Generation Interconnection

Feasibility Study Report

for

Queue Project AF1-019

BRANCHVILLE-HOLIDAY LAKES 34.5 KV

0 MW Capacity / 20 MW Energy

January, 2020

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1 Introduction

This Feasibility Study has been prepared in accordance with the PJM Open Access Transmission Tariff, 36.2, as well as the Feasibility Study Agreement between the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is Jersey Central Power and Light (JCPL).

2 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. Cost allocation rules for network upgrades can be found in PJM Manual 14A, Attachment B. 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.

PJM utilizes manufacturer models to ensure the performance of turbines is properly captured during the simulations performed for stability verification and, where applicable, for compliance with low voltage ride through requirements. Turbine manufacturers provide such models to their customers. The list of manufacturer models PJM has already validated is contained in Attachment B of Manual 14G. Manufacturer models may be updated from time to time, for various reasons such as to reflect changes to the control systems or to more accurately represent the capabilities turbines and controls which are currently available in the field. Additionally, as new turbine models are developed, turbine manufacturers provide such new models which must be used in the conduct of these studies. PJM needs adequate time to evaluate the new models in order to reduce delays to the System Impact Study process timeline for the Interconnection Customer as well as other Interconnection Customers in the study group. Therefore, PJM will require that any Interconnection Customer with a new manufacturer model must supply that model to PJM, along with a $10,000 fully refundable deposit, no later than three (3) months prior to the starting date of the System Impact Study (See Section 4.3 for starting dates) for the Interconnection Request which shall specify the use of the new model. The Interconnection Customer will be required to submit a completed dynamic model study request form (Attachment B-1 of Manual 14G) in order to document the request for the study.

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.

3 General

The Interconnection Customer (IC), has proposed a Storage generating facility located in Sussex County, New Jersey. The installed facilities will have a total capability of 20 MW with 0 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is March 1, 2021. This study does not imply a TO commitment to this in-service date.

Queue Number	**AF1-019**
Project Name	BRANCHVILLE-HOLIDAY LAKES 34.5 KV
State	New Jersey
County	Sussex
Transmission Owner	JCPL
MFO	20
MWE	20
MWC	0
Fuel	Storage
Basecase Study Year	2023

3.1 Point of Interconnection

The interconnection of the project to the JCPL system will be accomplished by tapping the Branchville-Holiday Lakes 34.5 kV line with a three-switch tap and constructing a one span 34.5 kV line extension. The transmission line tap will be located approximately 10 miles from Branchville substation and 1.50 miles from Holiday Lakes substation. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection line tap and the associated Attachment facilities. The project will also require non-direct connection upgrades at Branchville substation.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AF1-019 generation project to connect to the FirstEnergy ("FE") transmission system. IC will be responsible for constructing all of the facilities on its side of the POI, including the Attachment facilities which connect the generator to the FE transmission system.

3.2 Cost Summary

The AF1-019 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$558,200
Direct Connection Network Upgrade	$0
Non Direct Connection Network Upgrades	$1,320,400
Total Costs	**$1,878,600**

In addition, the AF1-019 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	**$1,072,000**

Cost allocations for these upgrades will be provided in the System Impact Study Report.

The Feasibility Study is used to make a preliminary determination of the type and scope of Attachment Facilities, Local Upgrades, and Network Upgrades that will be necessary to accommodate the Interconnection Request and to provide the Interconnection Customer a preliminary estimate of the time that will be required to construct any necessary facilities and upgrades and the Interconnection Customer's cost responsibility. The System Impact Study provides refined and comprehensive estimates of cost responsibility and construction lead times for new facilities and system upgrades. Facilities Studies will include, commensurate with the degree of engineering specificity as provided in the Facilities Study Agreement, good faith estimates of the cost, determined in accordance with Section 217 of the Tariff,

(a) to be charged to each affected New Service Customer for the Facilities and System Upgrades that are necessary to accommodate this queue project;

(b) the time required to complete detailed design and construction of the facilities and upgrades; and

(c) a description of any site-specific environmental issues or requirements that could reasonably be anticipated to affect the cost or time required to complete construction of such facilities and upgrades.

