Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AC1-103

Nottingham 138 kV

April 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 proposes to install PJM Project #AC1-103, a 1050.0 MW (1026.0 MW Capacity) natural gas generating facility in Cadiz, Ohio (see Figure 2). The plant will consist of two (2) 1x1 combined cycle units. The point of interconnection will be a direct connection to AEP's Nottingham 138 kV substation (see Figure 1).

The requested backfeed date is January 30, 2020.

The requested in service date is December 30, 2020.

Attachment Facilities

Point of Interconnection (Nottingham 138 kV Substation)

To accommodate the interconnection at the Nottingham 138 kV substation, the substation will have to be expanded requiring the installation of three (3) 138 kV circuit breakers, extending the two 138 kV buses, and starting a new string (see Figure 1). Installation of associated protection and control equipment, 138 kV line risers, SCADA, and 138 kV revenue metering will also be required.

Note: This is a conceptual level proposal and will have to be reviewed by engineering in the subsequent studies to determine what is actually feasible and provides the best performance in terms of reliability.

Nottingham Station Work:

- Expand the Nottingham 138 kV substation, start a new string, extend the two 138 kV buses and install three (3) 138 kV circuit breakers (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: $4,000,000**

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	**$300,000**

Upgrade line protection and controls at the expanded Nottingham 138 kV substation.	**$300,000**
Upgrade line protection and control settings at the Knox, Brookside, Longview, and Harmon FE 138 kV substations to coordinate with the expanded Nottingham 138 kV substation. As a part of the Impact Study, PJM will coordinate with FE to identify the scope and cost to replace relays or upgrade relay settings at the remote end substations. The AC1-103 customer can expect to see a similar cost as AEP's estimate below	To be provided by FE
Upgrade line protection and control settings at the Freebyrd, Yager, and Holloway AEP 138 kV substations to coordinate with the expanded Nottingham 138 kV substation.	**$200,000**
Total	**$800,000**

Table 1

It is understood that The Interconnection Customer is responsible for all costs associated with this interconnection. The costs above are reimbursable to AEP (or FE, where noted.) The cost of The Interconnection Customer's generating plant and the costs for the line connecting the generating plant to The Interconnection Customer's switching station are not included in this report; these are assumed to be The Interconnection Customer'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 AC1-103 was evaluated as a 1050.0 MW (Capacity 1026.0 MW) injection at the Nottingham 138kV substation in the AEP area. Project AC1-103 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC1-103 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**
9038	CONTINGENCY '9038' OPEN BRANCH FROM BUS 239354 TO BUS 247460 CKT 1 / 239354 02HARMON 138 247460 05NOTTINGHAM 138 1 OPEN BRANCH FROM BUS 247460 TO BUS 247700 CKT 2 / 247460 05NOTTINGHAM 138 247700 05YAGER 138 2 END
8971_B2	CONTINGENCY '8971_B2' OPEN BRANCH FROM BUS 242932 TO BUS 247627 CKT 1 / 242932 05CANTNC 345 247627 Y2-050 TAP 345 1 END
9110_C2_05NOTTINGHAM 138-J	CONTINGENCY '9110_C2_05NOTTINGHAM 138-J' OPEN BRANCH FROM BUS 247131 TO BUS 247460 CKT 5 / 247131 05HOLLOW 138 247460 05NOTTINGHAM 138 5 OPEN BRANCH FROM BUS 247460 TO BUS 247700 CKT 1 / 247460 05NOTTINGHAM 138 247700 05YAGER 138 1 END
B2-TIE-138-810	CONTINGENCY 'B2-TIE-138-810' /* LINE 05YAGER TO 05NOTTINGHAM 138 CK 1 (FE OWNS TL) DISCONNECT BRANCH FROM BUS 247700 TO BUS 247460 CKT 1 /* 05YAGER 138 05NOTTINGHAM138 END
B2-TIE-345-521_A	CONTINGENCY 'B2-TIE-345-521_A' /* WYLIE RIDGE - TIDD 345KV APS-AEP TIE DISCONNECT BRANCH FROM BUS 235707 TO BUS 922161 CKT 1 /* 01WYLIE R 345 AA2-121 TAP END
P12_301	CONTINGENCY 'P12_301' OPEN BRANCH FROM BUS 242946 TO BUS 253965 CKT 1 / 242946 05TIDD 345 253965 15COLLIE 345 1

	END

Table 2

Generator Deliverability

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

Option 1 AC1-103 Generator Deliverability														
	Contingency				Bus				Loading		Rating			
#	Type	Name	Affected Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type	MVA	MW Con.	FG App.
1	N-1	B2-TIE-138-810	AEP - AEP	05NOTTINGHAM-05YAGER 138 kV line	247460	247700	2	DC	57.19	109.02	ER	242	125.42	
2	N-1	8971_B2	AEP - AP	AA2-121 TAP-01WYLIE R 345 kV line	922161	235707	1	DC	95.44	101.67	NR	1542	95.94	

Table 3

Multiple Facility Contingency

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

AC1-103 Multiple Facility Contingency														
	Contingency				Bus				Loading		Rating			
#	Type	Name	Affected Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type	MVA	MW Con.	FG App.
1	DCTL	9038	AEP - AEP	05NOTTINGHAM-05YAGER 138 kV line	247460	247700	1	DC	52.23	102.95	ER	291	147.6	1
2	LFFB	9110_C2_05NOTTINGHAM 138-J	AEP - AEP	05NOTTINGHAM-05YAGER 138 kV line	247460	247700	2	DC	54.88	110.7	ER	242	135.09	2

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)

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.

