Generation Interconnection System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AC1-103

Nottingham 138 kV

March 2018

Preface

The intent of the System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. 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. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

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 or merchant transmission upgrade, may also contribute to the need for the same network reinforcement.

The System Impact 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

Harrison Power, LLC 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 in service date is October 21, 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.

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: $4,500,000**

Non-Direct Connection Cost Estimate

The total preliminary cost estimate for Non-Direct Connection work is given in the following tables below:

Description	Estimated Cost
138 kV Revenue Metering	$250,000
Upgrade line protection and controls at the expanded Nottingham 138 kV substation.	$400,000
Upgrade line protection and control settings at the Knox FE 138 kV substations to coordinate with the expanded Nottingham 138 kV substation. PJM will have to coordinate this upgrade with FE.	$250,000
Upgrade line protection and control settings at the Brookside FE 138 kV substations to coordinate with the expanded Nottingham 138 kV substation. PJM will have to coordinate this upgrade with FE.	$250,000

Description	Estimated Cost
Upgrade line protection and control settings at the Longview FE 138 kV substations to coordinate with the expanded Nottingham 138 kV substation. PJM will have to coordinate this upgrade with FE.	$250,000
Upgrade line protection and control settings at the Harmon FE 138 kV substations to coordinate with the expanded Nottingham 138 kV substation. PJM will have to coordinate this upgrade with FE.	$250,000
Upgrade line protection and control settings at the Freebyrd 138 kV remote-end substation.	$250,000
Upgrade line protection and control settings at the Yager 138 kV remote-end substation.	$250,000
Upgrade line protection and control settings at the Holloway 138 kV remote-end substation.	$250,000
Total	**$2,400,000**

Table 1

Interconnection Customer Requirements

It is understood that Harrison Power is responsible for all costs associated with this interconnection. The costs above are reimbursable to AEP (or FE, where noted.) The cost of Harrison Power's generating plant and the costs for the line connecting the generating plant to Harrison Power's switching station are not included in this report; these are assumed to be Harrison Power'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 AC1-103 was evaluated as a 1026.0 MW (Capacity 1026.0 MW) injection into the Nottingham 138 kV 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 100%. Potential network impacts were as follows:

Base Case Used

Summer Peak Analysis – 2020 Case

Contingency Descriptions

The following contingencies resulted in overloads:

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

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)

The Queue Project AC1-103 Multiple Facility Contingency														
	Contingency		Affected	Facility	Bus				Loading		Rating		MW	FG
#	Type	Name	Area	Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
1	DCTL	9038	AEP - AEP	05NOTTINGHAM-05YAGER 138 kV line	247460	247700	1	AC	53.72	103.13	ER	291	144.2	2

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)

None

Steady-State Voltage Requirements

(Results of the steady-state voltage studies should be inserted here)

None

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

None

Stability and Reactive Power Requirement

(Results of the dynamic studies should be inserted here)

No problems identified

Affected System Analysis & Mitigation

LGEE Impacts:

None

MISO Impacts:

None

Duke, Progress & TVA Impacts:

None

OVEC Impacts:

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.

Not Applicable

New System Reinforcements

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

#	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
1	05NOTTINGHAM-05YAGER 138 kV Circuit #1	AEP-end ratings are S/N: 398 MVA S/E: 398 MVA. No upgrade is requirement from AEP.	N/A	N/A
2	05NOTTINGHAM-05YAGER 138 kV Circuit #1	FE / ATSI owns and operates the transmission lines between the AEP owned and operated substations (Nottingham and Yager). To mitigate this overload, the Nottingham-Yager #1 138 kV Line (18.5 miles) would need to be reconductored, replacing the existing 477 ACSR conductor with 795 ACSR. The work to reconductor this line is estimated to take 31 months to complete. The cost of this work would be $34,505,500. This cost includes a federal income tax charge of $4,056,000. This tax may or may not be charged based on whether or not this project meets the eligibility requirements	31 months	$34,505,500

#	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
		of IRS Notice 88-129.		
			Total New Network Upgrades	**$34,505,500**

Table 4

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)

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 System Impact Study, the construction of the 1050.0 MW (1026.0 MW Capacity) natural gas generating facility of Harrison Power (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 Harrison Power generating facility.

Cost Breakdown for AC1-103 Nottingham 138 kV			
Type of Network Upgrade	**Network Upgrade Number**	**Description**	**Estimated Cost**
Direct Connection	**n5540**	Expand Nottingham 138 kV Substation	$4,500,000

