Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AC2-029

Circleville 138 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 #AC2-029, a 70.0 MW (26.6 MW Capacity) solar generating facility in Pickaway County, Ohio (see Figure 2). The point of interconnection will be a direct connection to AEP's Circleville 138 kV substation (see Figure 1).

The requested in service date is December 31, 2018.

Attachment Facilities

Point of Interconnection (Circleville 138 kV Substation)

To accommodate the interconnection at the Circleville 138 kV substation, the installation of a new 138kV circuit breaker will be required (see Figure 1). Installation of associated protection and control equipment, 138 kV line risers, SCADA, and 138 kV revenue metering will also be required.

Station Work:

- Install one (1) 138 kV circuit breaker at the Circleville 138kV substation (see Figure 1). Installation of associated protection and control equipment, 138 kV line risers, SCADA, and 138 kV revenue metering will also be required.
    - **Estimated Station Cost: $1,000,000**

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 Circleville 138 kV substation.	**$250,000**
Total	**$500,000**

Table 1

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

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 AC2-029 was evaluated as a 70.0 MW (Capacity 26.6 MW) injection at the Circleville 138 kV substation in the AEP area. Project AC2-029 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC2-029 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:

Option 1	
Contingency Name	**Description**
6783	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
5808_B2_TOR1983B_MOAB	CONTINGENCY '5808_B2_TOR1983B_MOAB' OPEN BRANCH FROM BUS 243522 TO BUS 243593 CKT 1 / 243522 05HARRIS 138 243593 05ZUBER 138 1 END
8094_C2_05BIXBY 345-303C	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

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)

AC2-029 Multiple Facility Contingency												
		Contingency	Affected	Facility	Bus		Loading		Rating		MW	FG
#	Type	Name	Area	Description	From	To	Initial	Final	Type	MVA	Con.	App.
1	LFFB	8094_C2_05BIXBY 345-303C	AEP - AEP	05HARRIS-05OBETZ 138 kV line	243522	243550	88.71	96.6	ER	179	14.12	1
2	DCTL	6783	AEP - AEP	05HARRIS-05OBETZ 138 kV line	243522	243550	88.71	96.6	ER	179	14.12	

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)

Note: Please see Appendices for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper table in the Appendix.

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.

AC2-029 Delivery of Energy Portion of Interconnection Request												
#	Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Loading Initial	Loading Final	Rating Type	Rating MVA	MW Con.	FG App.
1	N-1	5808_B2_TOR1983B_MOAB	AEP - AEP	05HARRIS-05OBETZ 138 kV line	243522	243550	67.1	80.7	ER	179	24.36	

Table 4

New System Reinforcements

Violation #	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
#1	05HARRIS-05OBETZ 138 kV line	Upgrade the Harrison bus work from circuit breaker switches to wavetrap. The AC2 Queue overloads this facility and AC2-029 contributes to this overload.	An approximate construction time would be 12 months after signing an interconnection agreement.	**$200,000**
			Total New Network Upgrades	**$200,000**

Table 5

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 70.0 MW (26.6 MW Capacity) solar generating facility of IC (PJM Project #AC2-029) 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 Point of Interconnection (Circleville 138 kV Substation)		
Attachment Cost	Install one 138 kV Circuit Breaker at the Circleville 138 kV Substation	**$1,000,000**
Non-Direct Connection Cost Estimate	138 kV Revenue Metering	**$250,000**
	Upgrade line protection and controls at the Circleville 138 kV substation.	**$250,000**
	Upgrade the Harrison bus work from circuit breaker switches to wavetrap.	**$200,000**
	Total Estimated Cost for Project AC2-029	**$1,700,000**

Table 6

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 (Circleville 138 kV Substation)

Single-Line Diagram

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 88.71% to 96.6% (**DC 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 14.12 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*
931201	*AC2-029 C*	*5.37*
931202	*AC2-029 E*	*8.76*
931411	*AC2-059 C*	*8.86*
931412	*AC2-059 E*	*9.14*
931811	*AC2-106 C OP*	*5.59*
931812	*AC2-106 E OP*	*2.58*
924351	*AB2-083 C OP*	*2.83*
924352	*AB2-083 E OP*	*1.33*
925341	*AC1-001 C*	*5.65*
925342	*AC1-001 E*	*2.66*
927161	*AC1-210 C OP*	*8.9*
927162	*AC1-210 E OP*	*4.02*