# *Generation Interconnection Feasibility Study Report*

# *For*

# *PJM Generation Interconnection Request Queue Position AD1-128*

# *Modoc 138 kV*

**May 2018**

# 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 #AD1- 128, a 150.0 MW (57.0 MW Capacity) solar generating facility in Randolph County, Indiana. The primary point of interconnection will be a direct connection to AEP's Modoc 138 kV substation (see Figure 1). The secondary point of interconnection is to AEP's Modoc – Delaware 138 kV section of the College Corner – Delaware 138 kV circuit.

The requested in Backfeed date is August 1, 2021.

The requested in service date is October 31, 2021.

The objective of this Feasibility 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 maintaining the reliability of the AEP transmission system. Stability analysis is not included as part of this study.

# Attachment Facilities

**Primary Point of Interconnection (Modoc 138 kV Substation)**

To accommodate the interconnection at the Modoc 138 kV substation, the substation will have to be expanded requiring the installation of four (4) 138 kV circuit breakers, 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>Modoc Station Work and Cost:</u>

- Construct a new four (4) 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**

## 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 | Total Cost |
|---|---|
| College Corner-Delaware 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 expanded Modoc 138 kV | $250,000 |
| Upgrade line protection and controls at the Centreville 138 kV substation to coordinate with the expanded Modoc 138 kV substation. | $250,000 |
| Upgrade line protection and controls at the Delaware 138 kV substation to coordinate with the expanded Modoc 138 kV substation. | $250,000 |
| **Total** | **$1,000,000** |

**Table 2**

**Secondary Point of Interconnection (Modoc – Delaware 138 kV)**

To accommodate the interconnection on the Modoc – Delaware 138 kV section of the College Corner – Delaware 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. 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.

# Interconnection Customer Requirements

It is understood that The IC Energy is responsible for all costs associated with this interconnection. The cost of The IC Energy's generating plant and the costs for the line connecting the generating plant to the Modoc 138 kV substation are not included in this report; these are assumed to be The IC Energy'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

## Option 1

## Network Impacts

The Queue Project AD1-128 was evaluated as a 150.0 MW (Capacity 57.0 MW) injection at the Modoc 138kV substation in the AEP area. Project AD1-128 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD1-128 was studied with a commercial probability of 53%. Potential network impacts were as follows:

## Base Case Used

Summer Peak Analysis – 2021 Case

## Contingency Descriptions

The following contingencies resulted in overloads:

| Option 1 | |
|---|---|
| **Contingency Name** | **Description** |
| AEP_P1-2_#2811 | CONTINGENCY 'AEP_P1-2_#2811'<br><br>OPEN BRANCH FROM BUS 243233 TO BUS 248001 CKT Z1 / 243233 05TANNER 345 248001 06DEARB1 345 Z1<br><br>OPEN BRANCH FROM BUS 243233 TO BUS 249565 CKT 1 / 243233 05TANNER 345 249565 08EBEND 345 1<br><br>OPEN BRANCH FROM BUS 248000 TO BUS 248001 CKT 1 / 248000 06CLIFTY 345 248001 06DEARB1 345 1<br><br>OPEN BRANCH FROM BUS 248001 TO BUS 248013 CKT 1 / 248001 06DEARB1 345 248013 06PIERCE 345 1<br><br>END |
| AEP_P1-2_#349 | CONTINGENCY 'AEP_P1-2_#349'<br><br>OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 1 / 242528 05SPORN 345 248005 06KYGER 345 1<br><br>END |
| AEP_P1-2_#8702 | CONTINGENCY 'AEP_P1-2_#8702'<br><br>OPEN BRANCH FROM BUS 243218 TO BUS 243232 CKT 2 / 243218 05DESOTO 345 243232 05SORENS 345 2<br><br>END |

**Table 3**

## 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

**Table 4**

## 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

## 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:

Duke Carolina, Progress, & TVA Impacts to be determined during later study phases (as applicable).

