). 20-1288-EL-BGN

Summary: Exhibit Application Exhibit A electronically filed by Ms. Karen A. Winters on behalf of Hecate Energy Highland 4 LLC