The costs provided above exclude the Contribution in Aid of Construction ("CIAC") Federal Income Tax Gross Up charge. If, at a future date, it is determined that the CIAC Federal Income Tax Gross charge is required, the Transmission Owner shall be reimbursed by the Interconnection Customer for such taxes.

The required Attachment Facilities and Direct and/or Non-Direct Connection work for the interconnection of the AF1-019 generation project to the FE Transmission System is detailed in the following sections. The associated one-line with the generation project Attachment Facilities and the Primary Direct and Non-Direct Connection facilities are shown in Attachment 1.

4 Transmission Owner Scope of Work

The interconnection of the project to the JCPL system will be accomplished by tapping the Branchville-Holiday Lakes 34.5 kV line with a three-switch tap and constructing a one span 34.5 kV line extension. The transmission line tap will be located approximately 10 miles from Branchville substation and 1.50 miles from Holiday Lakes substation. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection line tap and the associated Attachment facilities. The project will also require non-direct connection upgrades at Branchville substation.

5 Attachment Facilities

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

Description	Total Cost
Install a switch (load-break air switch with SCADA control) tap to interconnect queue project AF1-019 on the Branchville-Holiday Lakes (A781) 34.5 kV line. @ Branchville-Holiday Lakes 34.5 kV: Tap to AF1-019	$281,600
Metering, NPs & Cust Dwg Review @ AF1-019	$276,600
Total Attachment Facility Costs	**$558,200**

6 Direct Connection Cost Estimate

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

Description	Total Cost
Total Direct Connection Facility Costs	$0

7 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
Install (2) switches (load-break air switches with SCADA control) tap to interconnect queue project AF1-019 on the Branchville-Holiday Lakes (A781) 34.5 kV line. @ Branchville-Holiday Lakes 34.5 kV: Tap to AF1-019	$1,302,500
Update relay settings @ Branchville	$17,900
Total Non-Direct Connection Facility Costs	**$1,320,400**

8 Schedule

Based on the scope of work for the Attachment Facilities and the Direct and/or Non-Direct Connection facilities, it is expected to take a minimum of **12 months** after the signing of an Interconnection Construction Service Agreement to complete the installation. This assumes that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the defined interconnection work and network upgrades, and that all transmission system outages will be allowed when requested.

The schedule for the required Network Impact Reinforcements will be more clearly identified in future study phases. The estimate elapsed time to complete each of the required reinforcements is identified in the "System Reinforcements" section of the report.

9 Transmission Owner Analysis

9.1 Power Flow Analysis

FE performed an analysis of its underlying transmission <100 kV system. The AF1-019 project did not contribute to any overloads on the FE transmission <100 kV system.

10 Interconnection Customer Requirements

10.1 System Protection

The IC must design its Customer Facilities in accordance with all applicable standards, including the standards in FE's "Requirements for Transmission Connected Facilities" document located at: http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx. Preliminary Protection requirements will be provided as part of the Facilities Study. Detailed Protection Requirements will be provided once the project enters the construction phase.

All new generator only and new generator plus load facilities must be isolated from the FE transmission System by a Power Transformer. Section 14.2.6 of FE's "Requirements for Transmission Connected Facilities" document specifies the winding configurations of the transformer connecting to a non-effectively grounded portion of the FE Transmission system shall be determined by FE on a case-by-case basis. The IC has requested a GSU transformer winding configuration that will not be accepted. The GSU transformer must have a delta or ungrounded wye connection on the high (utility) side.

