Generator Interconnection
System Impact Study Report

For

PJM Generation Interconnection Request
Queue Position #AB2-170

East Lima-Marysville 345 kV

November 2017

General

Invenergy Solar Development, LLC proposes to install PJM Project #AB2-170, a 130.0 MW (49.4 MW Capacity) solar generating facility in Hardin County, OH (see Figure 2). The generating facility will consist of thirty-seven (37) 4.0 MVA inverters. The point of interconnection for the generating facility will be to interconnect to the proposed Hardin Switch 345 kV switching station connecting to AEP's East Lima – Marysville 345 kV line being built for PJM Project #U2-041 (See Figure 1).

The requested Backfeed date is October 31, 2018.
The requested in-service date is December 31, 2018.

The objective of this System Impact Study is to determine budgetary cost estimates and approximate construction timelines for identified transmission facilities required to connect the proposed generating facilities to the AEP Transmission System. These reinforcements include the Attachment Facilities, Local Upgrades, and Network Upgrades required to maintain the reliability of the AEP Transmission System. Stability analysis is included as part of this study.

Attachment Facilities

Point of Interconnection (East Lima – Marysville 345 kV Line)

To accommodate the interconnection at the proposed Hardin Switch 345 kV substation for U2-041, the substation will have to be expanded requiring the installation of one (1) new 345 kV circuit breaker. Installation of associated protection and control equipment, SCADA, and 345 kV revenue metering will also be required.

New Switching Station Work and Cost:

- Expand the proposed Hardin Switch 345 kV substation; install one (1) new 345 kV circuit breaker (see Figure 1). Installation of associated protection and control equipment, SCADA, and 345 kV revenue metering will also be required.
- **Estimated Station Cost: $2,000,000 (Network Upgrade n5428)**
- **Estimated 345 kV Revenue Metering Cost: $250,000 (Network Upgrade n5429)**

Protection and Relay Work and Cost:

- Install line protection and controls at the proposed Hardin Switch 345 kV Switching Station.
- **Estimated Cost: $200,000 (Network Upgrade n5429)**
- Adjust relay settings at the Marysville 345 kV substation.

- **Estimated Cost: $25,000 (Network Upgrade n5430)**
- Adjust relay settings at the East Lima 345 kV substation.
- **Estimated Cost: $25,000 (Network Upgrade n5431)**

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

Local and Network Impacts for the Point of Interconnection

The impact of the proposed generating facility on the AEP System was assessed for adherence with applicable reliability criteria. AEP planning criteria require that the transmission system meet performance parameters prescribed in the AEP FERC Form 715[1] and Connection Requirements for AEP Transmission System[2]. Therefore, these criteria were used to assess the impact of the proposed facility on the AEP System. The Queue Project AB2-170 was evaluated as a 130.0 MW (Capacity 49.4 MW) injection into the U2-041/U2-072/V3-028 345 kV substation (which is a tap of the East Lima – Marysville 345 kV line) in the AEP area. Project AB2-170 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AB2-170 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Analysis - 2020

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

None

Multiple Facility Contingency

1 https://www.aep.com/about/codeofconduct/OASIS/TransmissionStudies/docs/2017/AEP_East%20FERC%20715_2017_Final_Part%204.pdf

2 https://www.aep.com/about/codeofconduct/OASIS/TransmissionStudies/Requirements/AEP_Interconnection_Requirements_rev1.pdf

(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

Short Circuit
(Summary of impacted circuit breakers)

None

Stability Analysis

No problems identified

Voltage Variations

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.
Only the most severely overloaded conditions are listed. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed, which will study all overload conditions associated with the overloaded element(s) identified.

None

Additional Limitations of Concern

None

Light Load Analysis

Not required

System Reinforcements

None

Schedule

It is anticipated that the time between receipt of executed agreements and Commercial Operation may range from 18 to 24 months if no line work is required. If line work is required, construction time would be between 36 to 48 months after signing an interconnection agreement.

Conclusion

Based upon the results of this System Impact Study, the construction of the 130.0 MW (49.4 MW Capacity) solar generating facility of Invenergy Solar (PJM Project #AB2-170) 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 Invenergy Solar generating facility.