Cost Breakdown for AC1-103 Nottingham 138 kV			
Network Upgrades			
Non-Direct Connection Network Upgrades	**n5541**	138 kV Revenue Metering	$250,000
	n5542	Upgrade line protection and controls at the expanded Nottingham 138 kV substation.	$400,000
	n5543	Upgrade line protection and control settings at the Freebyrd 138 kV remote-end substation.	$250,000
	n5544	Upgrade line protection and control settings at the Yager 138 kV remote-end substation.	$250,000
	n5545	Upgrade line protection and control settings at the Holloway 138 kV remote-end substation.	$250,000
	n5473	FE / ATSI owns and operates the transmission lines between the AEP owned and operated substations (Nottingham and Yager). To mitigate this overload, the Nottingham-Yager #1 138 kV Line (18.5 miles) would need to be reconductored, replacing the existing 477 ACSR conductor with 795 ACSR. The work to reconductor this line is estimated to take 31 months to complete. The cost of this work would be $34,505,500. This cost includes a federal income tax charge of $4,056,000. This tax may or may not be charged based on whether or not this project meets the eligibility requirements of IRS Notice 88-129. Note: The AEP-end ratings are 487/504 MVA SN/SE and are sufficient. No AEP upgrades required.	$34,505,500
	n5546	Upgrade line protection and control settings at the Knox FE 138 kV substations to coordinate with the expanded Nottingham 138 kV substation. PJM will have to coordinate this upgrade with FE.	$250,000
	n5547	Upgrade line protection and control settings at the Brookside FE 138 kV substations to coordinate with the expanded Nottingham 138 kV substation. PJM will have to coordinate this upgrade with FE.	$250,000
	n5548	Upgrade line protection and control settings at the Longview FE 138 kV substations to coordinate with the expanded Nottingham 138 kV substation. PJM will have to coordinate this upgrade with FE.	$250,000
	n5549	Upgrade line protection and control settings at the Harmon FE 138 kV substations to coordinate with the expanded Nottingham 138 kV substation. PJM will have to coordinate this upgrade with FE.	$250,000
		Total Estimated Cost for Project AC1-103	**$41,405,500**

Table 5

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 (Nottingham 138 kV Substation)

