Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AD2-005

Nottingham 138 kV

November 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 increase the generation of its previous PJM project #AC1-103 request, 1050.0 MW (1026.0 Capacity) natural gas facility in Cadiz county, Ohio by 35.0 MW (35.0 MW Capacity). The 35.0 MW request will be split evenly between Units 1 and Unit 2 and studied as a 17.5 MW increase for each Unit in the System Impact Study. 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 in service date is December 31, 2021.

Attachment Facilities

To be constructed by PJM Project #AC1-103.

Note: It is assumed that the 138 kV revenue metering and gen lead installed for the #AC1-103 will be adequate for the additional generation.

Interconnection Customer Requirements

It is understood that IC is responsible for all costs associated with this interconnection. The costs above are reimbursable to AEP (or FE, where noted.) 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.

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 AD2-005 was evaluated as a 35.0 MW (Capacity 35.0 MW) uprate to the AC1-103 Queue project which is injection at the Nottingham 138kV substation in the AEP area. Project AD2-005 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD2-005 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:

Contingency Name	Description
'AEP_P7-1_#9034'	CONTINGENCY 'AEP_P7-1_#9034' OPEN BRANCH FROM BUS 242958 TO BUS 243133 CKT 1 / 242958 05BATTLE 138 243133 05VALLEY 138 1 OPEN BRANCH FROM BUS 242958 TO BUS 243138 CKT 1 / 242958 05BATTLE 138 243138 05W.LIBE 138 1 OPEN BRANCH FROM BUS 242961 TO BUS 246945 CKT Z1 / 242961 05BIGGRC 138 246945 05BIGR1Z 138 Z1 OPEN BRANCH FROM BUS 246945 TO BUS 243012 CKT 1 / 246945 05BIGR1Z 138 243012 05G WASH 138 1 OPEN BRANCH FROM BUS 246945 TO BUS 243133 CKT 1 / 246945 05BIGR1Z 138 243133 05VALLEY 138 1 OPEN BRANCH FROM BUS 243012 TO BUS 243049 CKT 1 / 243012 05G WASH 138 243049 05NATRIU 138 1 OPEN BRANCH FROM BUS 243127 TO BUS 243138 CKT 1 / 243127 05TIDD 138 243138 05W.LIBE 138 1 END
'AEP_P1-2_#737'	CONTINGENCY 'AEP_P1-2_#737' OPEN BRANCH FROM BUS 242931 TO BUS 242940 CKT 1 / 242931 05BEVERL 345 242940 05MUSKNG 345 1 END
'AEP_P1-2_#5152'	CONTINGENCY 'AEP_P1-2_#5152' OPEN BRANCH FROM BUS 243012 TO BUS 243049 CKT 1 / 243012 05G WASH 138 243049 05NATRIU 138 1 END
'AEP_P1-2_#5213'	CONTINGENCY 'AEP_P1-2_#5213' OPEN BRANCH FROM BUS 243012 TO BUS 243026 CKT 1 / 243012 05G WASH 138 243026 05KAMMR1 138 1 END
'AEP_P4_#7642_05KAMMR1 138'	CONTINGENCY 'AEP_P4_#7642_05KAMMR1 138' OPEN BRANCH FROM BUS 242937 TO BUS 243026 CKT 01 / 242937 05KAMMER 345 243026 05KAMMR1 138 01 OPEN BRANCH FROM BUS 243012 TO BUS 243026 CKT 1 / 243012 05G WASH 138 243026 05KAMMR1 138 1 END

Contingency Name	Description
'AEP_P7-1_#9038'	CONTINGENCY 'AEP_P7-1_#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

Table 1

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)

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.

AD2-005 Contribution to Previously Identified Overloads													
	Contingency		Affected	Facility	Bus				Loading		Rating		MW
#	Type	Name	Area	Description	From	To	Ckt.	PF	Initial	Final	Type	MVA	Con.
1	DCTL	'AEP_P7-1_#9034'	AEP - AEP	05G WASH-05KAMMR1 138 kV line	243012	243026	1	DC	115.88	117.69	ER	409	7.43
2	N-1	'AEP_P1-2_#737'	AEP - AEP	05G WASH-05KAMMR1 138 kV line	243012	243026	1	DC	114.54	116.23	ER	409	6.91
3	N-1	'AEP_P1-2_#5152'	AEP - AEP	05G WASH-05KAMMR1 138 kV line	243012	243026	1	DC	107.76	109.52	ER	409	7.18
4	N-1	'AEP_P1-2_#5213'	AEP - AEP	05G WASH-05NATRIU 138 kV line	243012	243049	1	DC	121.23	122.6	ER	205	2.8
5	LFFB	'AEP_P4_#7642_05KAMMR1 138'	AEP - AEP	05G WASH-05NATRIU 138 kV line	243012	243049	1	DC	118.15	118.76	ER	205	2.76
6	DCTL	'AEP_P7-1_#9038'	AEP - AEP	05NOTTINGHAM-05YAGER 138 kV line	247460	247700	1	DC	101.45	103.16	ER	291	4.97

Table 2

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.