10.2 Compliance Issues and Interconnection Customer Requirements

The proposed Customer Facilities must be designed in accordance with FE's "Requirements for Transmission Connected Facilities" document located at: http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx. In particular, the IC is responsible for the following:

1. The purchase and installation of a fully rated 34.5 kV circuit breaker to protect the AF1-019 generator lead line. A single circuit breaker must be used to protect this line; if the project has several GSU transformers, the individual GSU transformer breakers cannot be used to protect this line.

2. The purchase and installation of the minimum required FE generation interconnection relaying and control facilities. This includes over/under voltage protection, over/under frequency protection, and zero sequence voltage protection relays.

3. The purchase and installation of supervisory control and data acquisition ("SCADA") equipment to provide information in a compatible format to the FE Transmission System Control Center.

4. Compliance with the FE and PJM generator power factor and voltage control requirements.

5. The execution of a back-up service agreement to serve the customer load supplied from the AF1-019 generation project metering point when the units are out-of-service. This assumes the intent of the IC is to net the generation with the load.

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 FE system.

10.3 Power Factor Requirements

The IC shall design its non-synchronous Customer Facility with the ability to maintain a power factor of at least 0.95 leading (absorbing VARs) to 0.95 lagging (supplying VARs) measured at the high-side of the facility substation transformer(s) connected to the FE transmission system.

11 Revenue Metering and SCADA Requirements

11.1 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 Section 8 of Attachment O.

11.2 JCPL Requirements

The IC will be required to comply with all FE revenue metering requirements for generation interconnection customers which can be found in FE's "Requirements for Transmission Connected Facilities" document located at: http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx.

12 Network Impacts

The Queue Project AF1-019 was evaluated as a 20.0 MW (Capacity 0.0 MW) injection tapping the Branchville to Holiday Lakes 34.5 kV line in the JCPL area. Project AF1-019 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-019 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Load Flow

13 Generation Deliverability

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

None

14 Multiple Facility Contingency

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

None

15 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)

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
50234146	206254	28W WHARTN	115.0	JCP&L	206232	28FRNKLNJ	115.0	JCP&L	1	JC-P2-2-JCN-115-003	bus	148.0	102.39	105.38	DC	4.42
50234184	206254	28W WHARTN	115.0	JCP&L	206231	28FRNKLND	115.0	JCP&L	1	JC-P2-2-JCN-115-002	bus	148.0	112.31	115.01	DC	3.99
50234522	206254	28W WHARTN	115.0	JCP&L	206231	28FRNKLND	115.0	JCP&L	1	JC-P2-3-JCN-115-43	breaker	148.0	112.38	115.08	DC	3.99
50234523	206254	28W WHARTN	115.0	JCP&L	206231	28FRNKLND	115.0	JCP&L	1	JC-P2-3-JCN-230-16	breaker	148.0	104.34	109.18	DC	7.16
50235783	206254	28W WHARTN	115.0	JCP&L	206231	28FRNKLND	115.0	JCP&L	1	JC-P7-1-JCN-230-11	tower	148.0	104.34	109.18	DC	7.16

16 Potential Congestion due to Local Energy Deliverability

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.

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
50235420	206254	28W WHARTN	115.0	JCP&L	206231	28FRNKLN D	115.0	JCP&L	1	JC-P1-2-JCN-115-053	operation	148.0	115.66	118.08	DC	3.58

17 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
50235783,50234522,50234523,50234184	2	**28W WHARTN 115.0 kV - 28FRNKLN D 115.0 kV Ckt 1**	**JCP&L-AF1-F-0032a (188) : Replace relaying at West Wharton** **Project Type : FAC** **Cost : $469,000** **Time Estimate : 12.0 Months** **JCP&L-AF1-F-0032b (189) : Reconductor substation conductor West Wharton** **Project Type : FAC** **Cost : $134,000** **Time Estimate : 6.0 Months**	$603,000
50234146	1	**28W WHARTN 115.0 kV - 28FRNKLN J 115.0 kV Ckt 1**	**JCP&L-AF1-F-0033a (191) : Replace relaying at West Wharton** **Project Type : FAC** **Cost : $469,000** **Time Estimate : 12.0 Months**	$469,000
			TOTAL COST	**$1,072,000**

18 Flow Gate Details

The following indices contain additional information about each flowgate presented in the body of the report. For each index, 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.