Single-Line Diagram

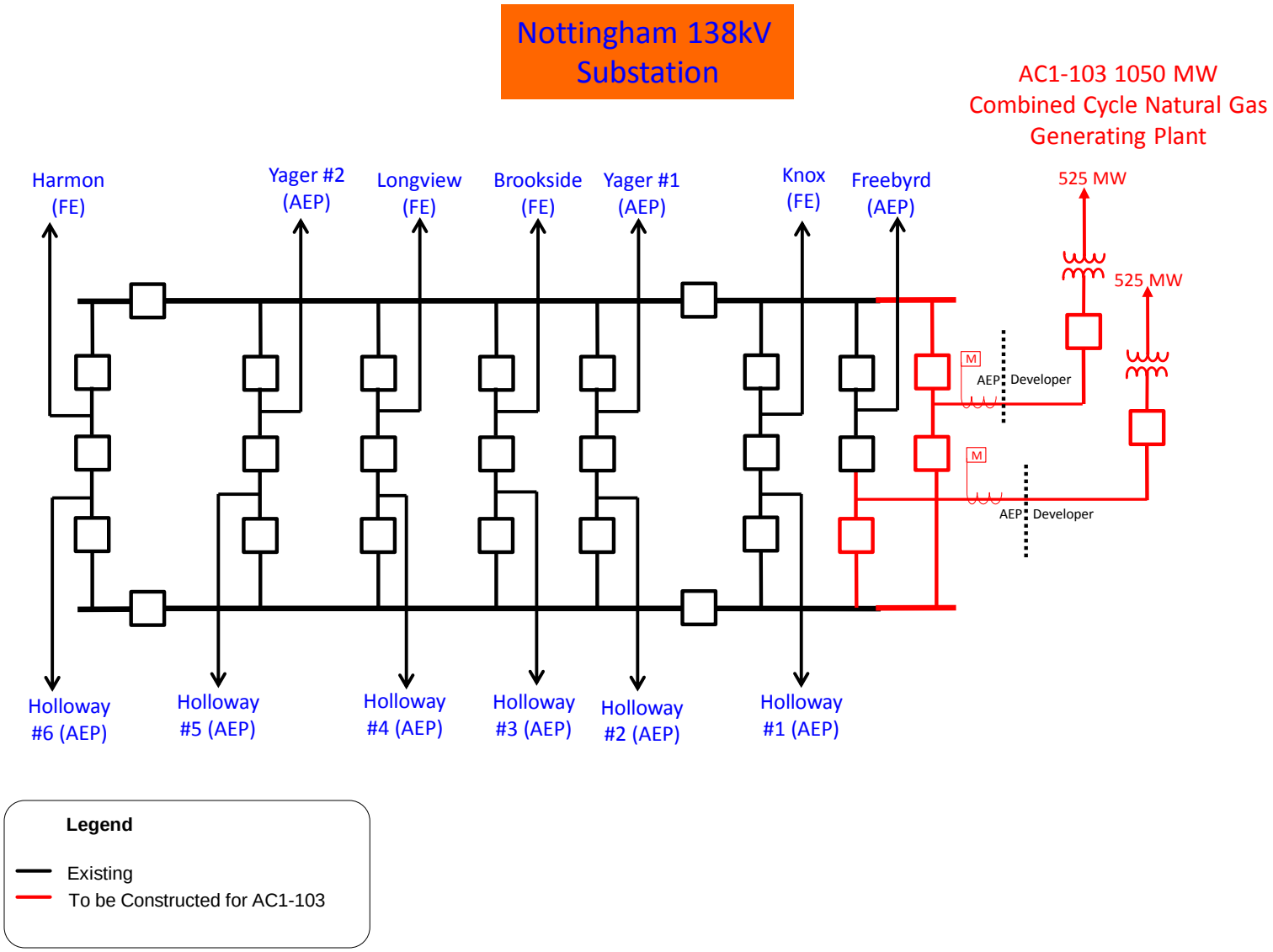
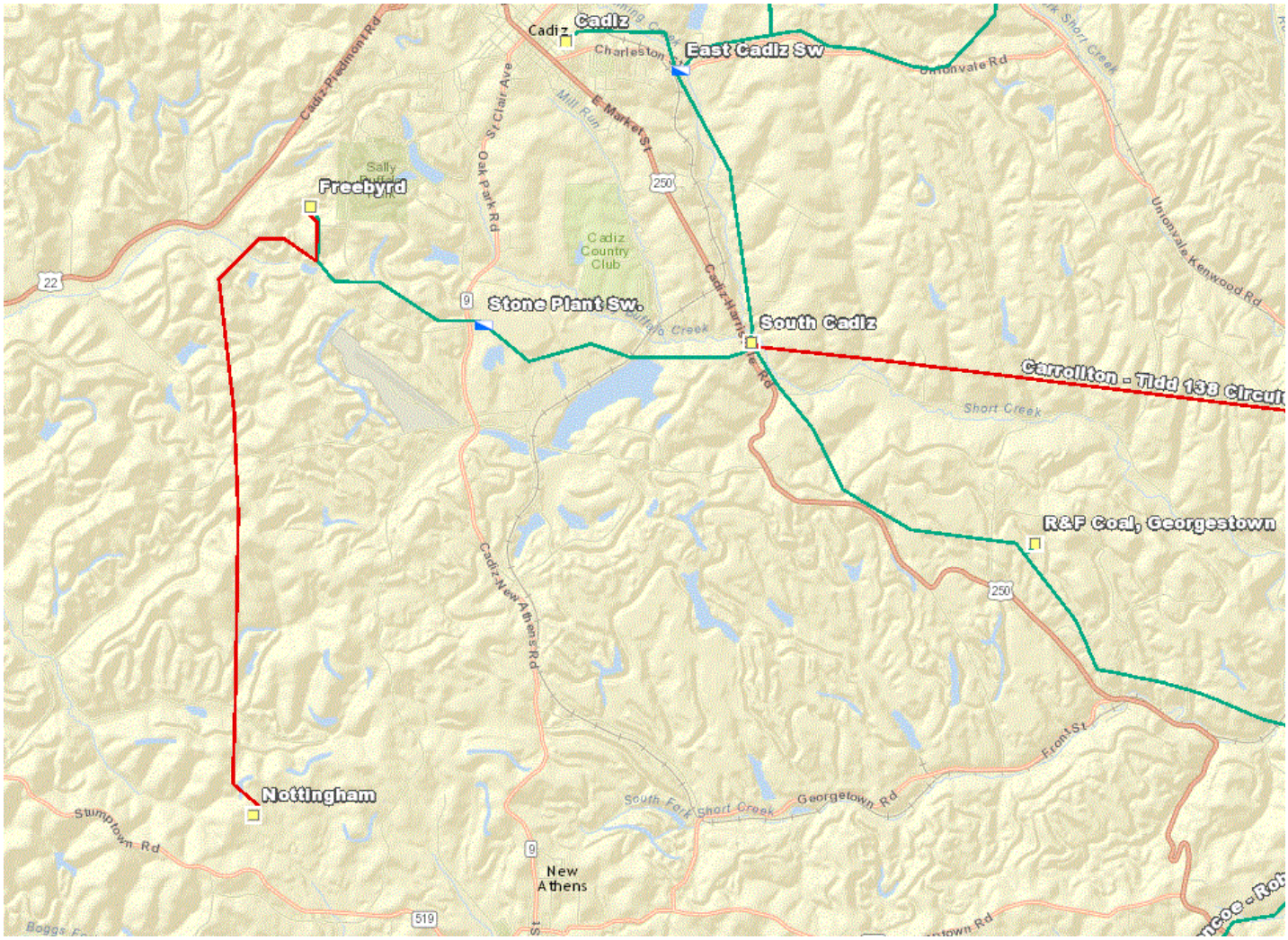


Figure 2: Point of Interconnection (Nottingham 138 kV Substation)



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 05NOTTINGHAM-05YAGER 138 kV line (from bus 247460 to bus 247700 ckt 1) loads from 53.72% to 103.13% (AC power flow) of its emergency rating (291 MVA) for the tower line contingency outage of '9038'. This project contributes approximately 144.21 MW to the thermal violation.

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

Bus Number	*Bus Name*	*Full Contribution*
927021	*AC1-103 C*	*144.21*