Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AC1-144

Hillsboro 138 kV

April 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 proposes to install PJM Project #AC1-144, a 100.0 MW (67.3 MW Capacity) Hybrid solar/energy storage 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 AEP's Hillsboro – Sinking Springs 138 kV section of the Hillsboro – Millbrook Park 138 kV circuit (see Figure 3).

The requested in service date is October 1, 2020.

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 (Duke) substation to coordinate with the expanded Hillsboro 138 kV substation. As a part of the Impact Study, PJM will coordinate with Duke to identify the scope and cost to replace relays or upgrade relay settings at the remote end substations. The Interconnection Customer can expect to see a similar cost as AEP's estimate	**To be provided by Duke**
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. As a part of the Impact Study, PJM will coordinate with DP&L to identify the scope and cost to replace relays or upgrade relay settings at the remote end substations. The Interconnection Customer can expect to see a similar cost as AEP's estimate	**To be provided by DP&L**
Total	**$675,000**

Table 1

Secondary Point of Interconnection (Hillsboro – Sinking Springs 138 kV)

To accommodate the interconnection on the Hillsboro – Sinking Springs 138 kV section of the Hillsboro – Millbrook Park 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.

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

The Generation Interconnection Agreement does not in or by itself establish a requirement for American Electric Power to provide power for consumption at the developer's facilities. A separate agreement may be reached with the local utility that provides service in the area to ensure that infrastructure is in place to meet this demand and proper metering equipment is installed. It is the responsibility of the developer to contact the local service provider to determine if a local service agreement is required.

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 AC1-144 was evaluated as a 100.0 MW (Capacity 67.3 MW) injection at the Hillsboro 138kV substation in the AEP area. Project AC1-144 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC1-144 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
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

Option 1	
Contingency Name	**Description**
	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
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
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

Option 1	
Contingency Name	**Description**
	END
P7-1..C5 4524FOSTRSUGRCRK34598FOSTERBATH	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

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)

AC1-144 Multiple Facility Contingency

#	Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Cir.	PF	Loading Initial	Loading Final	Rating Type	Rating MVA	MW Con.	FG App.
1	DCTL	P7-1..C5 4524FOSTRSUGRCRK34598FOSTERBATH	AEP - DAY	05HILLSB-09MIDDLE 138 kV line	243019	253111	1	DC	97.56	105.66	ER	185	14.99	1
2	DCTL	P7-1..C5 4524FOSTRSUGRCRK34598FOSTERBATH	DAY - DAY	09MIDDLE-09OHH 138 kV line	253111	253057	1	DC	95.29	103.39	ER	185	14.99	2

Table 3

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.

AC1-144 Contribution to Previously Identified Overloads

#	Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Cir.	PF	Loading Initial	Loading Final	Rating Type	Rating MVA	MW Con.	FG App.
1	LFFB	8107_C2_05HILLSB 138-C_B	AEP - AEP	05HILLSB-05SINKG8 138 kV line	243019	243102	1	DC	102.68	121.84	ER	185	35.43	3

2	LFFB	8107_C2_05HILLSB 138-C_A	AEP - AEP	05HILLSB-05SINKG8 138 kV line	243019	243102	1	DC	102.63	121.78	ER	185	35.43	
3	LFFB	8108_C2_05HILLSB 138-D	AEP - AEP	05HILLSB-05SINKG8 138 kV line	243019	243102	1	DC	101.81	120.67	ER	185	34.89	
4	DCTL	7981	AEP - AEP	05HILLSB-05SINKG8 138 kV line	243019	243102	1	DC	101.81	120.67	ER	185	34.89	
5	LFFB	8107_C2_05HILLSB 138-C_A	AEP - DEO&K	05HILLSB-08CLINCO 138 kV line	243019	249995	1	DC	134.51	154.27	ER	184	36.37	4
6	LFFB	8107_C2_05HILLSB 138-C_B	AEP - DEO&K	05HILLSB-08CLINCO 138 kV line	243019	249995	1	DC	134.51	154.27	ER	184	36.37	
7	LFFB	8109_C2_05HILLSB 138-A	AEP - DEO&K	05HILLSB-08CLINCO 138 kV line	243019	249995	1	DC	124.49	143.87	ER	184	35.66	
8	LFFB	8115_C2_05HIGHLA 138-_MOAB	AEP - DEO&K	05HILLSB-08CLINCO 138 kV line	243019	249995	1	DC	101.14	116.94	ER	184	29.08	
9	LFFB	7350_C2_05HIGHLA 138-_WOMOAB	AEP - DEO&K	05HILLSB-08CLINCO 138 kV line	243019	249995	1	DC	101.14	116.94	ER	184	29.08	
10	LFFB	8107_C2_05HILLSB 138-C_B	AEP - AEP	05SINKG8-05MILLBR 138 kV line	243102	243042	1	DC	104.67	123.91	ER	179	35.43	5
11	LFFB	8107_C2_05HILLSB 138-C_A	AEP - AEP	05SINKG8-05MILLBR 138 kV line	243102	243042	1	DC	104.67	123.91	ER	179	35.43	
12	LFFB	8108_C2_05HILLSB 138-D	AEP - AEP	05SINKG8-05MILLBR 138 kV line	243102	243042	1	DC	103.58	122.76	ER	179	34.89	
13	DCTL	7981	AEP - AEP	05SINKG8-05MILLBR 138 kV line	243102	243042	1	DC	103.58	122.76	ER	179	34.89	
14	LFFB	8108_C2_05HILLSB 138-D	AEP - AEP	05HIGHLA 138/69 kV transformer	246911	243606	3	DC	126.65	138.9	ER	122	14.94	6
15	DCTL	7981	AEP - AEP	05HIGHLA 138/69 kV transformer	246911	243606	3	DC	126.65	138.9	ER	122	14.94	
16	LFFB	8109_C2_05HILLSB 138-A	AEP - AEP	05HIGHLA 138/69 kV transformer	246911	243606	3	DC	119.15	131.12	ER	122	14.6	
17	LFFB	8107_C2_05HILLSB 138-C_A	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	249995	250122	1	DC	111.49	129.86	ER	198	36.37	7
18	LFFB	8107_C2_05HILLSB 138-C_B	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	249995	250122	1	DC	111.44	129.81	ER	198	36.37	
19	LFFB	8109_C2_05HILLSB 138-A	DEO&K - DEO&K	08CLINCO-08WARRN1 138 kV line	249995	250122	1	DC	102.17	120.18	ER	198	35.66	