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)

#	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
#1	05G WASH – 05KAMMR1 138kV line	Baseline project b2753.1: Rebuild George Washington 138kV station, this will resolve all the overloads on George Washington – Kammer 138kV line.	Project ISD: 1/1/2019	
#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. For the violation identifying the Nottingham-Yager #1 138 kV Line, PJM has an STE line rating of 291 MVA for the Nottingham-Yager #1 138 kV Line. Our STE line rating is 241 MVA. Therefore, the 103.32 % overload identified by PJM is actually a 124.8% overload. The mitigation for this overload the Nottingham-Yager #1 138 kV Line (18.5 miles) would need to be rebuilt, replacing the existing structures and 477 ACSR (200/241 SN/STE) conductor with 795 ACSR (278/339). The cost of this work would be $30,449,500 excluding tax. The work to reconductor this line	N/A	**$34,505,500**

#	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
		is estimated to take 31 months to complete.		
#3	05G WASH – 05NATRIUM 138kV line	1) A Sag Study will be required on 13.9 miles of ACSR~556.5~26/7 conductor to determine if the line section can be operated above its emergency rating of 205 MVA. The result could prove that no additional upgrades are necessary, that some upgrades are necessary, or that the entire 13.9 mile section of line would need to be rebuilt. Estimated cost for rebuilding 13.9 miles of line ~20.85 Million. 2)Upgrade Natrium Bus work 3)Replace Natrium line risers	(1) Sag Study: 6 to 12 months. (2) Rebuild: The standard time required for construction differs from state to state. An approximate construction time would be 24 to 36 months after signing an interconnection agreement.	Sag Study: $55,000 Natrium Bus: $200,000 Natrium line risers: $200,000
			Total New AEP Network Upgrades	**$34,960,500**

Table 3

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 increase in 35.0MW (PJM Project #AD2-005) generation to the previous request of 1050.0MW (1026.0 MW Capacity) natural gas generating facility of IC (PJM Project #AD2-005) will require additional interconnection charges.

Cost Breakdown for Primary Point of Interconnection (Nottingham 138 kV Substation)		
Attachment Cost	PJM Project #AC1-103 will pay for the necessary direct connection work required.	PJM Project #AC1-103 to pay for Attachment Facilities
Non- Direct Cost Estimates	**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)*	**$34,505,500**
	Total Estimated Cost for Project AD2-005	**$455,000 to $20,850,000***

Table 4

*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 the sag study to be completed and identify any required mitigations up to an included rebuilding the George Washington-Natrium 138 kV line. The Sag study will be completed as part of the Facilities Study for AD2-005.

Figure 1: Point of Interconnection (Nottingham 138 kV Substation)

Single-Line Diagram

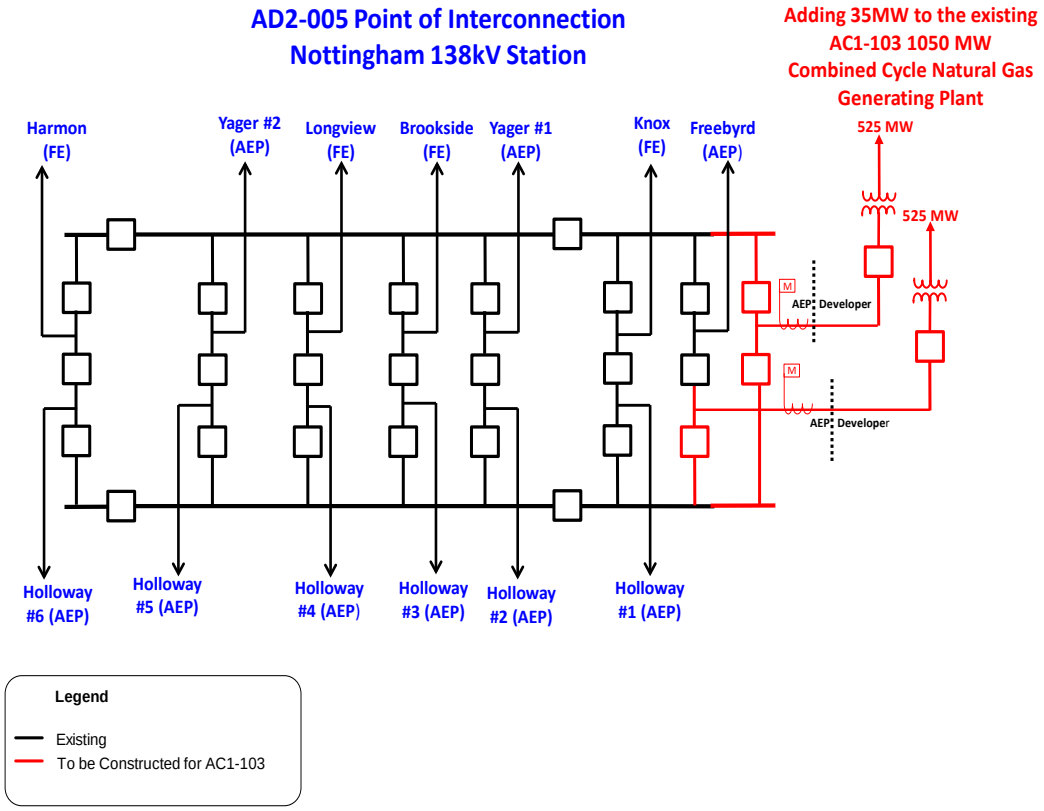

Figure 2: Point of Interconnection (Nottingham 138 kV Substation)