

***Generation Interconnection
Feasibility Study Report***

For

***PJM Generation Interconnection Request
Queue Position AC2-038***

Lee 69 kV

July 2017

Preface

The intent of the feasibility study is to determine a plan, with ballpark cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the Interconnection Customer. The Interconnection Customer may request the interconnection of generation as a capacity resource or as an energy-only resource. 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.

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, may also contribute to the need for the same network reinforcement. The possibility of sharing the reinforcement costs with other projects may be identified in the feasibility study, but the actual allocation will be deferred until the impact study is performed.

The Feasibility 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

The Interconnection Customer (IC) proposes to install PJM Project #AC2-038, a 20.0 MW (12.0 MW Capacity) solar generating facility in Carroll County, Ohio (see Figure 2). The primary point of interconnection will be a direct connection to AEP's Lee 69 kV substation (see Figure 1). The secondary point of interconnection is to AEP's Dexter – Rosewood Switch 138 kV section of the Dexter – Poston 138 kV circuit (see Figure 3 and 4).

The requested in service date is June 1, 2019.

Attachment Facilities

Primary Point of Interconnection (Lee 69 kV Substation)

To accommodate the interconnection at the Lee 69 kV substation, Lee substation will have to be expanded to a new three (3) circuit breaker 69 kV substation physically configured in a breaker and half bus arrangement (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.

Note: The radial nature of the primary POI may require a non-optimal switching configuration at the POI, as well as additional upgrades. This would be needed to provide acceptable P&C performance and provide flexibility for normal operation and maintenance of AEP equipment, such as performing maintenance on the 69 kV CB 67 at Elliott without interrupting both customer load and the solar project. Investigation of these issues goes beyond the scope of a Feasibility Study.

Station Work:

- Expand Lee 69 kV substation to a new three (3) circuit breaker 69 kV substation physically configured in a breaker and half bus arrangement (see Figure 1). Installation of associated protection and control equipment, 69 kV line risers, SCADA, and 69 kV revenue metering will also be required. (see Figure 1).
- **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
69 kV Revenue Metering	\$200,000
Upgrade line protection and controls at the Elliot 69 kV substation to coordinate with the expanded Lee 69 kV substation.	\$200,000
Total	\$400,000

Table 1

Secondary Point of Interconnection (Dexter – Rosewood Switch 138 kV)

To accommodate the interconnection on the Dexter – Rosewood Switch 138 kV section of the Dexter – Poston 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 3). 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.

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

Interconnection Customer Requirements

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 AC2-038 was evaluated as a 20.0 MW (Capacity 12.0 MW) injection at the Lee 69 kV substation in the AEP area. Project AC2-038 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC2-038 was studied with a commercial probability of 53%. 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

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.

1. (AEP - AEP) The 05SPENCR-05CROOKS 138 kV line (from bus 243107 to bus 242986 ckt 1) loads from 92.5% to 97.55% (**DC power flow**) of its emergency rating (134 MVA) for the single line contingency outage of '5923_B2_TOR10098A_MOAB'. This project contributes approximately 6.77 MW to the thermal violation.

CONTINGENCY '5923_B2_TOR10098A_MOAB'

OPEN BRANCH FROM BUS 243531 TO BUS 243555 CKT 1 / 243531
05KIMBRY 138 243555 05POSTON 138 1
END

System Reinforcements

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 Feasibility Study, the construction of the 20.0 MW (12.0 MW Capacity) solar generating facility of IC (PJM Project #AC2-038) 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 IC generating facility.

Cost Breakdown for Primary Point of Interconnection (Lee 69 kV Substation)		
Attachment Cost	Expand Lee 69 kV Substation	\$3,000,000
Non-Direct Connection Cost Estimate	69 kV Revenue Metering	\$200,000
	Upgrade line protection and controls at the Elliot 69 kV substation to coordinate with the expanded Lee 69 kV substation.	\$200,000
	Total Estimated Cost for Project AC2-038	\$3,400,000

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.

Option 2

Network Impacts

The Queue Project AC2-038 was evaluated as a 20.0 MW (Capacity 12.0 MW) injection tapping the Dexter – Rosewood 138 kV line in the AEP area. Project AC2-038 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC2-038 was studied with a commercial probability of 53%. 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

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.

1. (AEP - AEP) The 05SPENCR-05CROOKS 138 kV line (from bus 243107 to bus 242986 ckt 1) loads from 92.5% to 95.81% (**DC power flow**) of its emergency rating (134 MVA) for the single line contingency outage of '5923_B2_TOR10098A_MOAB'. This project contributes approximately 4.44 MW to the thermal violation.

