Generation Interconnection System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AC1-089

Wildcat 138 kV

March 2018

Preface

The intent of the System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. 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. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

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 or merchant transmission upgrade, may also contribute to the need for the same network reinforcement.

The System Impact 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

Willowbrook Solar, LLC proposes to install PJM Project #AC1-089, a 150.0 MW (57.0 MW Capacity) solar generating facility in Highland County, Ohio (see Figure 2). The point of interconnection will be a direct connection to AEP's Wildcat 138 kV substation (see Figure 1).

The requested backfeed date is September 1, 2019.

The requested in service date is October 1, 2019.

Attachment Facilities

Point of Interconnection (Wildcat 138 kV)

To accommodate the interconnection at the Wildcat 138 kV substation, the Wildcat substation will have to be expanded requiring two (2) additional 138 kV circuit breakers to physically configure the substation in a breaker and half bus arrangement (see Figure 2). Installation of associated protection and control equipment, 138 kV line risers, SCADA, and 138 kV revenue metering will also be required.

New Switching Station Work:

- Expand the Wildcat 138 kV substation; the Wildcat substation will have to be expanded requiring two (2) additional 138 kV circuit breakers to physically configure the substation in a breaker and half bus arrangement (see Figure 2). 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	$250,000
Upgrade line protection and controls at the expanded Wildcat 138 kV substation.	$250,000
Upgrade line protection and controls at the Hillsboro 138 kV substation.	$250,000
Upgrade line protection and controls at the Kenton 138 kV substation.(This estimate needs to be confirmed by LGEE)	250,000

Description	Estimated Cost
Total	**$1,000,000**

Table 1

Interconnection Customer Requirements

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

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 AC1-089 was evaluated as a 150.0 MW (Capacity 57.0 MW) injection into the Wildcat 138 kV substation in the AEP area. Project AC1-089 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC1-089 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:

Option 1	
Contingency Name	**Description**
349_B2_TOR21	CONTINGENCY '349_B2_TOR21' OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 1 / 242528 05SPORN 345 248005 06KYGER 345 1 END
892_B2	CONTINGENCY '892_B2' OPEN BRANCH FROM BUS 253014 TO BUS 253077 CKT 1 / 253014 09CLINTO 345 253077 09STUART 345 1 END
P1-#..B2 SPURLOCK-STUART 34553	CONTINGENCY 'P1-#..B2 SPURLOCK-STUART 34553' OPEN BRANCH FROM BUS 253077 TO BUS 342838 CKT 1 END
P7-1..C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK	CONTINGENCY 'P7-1..C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK' OPEN BRANCH FROM BUS 342838 TO BUS 249581 CKT 1 OPEN BRANCH FROM BUS 253077 TO BUS 342838 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)

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Cir.	PF	Loading Initial	Loading Final	Rating Type	Rating MVA	MW Con.
1	DCTL	P7-1..C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK	AEP - AEP	05WLDCAT-05HILLSB 138 kV line	246946	243019	1	AC	83.48	137.51	ER	185	100.47

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)

None

Steady-State Voltage Requirements

(Results of the steady-state voltage studies should be inserted here)

None

Short Circuit

(Summary of impacted circuit breakers)

None

Stability and Reactive Power Requirement

(Results of the dynamic studies should be inserted here)

No problems identified

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:

None

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.

Contingency					Bus				Loading		Rating		
#	Type	Name	Affected Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type	MVA	MW Con.
1	N-1	8468_B2	OVEC - AEP	06KYGER-05SPORN 345 kV line	248005	242528	1	AC	135.81	136.94	NR	1017	13.0
2	N-1	349_B2_TOR21	OVEC - AEP	06KYGER-05SPORN 345 kV line	248005	242528	2	AC	135.81	136.94	NR	971	13.0
3	N-1	P1-#..B2 SPURLOCK-STUART 34553	AEP - AEP	05WLDCAT-05HILLSB 138 kV line	246946	243019	1	AC	57.37	111.54	ER	185	99.09

Table 4

Note: The Kyger – Sporn 345 kV overload identified in Table 4 will be addressed by baseline project B2832.

New System Reinforcements

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

#	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
#1	WILDCAT-HILLSBORO 138 kV line	A sag check will be required for the 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 10.0 mile section of line would need to be rebuilt. If section 1of the line needs to be reconductored the minimum estimated cost will ~ $10,000,000. It will be more if the line needs to be rebuilt.	An approximate time for the sag study is 6 to 12 months after signing an interconnection agreement.	**$40,000**
			Total New Network Upgrades	**$40,000**

Table 5

Contribution to Previously Identified System Reinforcements
(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)
(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

None

Schedule

It is anticipated that the time between receipt of executed agreements and Commercial Operation may range from 12 to 18 months if no line work is required. If line work is required, construction time would be between 24 to 36 months after signing an interconnection agreement.

Note: The time provided between anticipated normal completion of System Impact, Facilities Studies, subsequent execution of ISA and ICSA documents, and the proposed Backfeed Date is shorter than usual and may be difficult to achieve.