AC1-103 Contribution to Previously Identified Overloads														
	Contingency				Bus				Loading		Rating			
#	Type	Name	Affected Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type	MVA	MW Con.	FG App.
1	N-1	B2-TIE-345-521_A	AEP - DLCO	05TIDD-15COLLIE 345 kV line	242946	253965	1	DC	102.12	108.89	NR	1229	83.24	3
2	N-1	P12_301	AEP - AP	AA2-121 TAP-01WYLIER 345 kV line	922161	235707	1	DC	101.84	109.42	NR	1542	116.84	5

Table 5

Steady-State Voltage Requirements

None

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

#	Over-Duty Circuit Breaker	Duty Percent with AC1-103	Duty Percent without AC1-103	Duty Percent Difference
#1	South Canton 138 kV Circuit Breaker M	100.18%	99.52%	**0.66%**
#2	South Canton 138 kV Circuit Breaker M2	100.18%	99.52%	**0.66%**
#3	South Canton 138 kV Circuit Breaker B1	100.07%	98.82%	**1.25%**

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.

AC1-103 Delivery of Energy Portion of Interconnection Request															
	Contingency			Bus					Loading		Rating				
#	Type	Name	Affected Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type	MVA	MW Con.	FG App.
1	N-1	B2-TIE-138-810	AEP - AEP	05NOTTINGHAM -05YAGER 138 kV line	247460	247700	2	DC	57.19	110.23	ER	242	128.35	

Table 6

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).

New System Reinforcements

#	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
#1	05NOTTINGHAM-05YAGER 138 kV Circuit #2	AEP-end ratings are S/N: 487 MVA S/E: 504 MVA. No upgrade is requirement from AEP. As a part of the Impact Study, PJM will coordinate with FE to make sure their equipment will not limit this line.		
#2	05NOTTINGHAM-05YAGER 138 kV Circuit #1	AEP-end ratings are S/N: 398 MVA S/E: 398 MVA. No upgrade is requirement from AEP. As a part of the Impact Study, PJM will coordinate with FE to make sure their equipment will not limit this line.		
#3	AA2-121 TAP-01WYLIE R 345 kV line	No upgrade is requirement from AEP. The overloaded portion of the AA2-121 – Wylie Ridge 345 kV line is owned by APS. As a part of the Impact Study, PJM will coordinate with APS to make sure their equipment will not limit this line.		
#4	05TIDD-15COLLIE 345 kV line	AEP-end ratings are S/N: 1409 MVA S/E: 1718 MVA. No upgrade is requirement from AEP. As a part of the Impact Study, PJM will coordinate with DLCO to make sure their equipment will not limit this line.		
#5	South Canton 138 kV Circuit Breaker M	Replace the South Canton 138 kV Circuit Breaker M	An approximate construction time will be 12 months after signing of an interconnection agreement.	**$800,000**
#\6	South Canton 138 kV Circuit Breaker M	Replace the South Canton 138 kV Circuit Breaker M2	An approximate construction time will be 12 months after signing of an interconnection agreement.	**$800,000**
#7	South Canton 138 kV Circuit Breaker M	Replace the South Canton 138 kV Circuit Breaker B1	An approximate construction time will be 12 months after signing of an interconnection agreement.	**$800,000**
			Total New Network Upgrades	**$2,400,000**

Table 7

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 1050.0 MW (1026.0 MW Capacity) natural gas generating facility of The Interconnection Customer (PJM Project #AC1-103) 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 The Interconnection Customer generating facility.

Cost Breakdown for Primary Point of Interconnection (Nottingham 138 kV Substation)		
Attachment Cost	Expand Nottingham 138 kV Substation	**$4,000,000**
Non-Direct Connection Cost Estimate	138 kV Revenue Metering	**$300,000**
	Upgrade line protection and controls at the expanded Nottingham 138 kV substation.	**$300,000**
	Upgrade line protection and control settings at the Freebyrd, Yager, and Holloway AEP 138 kV substations to coordinate with the expanded Nottingham 138 kV substation.	**$200,000**
	Upgrade line protection and control settings at the Knox, Brookside, Longview, and Harmon FE 138 kV substations to coordinate with the expanded Nottingham 138 kV substation. PJM will have to coordinate this upgrade with FE.	
	Replace the South Canton 138 kV Circuit Breaker M	**$800,000**
	Replace the South Canton 138 kV Circuit Breaker M2	**$800,000**
	Replace the South Canton 138 kV Circuit Breaker B1	**$800,000**
	Total Estimated Cost for Project AC1-103	**$7,200,000**

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. Estimates for FE and DLCO facility upgrades are not included in this document.