Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AD1-113

“Raritan River 230 kV”

75 MWE, 75 MWC Uprate

January 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), has proposed an increase in output of their existing Woodbridge Energy Center natural gas generating facility located at 1070 Riverside Drive, Keasbey, New Jersey (Attachment 1). The uprate will increase the maximum facility output (MFO) of the facility by **75 MW**, for a total plant MFO of 860 MW. The uprate will also increase the Capacity value by **75 MW**, for a total of 800 MW being recognized by PJM as Capacity. (See the summary table below.) The proposed in-service date for this project is **December 1, 2018**. **This study does not imply a Jersey Central Power and Light (JCP&L) commitment to this in-service date.**

Queue Number	MFO (MW)	Capacity (MW)
W4-009	725	725
X4-005	785 (60 MW increase)	725 (0 MW increase)
AD1-113	860 (75 MW increase)	800 (75 MW increase)
Total	**860**	**800**

PJM studied the proposed request and evaluated it for compliance with reliability criteria for summer peak conditions in 2021.

Point of Interconnection

AD1-113 "Raritan River 230 kV" uprate project will be an increase to the existing Woodbridge Energy Center natural gas generation plant which interconnects to the JCP&L transmission system at the Raritan River 230 kV bus. As defined by the IC and shown on Attachment 2, the connection point for this project will be accomplished by utilizing the existing 230 kV point of interconnection for the Woodbridge generation plant at JCP&L's Raritan River substation.

Attachment 2 shows a one-line diagram of the connection facilities that exist for the (AD1-113) generation project. As indicated, it will be studied as a 860 MW injection to the Jersey Central 230 kV system at the existing 230 kV connection for the Woodbridge generation plant at JCP&L's Raritan River substation. The JCP&L facilities required to be upgraded for the primary direct connection, non-direct connection, and network upgrades of the generation project and the associated cost estimate are outlined below.

Cost Summary

The AD1-113 "Raritan River 230 kV" project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 0
Direct Connection Network Upgrades	$ 0
Non Direct Connection Network Upgrades	$ 168,800
Total Costs	**$ 168,800**

In addition, the AD1-113 project may be responsible for a contribution to the following costs:

Description	Total Cost
New System Upgrades	$ 0
Previously Identified Upgrades	$ 0
Total Costs	**$ 0**

The transmission and substation costs given above exclude any applicable state or federal taxes. If at a future date Federal CIAC (contribution in aid of construction) taxes are deemed necessary by the IRS for this project, JCP&L shall be reimbursed by the Interconnection Customer for such taxes. JPCL estimates the tax, if applicable, would be approximately **$26,000**.

The required Attachment Facilities, Direct Connection, and Non-Direct Connection work for the interconnection of the AD1-113 generation uprate project to the JCP&L Transmission System is detailed in the following sections. The associated one-line with the generation project is shown in Attachment 2.

Note that the FE findings were made from a conceptual review of this project. A more detailed review of the connection facilities and their cost will be identified in the System Impact and Facilities Studies. Further note that the cost estimate data contained in this document should be

considered high level estimates since it was produced without a detailed engineering review. The applicant will be responsible for the actual cost of construction. FE herein reserves the right to return to any issues in this document and, upon appropriate justification, request additional monies to complete any reinforcements to the transmission systems.

Attachment Facilities

There is no Attachment Facilities work required for this project.

Direct Connection Cost Estimate

There is no Direct Connection scope of work required for this project.

Non-Direct Connection Cost Estimate

The total preliminary cost estimate for the Non-Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
Make relay setting changes on the 230kV line terminals. @ Raritan River SS	$ 42,200
Make relay setting changes on the 230kV line terminals to Raritan River. @ Parlin SS	$ 42,200
Make relay setting changes on the 230kV line terminals to Raritan River. @ Red Oak SS	$ 42,200
Make relay setting changes on the 230kV line terminals to Raritan River. @ Werner SS	$ 42,200
Total Non-Direct Connection Facility Costs	**$ 168,800**

The total Non-Direct Connection cost estimate for the AD1-113 project is approximately **$168,800**. This work is to perform required relay setting changes at JCP&L's Raritan River, Parlin, Red Oak, and Werner Substations.

JCP&L Interconnection Requirements

Power Flow Analysis

A power flow study was conducted to determine the reliability impact of the proposed (AD1-113) generation project on the JCP&L transmission systems. This study was completed using a 2021 summer peak power flow model that contains a detailed representation of the Jersey Central Power & Light transmission networks in the area of the proposed (AD1-113) generation project. The findings and the recommendations from this analysis are based on a contingency review that was performed to identify the facility loadings and/or voltage conditions that violate the ReliabilityFirst, PJM, or FE Planning Criteria and are attributable to this project. Note that in

accordance with PJM RTEP study procedures, the (AD1-113) generation project under study and earlier active queue projects are considered to be in-service. All active queue projects after the (AD1-113) project are considered to not be in-service.

