Generation Interconnection System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AC1-173

Logtown 138 kV

May 2017

General

Paulding Wind Farm IV, LLC proposes to install PJM Project #AC1-173, a 75.9 MW (9.9 MW Capacity) wind generating facility in Paulding County, Ohio (see Figure 2). The point of interconnection will be a direct connection to AEP's Logtown 138 kV switching station utilizing the Generator Lead for T-131 (see Figure 1)

The requested in service date is October 31, 2019.

Attachment Facilities

Point of Interconnection (Logtown 138 kV Switching Station)

PJM project #T-131 will pay for the necessary direct connection worked required at the Logtown 138 kV switching station. No additional attachment facilities are required to accommodate the additional wind generation associated with the AC1-173 request.

Note: The proposed interconnection configuration of the Timber Road III Switching Station (see Figure 1) creates a 3-terminal line that will need additional protection schemes to make this work. The following will be required in order for this configuration to work:

- Run Fiber from the Logtown 138 kV switching station to the AC1-173 collector substation.
- Add a relay panel at the AC1-173 collector substation to coordinate with the Logtown 138 kV switching station.
- Update/Modify relay settings/scheme at the Logtown 138 kV switching station and at the Timber Road III collector station for coordination.
- Installation of high side circuit breakers are recommended at both collector substations.

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**
Upgrade the 138 kV Revenue Metering for the additional 75.9 MW of generation	**$100,000**
Total	**$100,000**

Table 1

Interconnection Customer Requirements

The cost of Paulding Wind Farm's generating plant and the costs for the line connecting the generating plant to the Timber Road III switching station are not included in this report; these are assumed to be Paulding Wind Farm's responsibility

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

Requirement from the PJM Open Access Transmission Tariff:

1. An Interconnection Customer entering the New Services Queue on or after October 1, 2012 with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

2. The Interconnection Customer may be required to install and/or pay for metering as necessary to properly track real time output of the facility as well as installing metering which shall be used for billing purposes. See Section 8 of Appendix 2 to the Interconnection Service Agreement as well as Section 4 of PJM Manual 14D for additional information.

Revenue Metering and SCADA Requirements

PJM Requirements

The Interconnection Customer will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Sections 24.1 and 24.2.

AEP Requirements

The Interconnection Customer will be required to comply with all AEP Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "Requirements for Connection of New Facilities or Changes to Existing Facilities Connected to the AEP Transmission System" document located at the following link:

http://www.pjm.com/~/media/planning/plan-standards/private-aep/aep-interconnection-requirements.ashx

Network Impacts

The Queue Project AC1-173 was evaluated as a 75.9 MW (Capacity 9.9 MW) injection into the T-131/Logtown 138 kV substation in the AEP area. Project AC1-173 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC1-173 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Base Case Used

Summer Peak Analysis – 2020 Case

Contingency Descriptions

The following contingencies resulted in overloads:

None

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:

None

Stability Analysis

No mitigations were found to be required.

Affected System Analysis & Mitigation

LGEE Impacts:

None

MISO Impacts:

None

Duke, Progress & TVA Impacts:

None

OVEC Impacts:

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.

None

Light Load Analysis - 2020

1. (AEP - AEP) The 05HAVILN-05E LIMA 138 kV line (from bus 243017 to bus 242989 ckt 1) loads from 86.43% to 87.67% (AC power flow) of its emergency rating (220 MVA) for the tower line contingency outage of '7372'. This project contributes approximately 3.22 MW to the thermal violation.

CONTINGENCY '7372'
OPEN BRANCH FROM BUS 243242 TO BUS 243383 CKT 1 / 243242 05ALLEN 138 243383 05TILLMA 138 1
OPEN BRANCH FROM BUS 243242 TO BUS 247521 CKT 1 / 243242 05ALLEN 138 247521 T-131 C 138 1
OPEN BRANCH FROM BUS 243383 TO BUS 246950 CKT 1 / 243383 05TILLMA 138 246950 05TIMBSS 138 1
OPEN BRANCH FROM BUS 243383 TO BUS 246265 CKT 1 / 243383 05TILLMA 138 246265 05TILLMAN 34.5 1
OPEN BRANCH FROM BUS 246254 TO BUS 246265 CKT 1 / 246254 05MONROEVI 34.5 246265 05TILLMAN 34.5 1
OPEN BRANCH FROM BUS 246264 TO BUS 246265 CKT 1 / 246264 05ST R14 8 34.5 246265 05TILLMAN 34.5 1
END