Conclusion

Based upon the results of this System Impact Study, the construction of the 150.0 MW (57.0 MW Capacity) solar generating facility of Willowbrook Solar (PJM Project #AC1-089) 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 Willowbrook Solar generating facility.

Cost Breakdown for Point of Interconnection (Wildcat 138 kV Substation)			
	Network Upgrade Number	**Description**	**Estimated Cost**
Non-Direct Connection Cost Estimate	**n5582**	Expand the Wildcat 138 kV Substation	$3,000,000
	n5578	138 kV Revenue Metering	$250,000
	n5579	Upgrade line protection and controls at the expanded Wildcat 138 kV substation.	$250,000
	n5580	Upgrade line protection and controls at the Hillsboro 138 kV substation.	$250,000

Cost Breakdown for Point of Interconnection (Wildcat 138 kV Substation)			
	n5580	Upgrade line protection and controls at the Kenton 138 kV substation.	$250,000
	n5472	Sag Study for section 1of the Wildcat to Hillsboro 138 kV Line	$40,000
		Total Estimated Cost for Project AC1-089	**$4,040,000**

Table 6

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.

Figure 1: Point of Interconnection (Wildcat 138 kV)

Single-Line Diagram

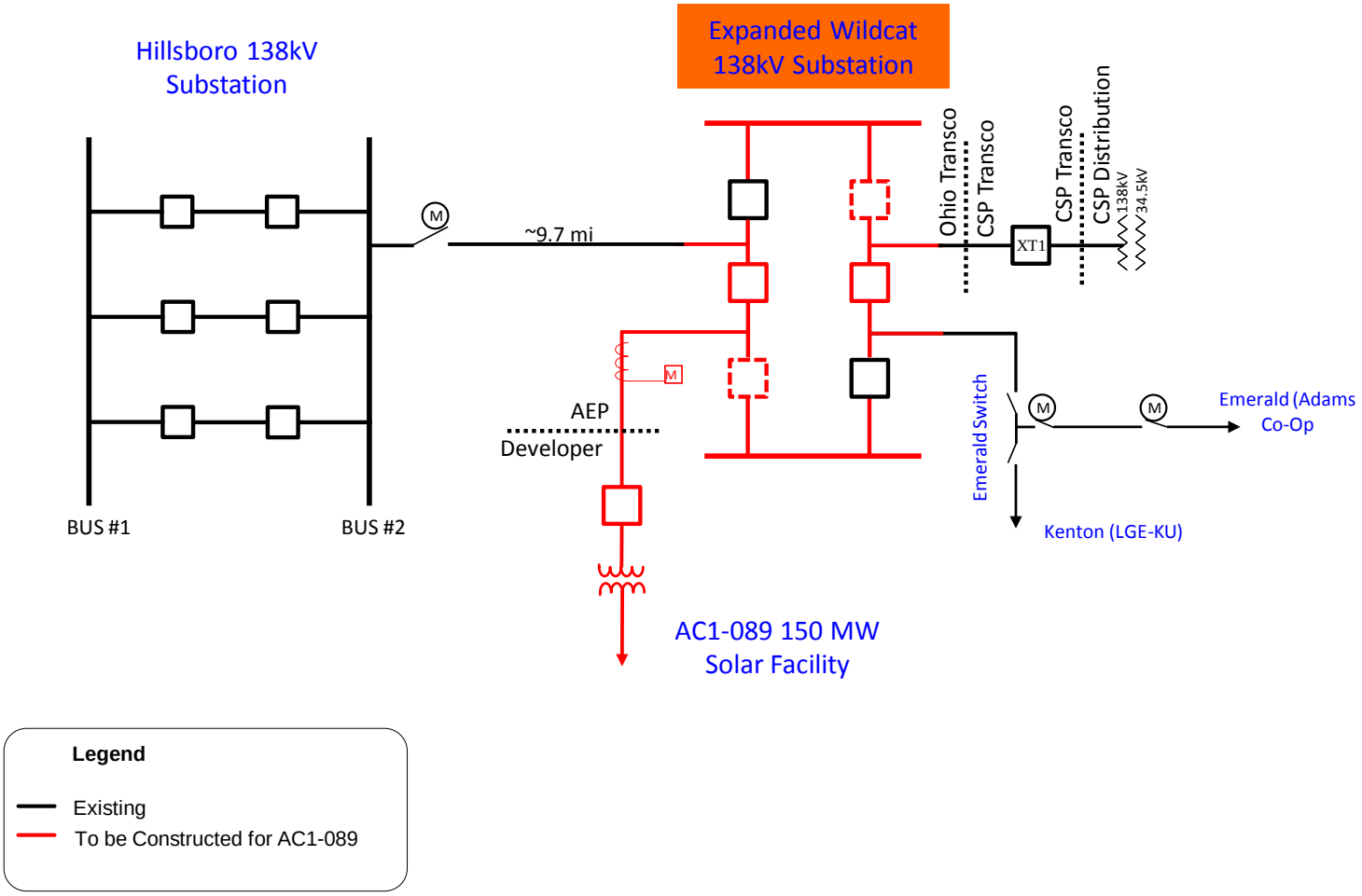

Figure 2: Point of Interconnection (Wildcat 138 kV)