Cost Breakdown for Point of Interconnection (East Lima-Marysville 345 kV)			
Category	**Task**	**Network Upgrade #**	**Estimated Cost**
Attachment Cost	Expand Hardin Switch 345 kV Switching Station	**n5428**	**$2,000,000**
Non-Direct Connection Cost Estimate	345 kV Revenue Metering	**n5429**	**$250,000**
	Install line protection and controls at the Hardin Switch 345 kV switching station.	**n5428**	**$200,000**
	Adjust relay settings at the Marysville 345 kV substation	**n5430**	**$25,000**
	Adjust relay settings at the East Lima 345 kV substation	**n5431**	**$25,000**
	Total Estimated Cost for Project AB2-170		**$2,500,000**

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.

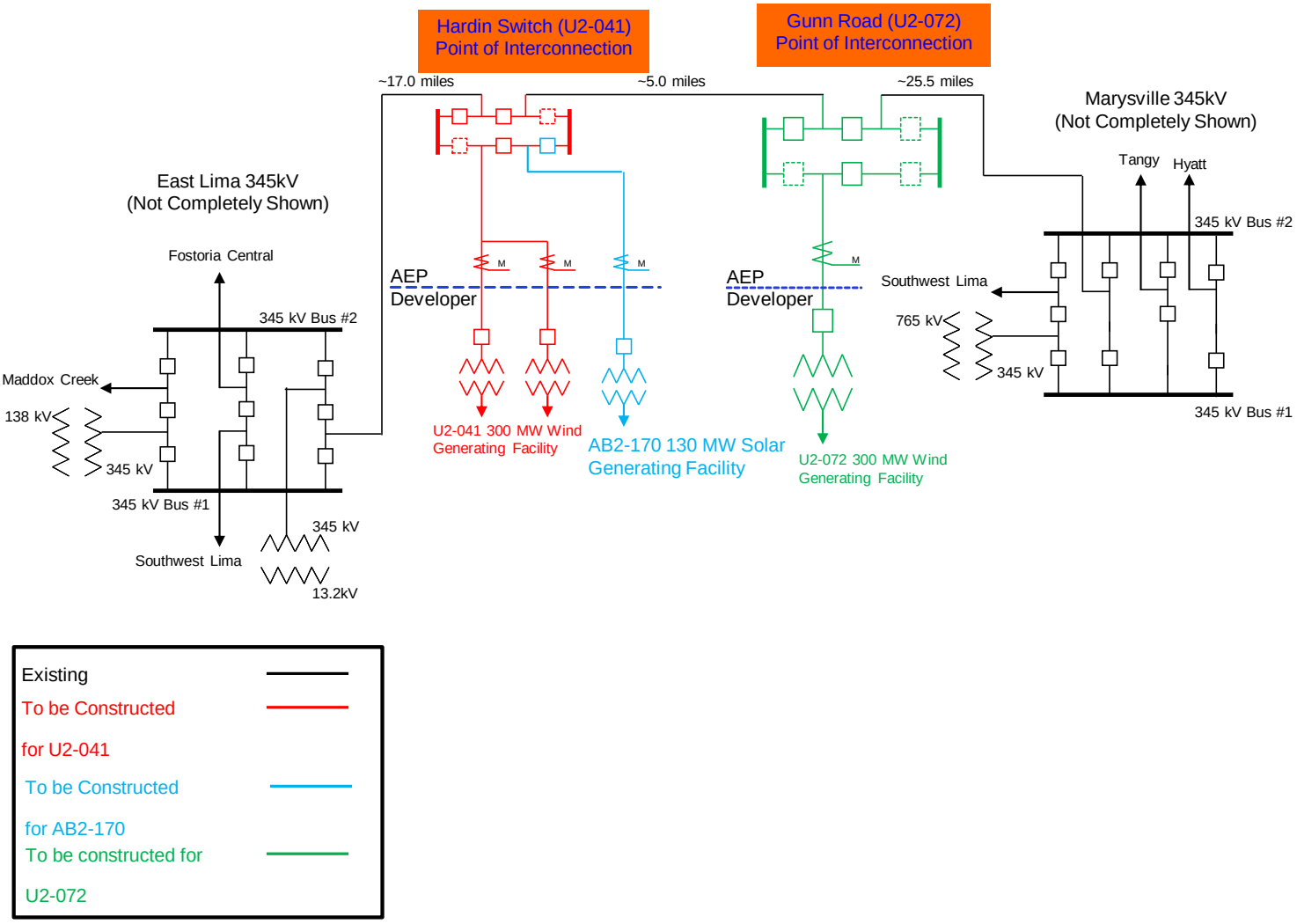

Figure 1: Point of Interconnection (East Lima - Marysville 345 kV Line) Single-Line Diagram