CONTINGENCY '5923_B2_TOR10098A_MOAB'

OPEN BRANCH FROM BUS 243531 TO BUS 243555 CKT 1 / 243531
05KIMBRY 138 243555 05POSTON 138 1

END

Figure 1: Primary Point of Interconnection (Lee 69 kV Substation)
Single-Line Diagram

AC2-038 Primary Point of Interconnection

Remote stations not completely shown.

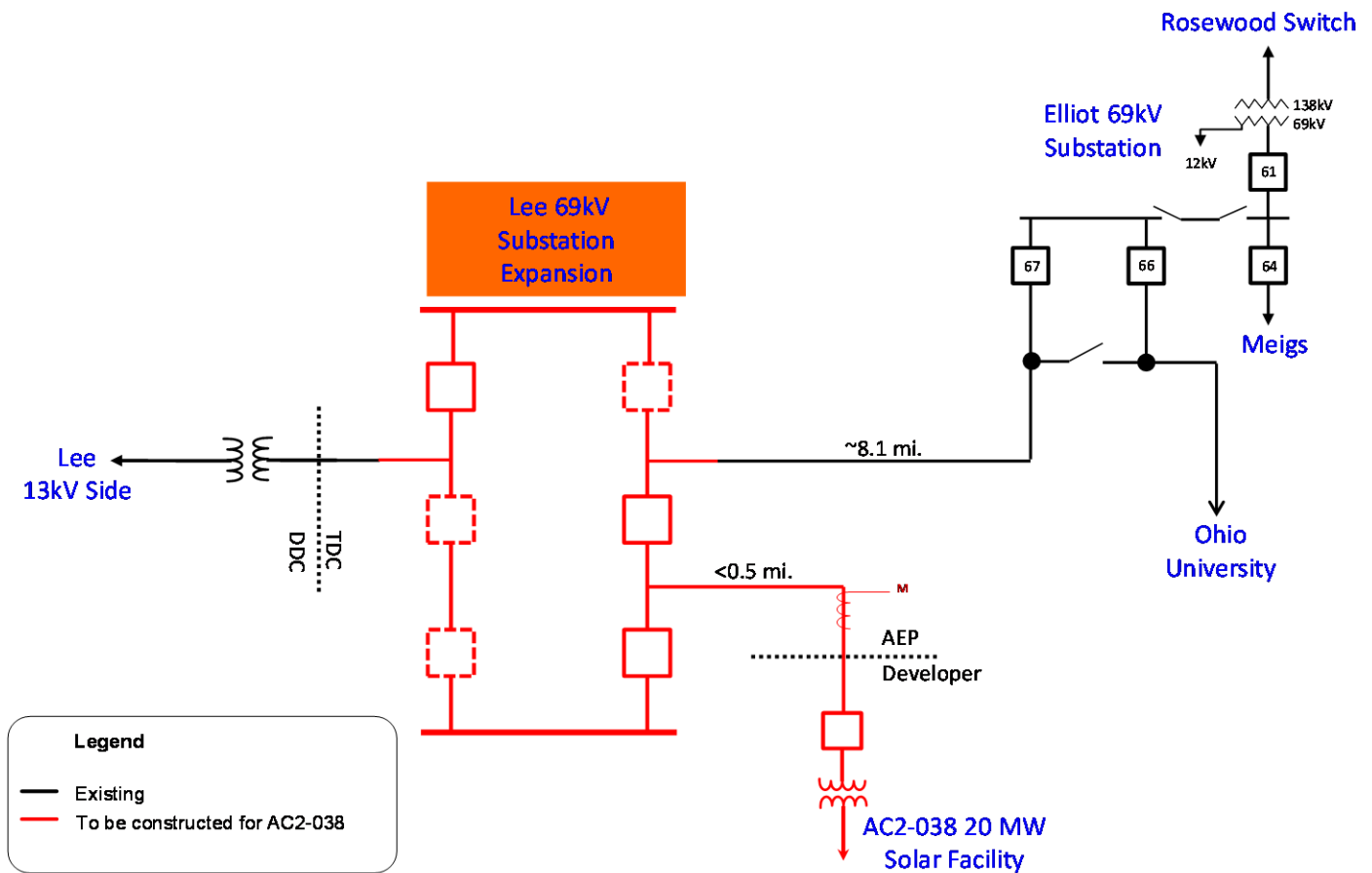


Figure 3: Secondary Point of Interconnection (Dexter – Rosewood Switch 138 kV)

Single-Line Diagram

**AC2-038 Secondary Point of Interconnection
Line Tap / New Substation**

Remote stations not completely shown.