Table 4

Steady-State Voltage Requirements

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.

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.

AC1-144 Delivery of Energy Portion of Interconnection Request

	Contingency			Bus					Loading		Rating			
#	Type	Name	Affected Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type	MVA	MW Con.	FG App.
1	N-1	7342_B2_TOR72022 68	AEP - DEO&K	05HILLSB-08CLINCO 138 kV line	243019	249995	1	DC	101.03	116.83	ER	184	29.08	
2	Non	Non	AEP - DEO&K	05HILLSB-08CLINCO 138 kV line	243019	249995	1	DC	92.55	106.68	NR	159	22.48	
3	N-1	P2-1..LOE BRKR OPEN AT HILLSBORO AEP 2381	AEP - DAY	05HILLSB-09MIDDLE 138 kV line	243019	253111	1	DC	90.54	101.11	ER	185	19.54	
4	N-1	P2-1..LOE BRKR OPEN AT HILLSBORO AEP 2381	AEP - AEP	05HIGHLA 138/69 kV transformer	246911	243606	3	DC	104.09	113.8	ER	122	11.86	

Table 5

New System Reinforcements

#	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
#1	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**
#2	05HILLSB-08CLINCO 138 kV line	AEP owns 17.5 miles of line between Hillsboro and Clinton County. This line will have to be reconductored or rebuilt because a Sag Study will only increase the capability of this line to 257 MVA which is not sufficient.	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**

#	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
		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.		
#3	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**
#4	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.	**$60,000**
#5	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	**$27,914,200**

Table 6

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 100.0 MW (67.3 MW Capacity) solar generating facility of The Interconnection Customer (PJM Project #AC1-144) 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 The Interconnection Customer 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 (Duke) 138 kV substation to coordinate with the expanded Hillsboro 138 kV substation.	**To be provided by Duke**
	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.	**To be provided by DP&L**
	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.	**$15,000**

	AEP owns 17.5 miles of line between Hillsboro and Clinton County. This line will have to be reconductored 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.	**$26,200,000**
	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	**$89,200**
	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. 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.	**$60,000**
	Replace the 138/69 kV Transformer #3 at Highland	**$1,500,000**
	Total Estimated Cost for Project AC1-144	**$31,639,200**

Table 7

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 AC1-144 was evaluated as a 100.0 MW (Capacity 67.3 MW) injection tapping the Hillsboro-Sinking Springs 138kV line in the AEP area. Project AC1-144 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC1-144 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**
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 05CORNU 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
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 2	
Contingency Name	**Description**
P04	CONTINGENCY 'P04' DISCONNECT BUS 200122 /* DISCONNECT BUS 200192 /* DISCONNECT BUS 200193 /* DISCONNECT BUS 200194 /* DISCONNECT BUS 200195 /* END

Table 8

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)

AC1-144 Contribution to Previously Identified Overloads															
	Contingency		Affected Area	Facility Description	Bus		Cir.	PF	Loading		Rating		MW Con.	FG App.
#	Type	Name			From	To			Initial	Final	Type	MVA		
1	N-1	363_B2_TOR1682	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	DC	171.64	171.64	ER	1370	0	1
2	Non	Non	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	DC	118.34	118.34	NR	1134	0	
3	N-1	4812_B2_TOR8931	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	DC	104.65	104.65	ER	1370	0	
4	Non	Non	MISO AMIL - MISO AMIL	7NEWTON-7CASEY 345 kV line	347830	346809	1	DC	108.77	108.77	NR	1200	0	2

5	LFFB	H1TH3	MISO AMIL - MISO AMIL	7NEWTON-7CASEY 345 kV line	347830	346809	1	DC	104.67	104.67	ER	1319	0	
6	N-1	P04	MISO AMIL - MISO AMIL	7NEWTON-7CASEY 345 kV line	347830	346809	1	DC	104.48	104.48	ER	1319	0	
7	N-1	4839_B1_05ROCK PT 765-1	MISO AMIL - MISO AMIL	7NEWTON-7CASEY 345 kV line	347830	346809	1	DC	104.31	104.31	ER	1319	0	

Table 9

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.

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.

AC1-144 Delivery of Energy Portion of Interconnection Request															
	Contingency				Bus				Loading		Rating			
#	Type	Name	Affected Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type	MVA	MW Con.	FG App.
8	N-1	363_B2_TOR1682	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	DC	182.68	182.68	ER	1370	0	
9	Non	Non	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	DC	115.08	115.08	NR	1134	0	
10	Non	Non	MISO AMIL - MISO AMIL	7NEWTON-7CASEY 345 kV line	347830	346809	1	DC	108.77	108.77	NR	1200	0	
11	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 10