The results of the analysis show that there are no network upgrades required for the deliverability of the (AD1-113) generation project generation capacity to the JCP&L transmission system. There also are no reinforcements defined for previous projects for which this project will have an impact.

Note that a further conclusion of this study is that it will be mandatory for the 75 MW (AD1-113) portion of the Woodbridge generation plant to have a range of dynamic reactive capability that supports its operation from a 1.0 (unity) to 0.90 lagging power factor at the generator's terminals. The existing 785 MW (725 MW capacity) portion of the Woodbridge generation plant shall retain the power factor requirements stated in the Interconnection Service Agreements for the existing generation. Should the IC fail to provide dynamic reactive capability from the (AD1-113) generation project for any reason once interconnected, the FE and/or PJM Dispatchers may need to take action to curtail its output to prevent non-compliance with voltage criteria.

Short Circuit and Dynamics Analysis

In accordance with the RTEP process, short circuit and dynamics analysis will not be conducted by PJM since the (AD1-113) generation project capacity increase request has no change to the electrical characteristics of the IC generating facility as indicated by the developer.

System Protection Analysis

An analysis was conducted to assess the impact of the (AD1-113) generation project on the system protection requirements in the area. The results of this review have identified the following as a result of the (AD1-113) generation project ring bus direct connection.

For a 75 MW capacity and maximum facility output increase in generation, there are no additional system protection upgrades.

The fault currents at the existing 230 kV connection for the Woodbridge generation plant at JCP&L's Raritan River substation are listed below.

Three phase fault current:	40,800 Amps
Single line to ground fault current:	44,780 Amps
Positive Sequence thevenin (ohms):	0.1842 + j 3.2489
Zero Sequence thevenin (ohms):	0.2707 + j 2.3731

These values are for the future system configuration without the (AD1-113) generation project contribution. Any system changes in the area could have a significant impact on these values. It will be the responsibility of the Interconnection Customer to make any protection upgrades required should this occur. The proposed interconnection facilities must be designed in accordance with the FE "Requirements for Transmission Connected Facilities."

Compliance Issues

The proposed interconnection facilities must be designed in accordance with the FE "Requirements for Transmission Connected Facilities" document located at:

http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx

The IC will also be responsible for following the requirements of the FE "Approved Vendors and Contractors" document which is also located at the above link.

The IC will also be required to meet all PJM, ReliabilityFirst and NERC reliability criteria and operating procedures for standards compliance. For example, the IC will need to properly locate and report the over and under voltage and over and under frequency system protection elements for its units as well as the submission of the generator model and protection data required to satisfy the PJM and ReliabilityFirst audits. Failure to comply with these requirements may result in a disconnection of service if the violation is found to compromise the reliability of the JCP&L systems.

Interconnection Customer Requirements

The IC will be responsible for meeting all criteria as specified in the applicable sections of the FE "Requirements for Transmission Connected Facilities" document including compliance with the FE and PJM generator power factor and voltage control requirements.

http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx

The above requirements are in addition to any metering or other requirements imposed by PJM.

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.

JCP&L Requirements

The IC will be required to comply with all FE revenue metering requirements for generation interconnection customers. The FE revenue metering requirements may be found in the FE "Requirements for Transmission Connected Facilities" document located at the following link:

http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx

Schedule

Based on the extent of the JCP&L primary Non-Direct Connection work required to support the AD1-113 generation project, it is expected to take a **minimum of 7 months** from the date of a fully executed Interconnection Construction Service Agreement to complete the installation subject to market conditions and vendor lead times. This includes the requirement for the Interconnection Customer to make a preliminary payment to JCP&L which funds the construction of the Non-Direct Connection facilities work. It assumes that there will be no environmental or permitting issues to implement the upgrades required for this uprate project and that all system outages will be allowed when requested.

Network Impacts

The Queue Project AD1-113 was evaluated as a 75 MW (Capacity 75 MW) uprate injection into the Raritan River 230 kV bus. Project AD1-113 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD1-113 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis - 2021

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)

None

Steady-State Voltage Requirements
(Results of the steady-state voltage studies should be inserted here)

To be provided in the System Impact Study.

Short Circuit
(Summary of impacted circuit breakers)

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).

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.

None

Light Load Analysis - 2021

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

System Reinforcements

Short Circuit

(Summary form of Cost allocation for breakers will be inserted here if any)

None

Stability and Reactive Power Requirement

(Results of the dynamic studies should be inserted here)

To be determined in System Impact Study.

Summer Peak Load Flow Analysis Reinforcements

New System Reinforcements

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

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)
(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

None

Light Load Load Flow Analysis Reinforcements

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

To be determined in System Impact Phase.

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)

To be determined in System Impact Phase.

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Attachment 1

Raritan River 230 kV
(AD1-113) Generation Project

Project Location

Attachment 2

Raritan River 230 kV
(AD1-113) Generation Project

Planning Interconnection Single Line Diagram