### 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.
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.

| AD1-128 Delivery of Energy Portion of Interconnection Request | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Contingency | Affected | | Bus | | | | Loading | | Rating | | MW |
| # | Type | Name | Area | Facility Description | From | To | Cir. | PF | Initial | Final | Type | MVA | Con. |
| 1 | N-1 | AEP_P1-2_#8702 | AEP - AEP | 05KEYSTN-05SORENS 345 kV line | 243225 | 243232 | 1 | DC | 123 | 125 | NR | 897 | 18.29 |
| 2 | N-1 | AEP_P1-2_#2811 | AEP - DEO&K | 05TANNER-08M.FORT 345 kV line | 243233 | 249567 | 1 | DC | 101 | 102 | NR | 1409 | 22.8 |
| 3 | N-1 | AEP_P1-2_#349 | OVEC - AEP | 06KYGER-05SPORN 345 kV line | 248005 | 242528 | 2 | DC | 130 | 130 | NR | 971 | 11.7 |

**Table 4**

## New System Reinforcements

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

None

## Previous System Reinforcements

*(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, identified for earlier generation or transmission interconnection projects in the PJM Queue)*

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 Feasibility Study, the construction of the IC's 150.0 MW (57.0 MW Capacity) solar generating facility (PJM Project #AD1- 128) 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's generating facility.

| Cost Breakdown for the Primary Point of Interconnection (Modoc 138 kV Substation) | | |
|---|---|---|
| **Attachment Cost** | Expand Modoc 138 kV Substation | $6,000,000 |
| **Non-Direct Connection Cost Estimate** | 138 kV Revenue Metering | $250,000 |
| | College Corner-Delaware 138 kV T-Line Cut In | $1,000,000 |
| | Upgrade line protection and controls at the expanded Modoc 138 kV | $250,000 |
| | Upgrade line protection and controls at the Centreville 138 kV substation to coordinate with the expanded Modoc 138 kV substation. | $250,000 |
| | Upgrade line protection and controls at the Delaware138 kV substation to coordinate with the expanded Modoc 138 kV substation. | $250,000 |
| | **Total Estimated Cost for Project AD1- 128** | **$8,000,000** |

**Table 5**

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.

## Option 2

## Network Impacts

The Queue Project AD1- 128 was evaluated as a 150.0 MW (Capacity 57.0 MW) injection tapping the Modoc - Delaware 138 kV line in the AEP area. Project AD1- 128 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD1- 128 was studied with a commercial probability of 53%. Potential network impacts were as follows:

## Base Case Used

Summer Peak Analysis – 2021 Case

## Contingency Descriptions

The following contingencies resulted in overloads:

| Option 2 | |
|---|---|
| **Contingency Name** | **Description** |
| AEP_P1-2_#2811 | CONTINGENCY 'AEP_P1-2_#2811'<br>OPEN BRANCH FROM BUS 243233 TO BUS 248001 CKT Z1 / 243233 05TANNER 345 248001 06DEARB1 345 Z1<br>OPEN BRANCH FROM BUS 243233 TO BUS 249565 CKT 1 / 243233 05TANNER 345 249565 08EBEND 345 1<br>OPEN BRANCH FROM BUS 248000 TO BUS 248001 CKT 1 / 248000 06CLIFTY 345 248001 06DEARB1 345 1<br>OPEN BRANCH FROM BUS 248001 TO BUS 248013 CKT 1 / 248001 06DEARB1 345 248013 06PIERCE 345 1<br>END |
| AEP_P1-2_#349 | CONTINGENCY 'AEP_P1-2_#349'<br>OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 1 / 242528 05SPORN 345 248005 06KYGER 345 1<br>END |
| AEP_P1-2_#8702 | CONTINGENCY 'AEP_P1-2_#8702'<br>OPEN BRANCH FROM BUS 243218 TO BUS 243232 CKT 2 / 243218 05DESOTO 345 243232 05SORENS 345 2<br>END |

**Table 6**

## Generator Deliverability

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

None

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*(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:

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## 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.

| AD1-128 Delivery of Energy Portion of Interconnection Request | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Contingency | | Affected | | Bus | | | | Loading | | Rating | | MW |
| # | Type | Name | Area | Facility Description | From | To | Cir. | PF | Initial | Final | Type | MVA | Con. |
| 1 | N-1 | AEP_P1-2_#8702 | AEP - AEP | 05KEYSTN-05SORENS 345 kV line | 243225 | 243232 | 1 | DC | 123 | 125 | NR | 897 | 20.19 |
| 2 | N-1 | AEP_P1-2_#2811 | AEP - DEO&K | 05TANNER-08M.FORT 345 kV line | 243233 | 249567 | 1 | DC | 100 | 102 | NR | 1409 | 23.68 |
| 3 | N-1 | AEP_P1-2_#349 | OVEC - AEP | 06KYGER-05SPORN 345 kV line | 248005 | 242528 | 2 | DC | 130 | 130 | NR | 971 | 11.06 |

