Generation Interconnection System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AC2-060

Buckskin 69kV

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 #AC2-060, a 100.0 MW (64.0 MW Capacity) solar generating facility in Ross County, Ohio (see Figure 1). The point of interconnection is a direct connection to AEP's Buckskin 69 kV substation.

The requested in service date is December 31, 2019.

Attachment Facilities

Primary Point of Interconnection (Buckskin 69kV substation)

To accommodate the interconnection at the Buckskin 69 kV substation, the substation will have to be expanded requiring the installation of two (2) 69 kV circuit breakers (see Figure 1). Installation of associated protection and control equipment, 69 kV line risers, SCADA, and 69 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.

Direct Connection at the Buckskin 69 kV Substation Work and Cost:

- Expand the substation requiring the installation of two (2) new 69 kV circuit breakers (see Figure 1). Installation of associated protection and control equipment, 69 kV line risers, SCADA, and 69 kV revenue metering will also be required.
- **Estimated Station Cost: $1,500,000**
- **Note:** The Interconnection Customer may be required to go offline for routine circuit breaker maintenance.

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
69 kV Revenue Metering	**$200,000**
Upgrade line protection and controls at the Buckskin 69 kV substation.	**$200,000**
Total	**$400,000**

Table 1

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 Buckskin 69 kV substation 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 AC2-060 was evaluated as a 100.0 MW (Capacity 64.0 MW) injection into the Buckskin 69 kV substation in the AEP area. Project AC2-060 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC2-060 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)

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

(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:

None

Stability and Reactive Power Requirement

(Results of the dynamic studies should be inserted here)

No mitigations are required due to instability; however, it was observed that the AC2-060 plant is deficient in lagging power factor requirement by 24.21 MVAr. This will need to be addressed through reactive power compensation.

First Solar Development will be responsible for addressing the deficiency in lagging power factor requirements.

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 05BCKSKI-05PETERSB8 69 kV line (from bus 243598 to bus 243612 ckt 1) loads from 72.83% to 163.71% (AC power flow) of its emergency rating (50 MVA) for the single line contingency outage of '412_B2_TOR13998_WOMOAB_B'. This project contributes approximately 48.67 MW to the thermal violation.

CONTINGENCY '412_B2_TOR13998_WOMOAB_B'

OPEN BRANCH FROM BUS 253030 TO BUS 932130 CKT 1 / 932130 AC2-020 TAP 69.0 253030 09GRNFLD 69.0 1
END

2. (AEP - AEP) The 05BCKSKI-05PETERSB8 69 kV line (from bus 243598 to bus 243612 ckt 1) loads from 48.02% to 103.04% (AC power flow) of its normal rating (50 MVA) for non-contingency condition. This project contributes approximately 32.11 MW to the thermal violation.

3. (AEP - AEP) The 05BCKSKI-AC2-020 TAP 69 kV line (from bus 243598 to bus 932130 ckt 1) loads from 44.47% to 113.63% (AC power flow) of its emergency rating (72 MVA) for the single line contingency outage of '413_B2_TOR9317'. This project contributes approximately 49.78 MW to the thermal violation.

CONTINGENCY '413_B2_TOR9317'
OPEN BRANCH FROM BUS 243598 TO BUS 243612 CKT 1 / 243598 05BCKSKI 69.0 243612 05PETERSB8 69.0 1
OPEN BRANCH FROM BUS 243606 TO BUS 243612 CKT 1 / 243606 05HIGHLA 69.0 243612 05PETERSB8 69.0 1
END

4. (AEP - AEP) The 05LATTAVL8-05BIERSRUN 69 kV line (from bus 243608 to bus 246893 ckt 1) loads from 90.92% to 192.26% (AC power flow) of its emergency rating (50 MVA) for the single line contingency outage of '412_B2_TOR13998_WOMOAB_B'. This project contributes approximately 51.33 MW to the thermal violation.

CONTINGENCY '412_B2_TOR13998_WOMOAB_B'
OPEN BRANCH FROM BUS 253030 TO BUS 932130 CKT 1 / 932130 AC2-020 TAP 69.0 253030 09GRNFLD 69.0 1
END

5. (AEP - AEP) The 05LATTAVL8-05BIERSRUN 69 kV line (from bus 243608 to bus 246893 ckt 1) loads from 68.51% to 127.34% (AC power flow) of its normal rating (50 MVA) for non-contingency condition. This project contributes approximately 34.26 MW to the thermal violation.

6. (AEP - AEP) The 05PETERSB8-05HIGHLA 69 kV line (from bus 243612 to bus 243606 ckt 1) loads from 74.43% to 153.53% (AC power flow) of its emergency rating (50 MVA) for the single line contingency outage of '412_B2_TOR13998_WOMOAB_B'. This project contributes approximately 48.67 MW to the thermal violation.

CONTINGENCY '412_B2_TOR13998_WOMOAB_B'
OPEN BRANCH FROM BUS 253030 TO BUS 932130 CKT 1 / 932130 AC2-020 TAP 69.0 253030 09GRNFLD 69.0 1
END

7. (AEP - AEP) The 05BIERSRUN-05SLATE 69 kV line (from bus 246893 to bus 243617 ckt 1) loads from 92.43% to 106.46% (AC power flow) of its emergency rating (50 MVA) for the single line contingency outage of '6786_B2'. This project contributes approximately 8.25 MW to the thermal violation.