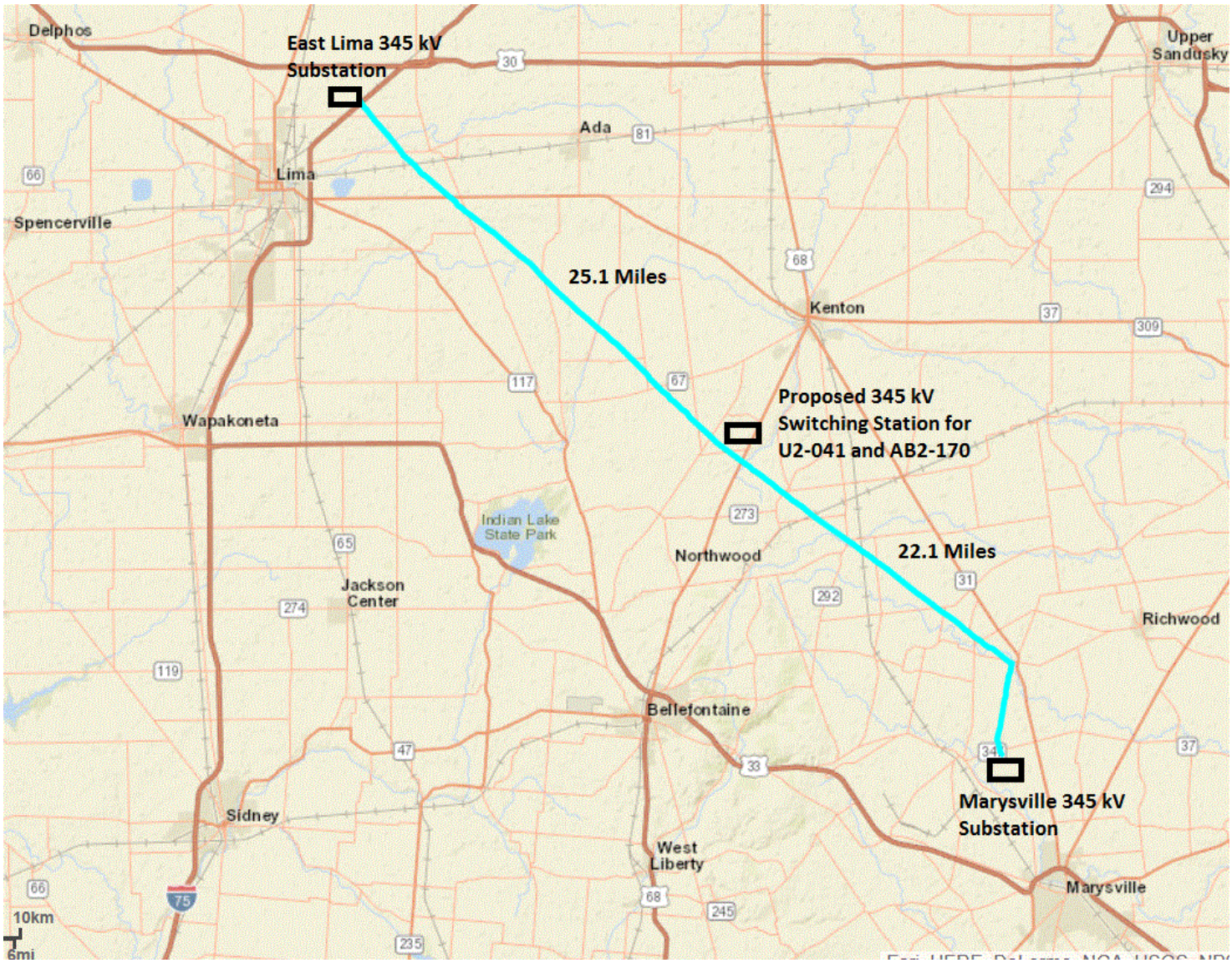

Figure 2: Point of Interconnection (East Lima – Marysville 345 kV Line)

Attachment 1 – Stability Analysis