**Table 7**

**Figure 1: Primary Point of Interconnection (Modoc 138 kV Substation)**

**Single-Line Diagram**

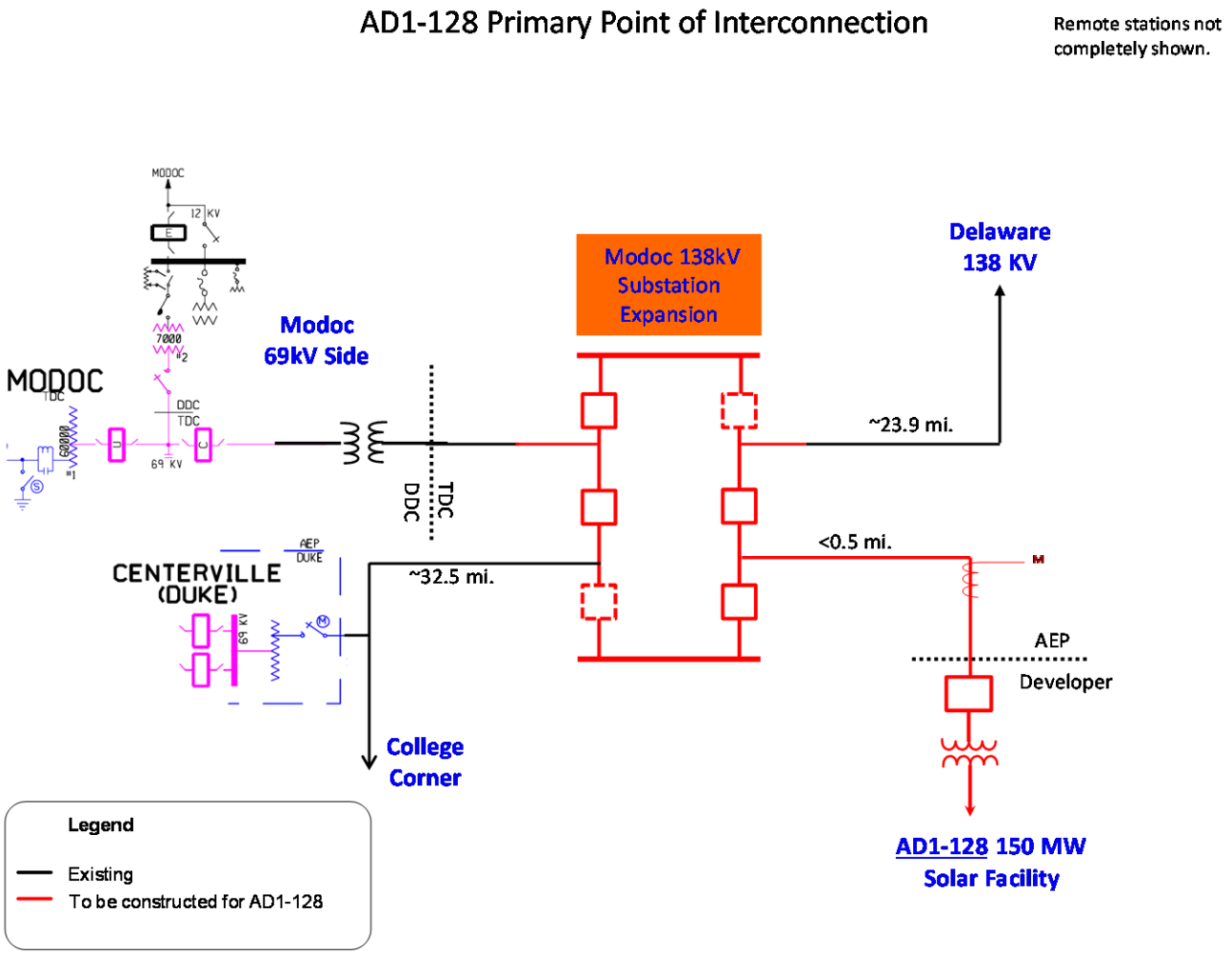

**Figure 3: Secondary Point of Interconnection (Modoc - Delaware 138 kV)**

**Single-Line Diagram**