Generation Interconnection System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AC2-059

Biers Run - Circleville 138kV

December 2019

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

First Solar Development, LLC proposes to install PJM Project #AC2-059, a 127.00 MW (62.5 MW Capacity) solar generating facility in Ross County, Ohio (see Figure 3). The point of interconnection is to AEP's Biers Run – Circleville 138 kV circuit (see Figure 1).

The requested in service date is December 31, 2019.

Attachment Facilities

Point of Interconnection (Biers Run - Circleville 138 kV substation)

To accommodate the interconnection on the Biers Run – Circleville 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 1). 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.

<u>New Switching Station Work:</u>

- Construct 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. Installation of associated protection and control equipment, 138 kV line risers, SCADA, and 138 kV revenue metering will also be required (see Figure 1).
    - **Estimated Station Cost: $6,000,000**

Direct Connection Cost Estimate

The total preliminary cost estimate for Direct Connection work is given in the following tables below.

For AEP building Direct Connection cost estimates:

Description	Total Cost
Biers Run – Circleville 138 kV T-Line Cut In	**$1,000,000**
Total	**$1,000,000**

Table 1

Non-Direct Connection Cost Estimate

The total preliminary cost estimate for Non-Direct Connection work is given in the following table below:

For AEP building Non-Direct Connection cost estimates:

Description	Estimated Cost
138 kV Revenue Metering	**$250,000**
Upgrade line protection and controls at the Biers Run 138 kV substation.	**$250,000**
Upgrade line protection and controls at the Circleville 138 kV substation.	**$250,000**
Total	**$750,000**

Table 2

Interconnection Customer Requirements

It is understood that First Solar Development is responsible for all costs associated with this interconnection. The cost of First Solar Development's generating plant and the costs for the line connecting the generating plant to the new proposed 138 kV switching station are not included in this report; these are assumed to be First Solar Development'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 AC2-059 was evaluated as a 127.0 MW (Capacity 62.5 MW) injection into a tap of the Biers Run – Circleville 138 kV line in the AEP area. Project AC2-059 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC2-059 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

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

1. (AEP - AEP) The 05HARRIS-05OBETZ 138 kV line (from bus 243522 to bus 243550 ckt 1) loads from 98.94% to 109.15% (AC power flow) of its emergency rating (179 MVA) for the line fault with failed breaker contingency outage of '8094_C2_05BIXBY 345-303C'. This project contributes approximately 18.01 MW to the thermal violation.

CONTINGENCY '8094_C2_05BIXBY 345-303C'
OPEN BRANCH FROM BUS 243453 TO BUS 243454 CKT 1 / 243453 05BEATTY 345 243454 05BIXBY 345 1
OPEN BRANCH FROM BUS 246888 TO BUS 243454 CKT 1 / 246888 05BIERSR 345 243454 05BIXBY 345 1
END

Please refer to Appendix 1 for a table containing the generators having contribution to this flowgate.

2. (AEP - AEP) The 05HARRIS-05OBETZ 138 kV line (from bus 243522 to bus 243550 ckt 1) loads from 98.94% to 109.15% (AC power flow) of its emergency rating (179 MVA) for the tower line contingency outage of '6783'. This project contributes approximately 18.01 MW to the thermal violation.

CONTINGENCY '6783'
OPEN BRANCH FROM BUS 243453 TO BUS 243454 CKT 1 / 243453 05BEATTY 345 243454 05BIXBY 345 1
OPEN BRANCH FROM BUS 246888 TO BUS 243454 CKT 1 / 246888 05BIERSR 345 243454 05BIXBY 345 1

END

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)

New circuit breakers found to be over-duty:

The 138 kV Circuit Breaker 6C at the Harrison 138 kV substation was found to be over-duty but will be mitigated by an existing baseline upgrade B2070.

Stability and Reactive Power Requirement

(Results of the dynamic studies should be inserted here)

No problems identified

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.
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.

1. (AEP - AEP) The 05HARRIS-05OBETZ 138 kV line (from bus 243522 to bus 243550 ckt 1) loads from 91.2% to 101.31% (AC power flow) of its emergency rating (179 MVA) for the single line contingency outage of '6763_B2_TOR5200548'. This project contributes approximately 17.8 MW to the thermal violation.

CONTINGENCY '6763_B2_TOR5200548'
OPEN BRANCH FROM BUS 246888 TO BUS 243454 CKT 1 / 246888 05BIERSR 345 243454 05BIXBY 345 1
END

New System Reinforcements

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

1. To relieve the Harrison – Obetz 138 kV line overloads:

   The flow at the end of the AC2 queue is 196 MVA. The overload is driven in the AC2 Queue. Upgrade the Harrison bus work from circuit breaker switches to wavetrap. Cost estimate is $200K. Time estimate is 12 months. PJM Network Upgrade N5526.

   The cost allocation is as follows:

Queue	MW contribution	Percentage of Cost	$ cost ($200 K)
AC2-029	14.1	43.93%	87.850
AC2-059	18.0	56.07%	112.150

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)

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 In-Service 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 127.00 MW (62.5 MW Capacity) solar generating facility of First Solar Development (PJM Project #AC2-059) will require the following additional interconnection charges. This plan of service will interconnect the proposed generating facility in a manner that will provide operational reliability and flexibility to both the AEP system and the First Solar Development generating facility.

Cost Breakdown for Point of Interconnection (Biers Run – Circleville 138 kV)		
Attachment Cost	New 138 kV Switching Station	**$6,000,000**
Direct Connection Cost Estimate	Biers Run - Circleville 138 kV T-Line Cut In	**$1,000,000**
Non-Direct Connection Cost Estimate	138 kV Revenue Metering	**$250,000**
	Upgrade line protection and controls at the Biers Run 138 kV substation.	**$250,000**
	Upgrade line protection and controls at the Circleville 138 kV substation.	**$250,000**
	New System Reinforcements	**$112,150**
	Total Estimated Cost for Project AC2-059	**$7,862,150**

Table 8

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.