- Final flow at the end of the AC1 Queue is 221.6 MVA
- The limiting elements are the Haviland and East Lima Wave traps (800A)

2. (AEP - AEP) The 05HAVILN-05E LIMA 138 kV line (from bus 243017 to bus 242989 ckt 1) loads from 86.43% to 87.67% (AC power flow) of its emergency rating (220 MVA) for the line fault with failed breaker contingency outage of '7528_C2_05ALLEN 138-H'. This project contributes approximately 3.22 MW to the thermal violation.

CONTINGENCY '7528_C2_05ALLEN 138-H'

OPEN BRANCH FROM BUS 243242 TO BUS 243383 CKT 1 / 243242 05ALLEN 138 243383 05TILLMA 138 1
OPEN BRANCH FROM BUS 243242 TO BUS 247521 CKT 1 / 243242 05ALLEN 138 247521 T-131 C 138 1
OPEN BRANCH FROM BUS 243383 TO BUS 246950 CKT 1 / 243383 05TILLMA 138 246950 05TIMBSS 138 1
OPEN BRANCH FROM BUS 243383 TO BUS 246265 CKT 1 / 243383 05TILLMA 138 246265 05TILLMAN 34.5 1
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OPEN BRANCH FROM BUS 246264 TO BUS 246265 CKT 1 / 246264 05ST R14 8 34.5 246265 05TILLMAN 34.5 1
END

- Final flow at the end of the AC1 Queue is 221.6 MVA
- The limiting elements are the Haviland and East Lima Wavetraps (800A)

Light Load Load Flow Analysis Reinforcements

New System Reinforcements

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

- Replace the Haviland and East Lima wave traps. Estimated Cost: $100,000.

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.

Conclusion

Based upon the results of this System Impact Study, the construction of the 75.9 MW (9.9 MW Capacity) wind generating facility of Paulding Wind Farm (PJM Project #AC1-173) will require additional interconnection charges. This plan of service will interconnect the proposed wind generating facility in a manner that will provide operational reliability and flexibility to both the AEP system and the Paulding Wind Farm generating facility.

Cost Breakdown for Point of Interconnection (Logtown 138 kV Switching Station)			
Type of Network Upgrade	**Network Upgrade Number**	**Description**	**Estimated Cost**
Attachment Cost		PJM project #T-131 will pay for the necessary direct connection worked required at the Logtown 138 kV switching station.	N/A
Non-Direct Connection Cost Estimate	**n5648**	Upgrade the 138 kV Revenue Metering for the additional 75.9 MW of generation	$100,000
	n5474	Replace the East Lima and Haviland wave traps	$100,000
		Total Estimated Cost for Project AC1-173	**$200,000**

Table 4

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.

Figure 1: Point of Interconnection (Logtown 138 kV Switching Station)