CONTINGENCY '6786_B2'
OPEN BRANCH FROM BUS 246889 TO BUS 246890 CKT 1 / 246889 05BIERSR 138 246890 05HOPETN 138 1
END

8. (AEP - DAY) The AC2-020 TAP-09GRNFLD 69 kV line (from bus 932130 to bus 253030 ckt 1) loads from 58.93% to 128.06% (AC power flow) of its emergency rating (72 MVA) for the single line contingency outage of '413_B2_TOR9317'. This project contributes approximately 49.78 MW to the thermal violation.

CONTINGENCY '413_B2_TOR9317'
OPEN BRANCH FROM BUS 243598 TO BUS 243612 CKT 1 / 243598 05BCKSKI 69.0 243612 05PETERSB8 69.0 1
OPEN BRANCH FROM BUS 243606 TO BUS 243612 CKT 1 / 243606 05HIGHLA 69.0 243612 05PETERSB8 69.0 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)

None

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 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 100.0 MW (64.0 MW Capacity) solar generating facility of First Solar Development (PJM Project #AC2-060) 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 (Buckskin 69 kV)		
Attachment Cost	Expand Buckskin 69 kV substation	**$1,500,000**
Non-Direct Connection Cost Estimate	69 kV Revenue Metering	**$200,000**
	Upgrade line protection and controls at the Buckskin 69 kV substation.	**$200,000**
	First Solar Development will be responsible for addressing the deficiency in lagging power factor requirements.	**First Solar Development Responsibility**
	Total Estimated Cost for Project AC2-055	**$1,900,000**

Table 2

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 (Buckskin 69 kV Substation)

Single Line Diagram

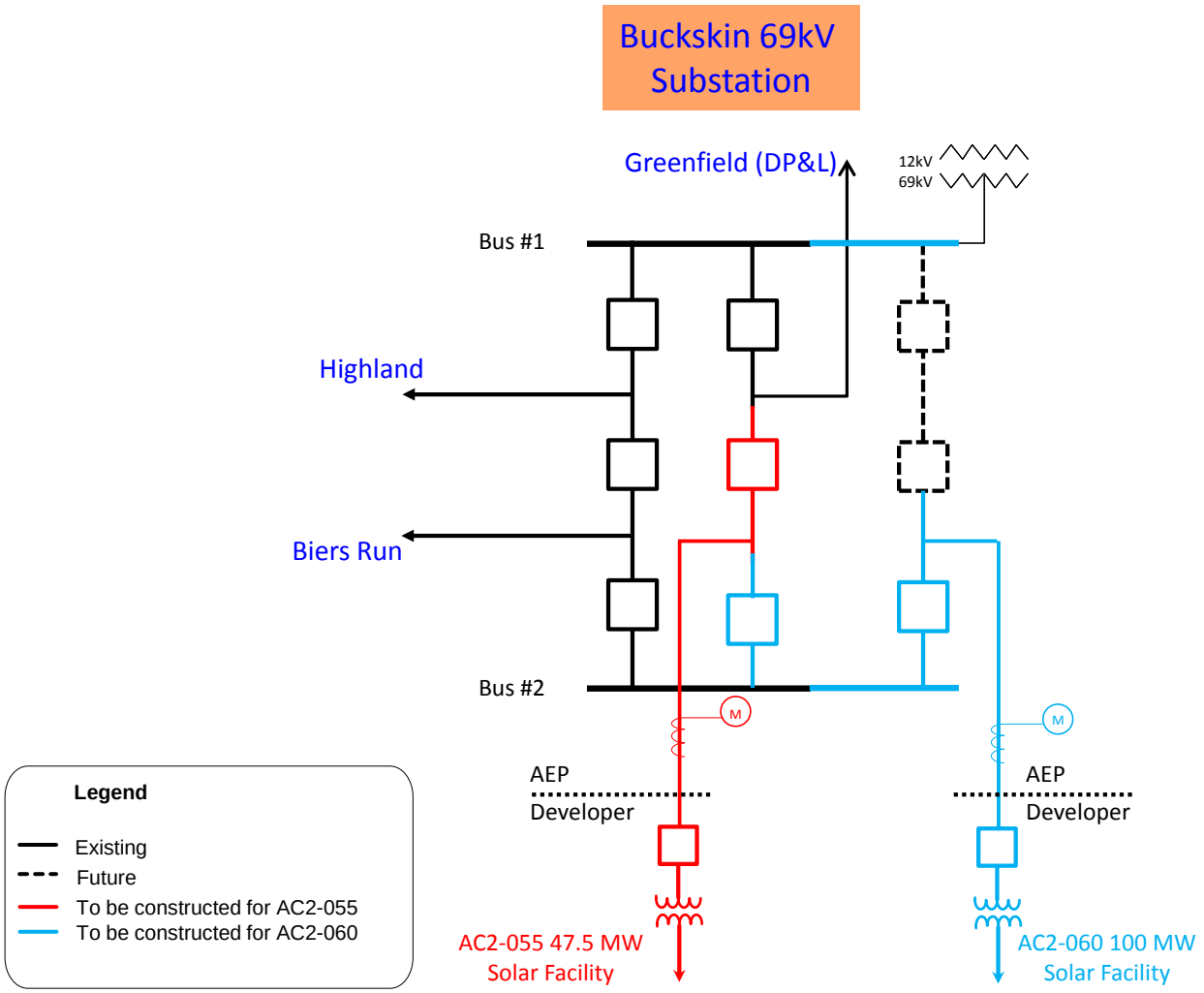

Figure 2: Customer Project Site and Point of Interconnection (Buckskin 69 kV Substation)