Appendices

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 05HARRIS-05OBETZ 138 kV line (from bus 243522 to bus 243550 ckt 1) loads from 98.94% to 109.15% (AC power flow) of its emergency rating (179 MVA) for the line fault with failed breaker contingency outage of '8094_C2_05BIXBY 345-303C'. This project contributes approximately 18.01 MW to the thermal violation.

CONTINGENCY '8094_C2_05BIXBY 345-303C'
OPEN BRANCH FROM BUS 243453 TO BUS 243454 CKT 1 / 243453 05BEATTY 345 243454 05BIXBY 345 1
OPEN BRANCH FROM BUS 246888 TO BUS 243454 CKT 1 / 246888 05BIERSR 345 243454 05BIXBY 345 1
END

Bus Number	*Bus Name*	*Full Contribution*
932201	*AC2-029 C*	*5.37*
932202	*AC2-029 E*	*8.76*
932411	*AC2-059 C O1*	*8.86*
932412	*AC2-059 E O1*	*9.14*
924351	*AB2-083 C OP*	*2.83*
924352	*AB2-083 E OP*	*1.33*
926001	*AC1-001 C OP*	*5.65*
926002	*AC1-001 E OP*	*2.66*
928211	*AC1-210 C OP*	*8.9*
928212	*AC1-210 E OP*	*4.02*

Figure 1: Point of Interconnection (Biers Run – Circleville 138kV)

Single Line Diagram

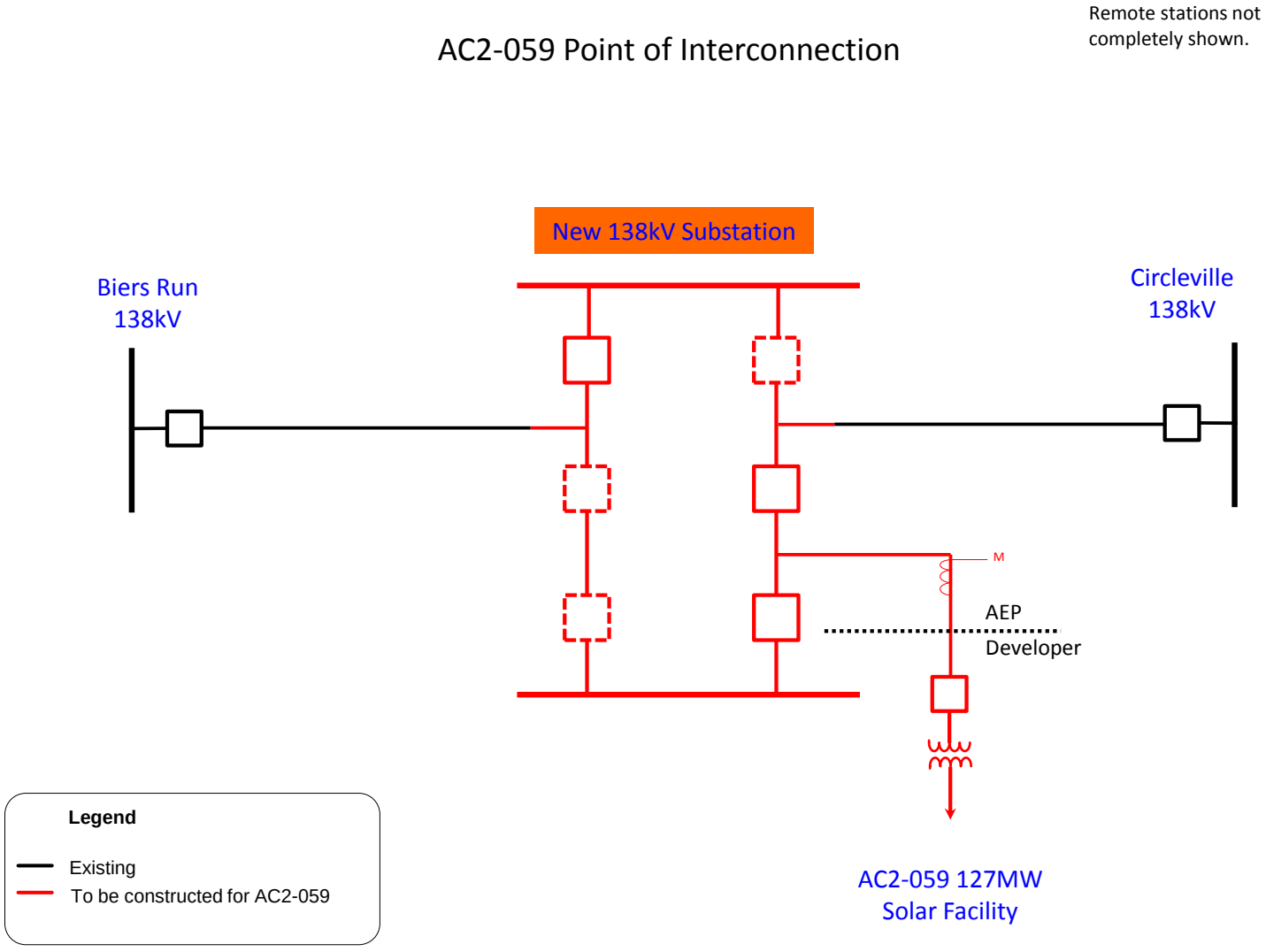

Figure 3: Point of Interconnection Map