Single-Line Diagram

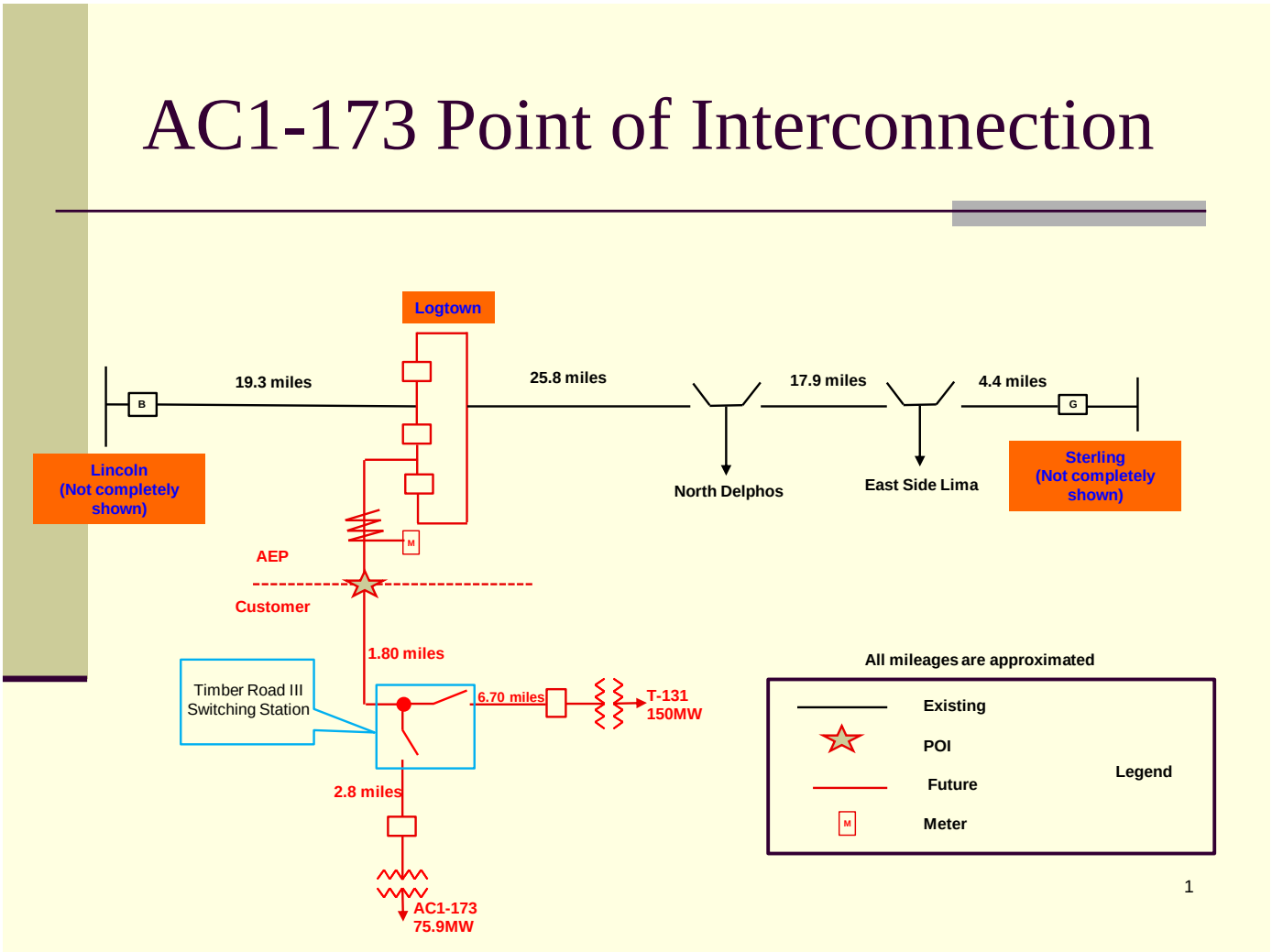
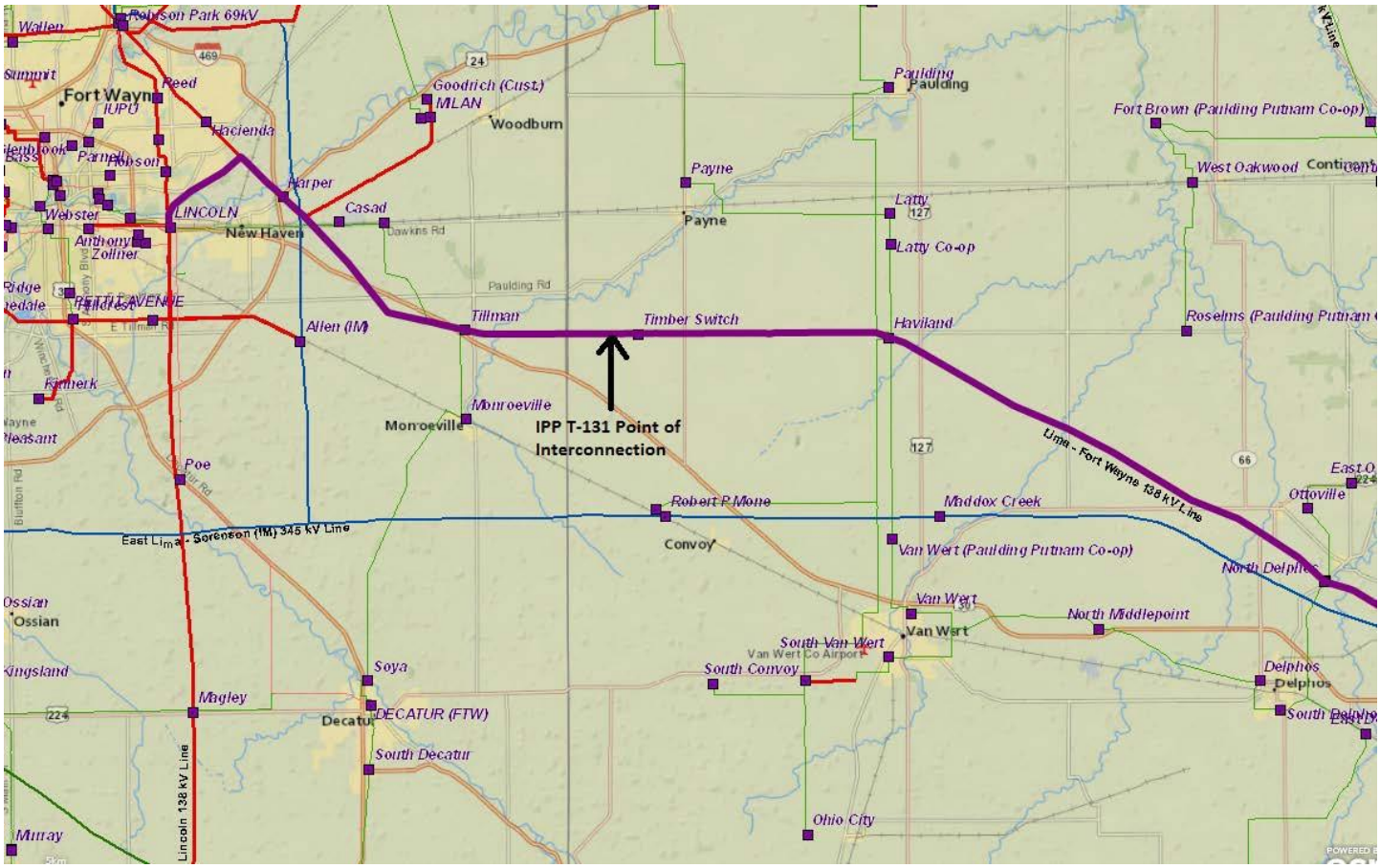


Figure 2: Point of Interconnection (Logtown 138 kV Switching Station)



Appendices for Light Load Contingency Violation

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 05HAVILN-05E LIMA 138 kV line (from bus 243017 to bus 242989 ckt 1) loads from 87.67% to 100.73% (AC power flow) of its emergency rating (220 MVA) for the tower line contingency outage of '7372'. This project contributes approximately 29.01 MW to the thermal violation.

CONTINGENCY '7372'
OPEN BRANCH FROM BUS 243242 TO BUS 243383 CKT 1 / 243242 05ALLEN 138 243383 05TILLMA 138 1
OPEN BRANCH FROM BUS 243242 TO BUS 247521 CKT 1 / 243242 05ALLEN 138 247521 T-131 C 138 1
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OPEN BRANCH FROM BUS 246264 TO BUS 246265 CKT 1 / 246264 05ST R14 8 34.5 246265 05TILLMAN 34.5 1
END

Bus Number	*Bus Name*	*Full Contribution*
246953	*05TIMB G C*	*2.04*
247911	*05TIMB G E*	*8.22*
247534	*R-048 C*	*0.33*
247928	*R-048 E*	*1.31*
247521	*T-131 C*	*1.27*
247925	*T-131 E*	*5.1*
247607	*V1-011 C*	*6.42*
247959	*V1-011 E*	*42.99*
247608	*V1-012 C*	*9.64*
247960	*V1-012 E*	*64.49*
926521	*AC1-173 C*	*0.42*
926522	*AC1-173 E*	*2.8*