18.1 Index 1

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
50234146	206254	28W WHARTN	JCP&L	206232	28FRNKLN J	JCP&L	1	JC-P2-2-JCN-115-003	bus	148.0	102.39	105.38	DC	4.42

Bus #	Bus	MW Impact
207411	AA2-060 BAT	1.7513
207414	AA2-061 BAT	2.3351
938413	AE1-060 BAT	1.2941
942253	AE2-237 BAT	64.9811
943483	AF1-019 BAT	4.4206
946393	AF1-303 BAT	86.6336
946613	AF1-325 BAT	9.8374
LGEE	LGEE	0.0023
CPLE	CPLE	0.0026
G-007A	G-007A	0.0479
VFT	VFT	0.1677
WEC	WEC	0.0013
CBM-W2	CBM-W2	0.0328
CBM-W1	CBM-W1	0.0500
TVA	TVA	0.0056
CBM-S2	CBM-S2	0.0231
CBM-S1	CBM-S1	0.0341
MEC	MEC	0.0064

18.2 Index 2

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
50234522	206254	28W WHARTN	JCP&L	206231	28FRNKLND	JCP&L	1	JC-P2-3-JCN-115-43	breaker	148.0	112.38	115.08	DC	3.99

Bus #	Bus	MW Impact
207411	AA2-060 BAT	1.5819
207414	AA2-061 BAT	2.1092
938413	AE1-060 BAT	1.1708
942253	AE2-237 BAT	86.7363
943483	AF1-019 BAT	3.9928
946393	AF1-303 BAT	59.2609
946613	AF1-325 BAT	8.8858
LGEE	LGEE	0.0011
CPLE	CPLE	0.0020
G-007A	G-007A	0.1343
VFT	VFT	0.5096
WEC	WEC	0.0006
CBM-W2	CBM-W2	0.0164
CBM-W1	CBM-W1	0.0250
TVA	TVA	0.0028
CBM-S2	CBM-S2	0.0116
CBM-S1	CBM-S1	0.0170
MEC	MEC	0.0032

Affected Systems

19 Affected Systems

19.1 LG&E

LG&E Impacts to be determined during later study phases (as applicable).

19.2 MISO

MISO Impacts to be determined during later study phases (as applicable).

19.3 TVA

TVA Impacts to be determined during later study phases (as applicable).

19.4 Duke Energy Progress

Duke Energy Progress Impacts to be determined during later study phases (as applicable).

19.5 NYISO

NYISO Impacts to be determined during later study phases (as applicable).

20 Contingency Definitions

Contingency Name	Contingency Definition
JC-P2-3-JCN-230-16	CONTINGENCY 'JC-P2-3-JCN-230-16' /* KITTATINY-NEWTON & NEWTON BK2 (NT_GCB) DISCONNECT BRANCH FROM BUS 206242 TO BUS 206260 CKT 1 /* 28KITATINY 230 28NEWTON 230 DISCONNECT BRANCH FROM BUS 206260 TO BUS 206211 CKT 1 /* 28NEWTON 230 28NEWTON 35 DISCONNECT BRANCH FROM BUS 206260 TO BUS 206211 CKT 2 /* 28NEWTON 230 28NEWTON 35 DISCONNECT BUS 206211 /* 28NEWTON 35 DISCONNECT BUS 206260 /* 28NEWTON 230 END
JC-P2-3-JCN-115-43	CONTINGENCY 'JC-P2-3-JCN-115-43' /* FLANDERS-WEST WHARTON & WEST WHARTON 115 KV A BUS (R918_OCB) DISCONNECT BRANCH FROM BUS 206254 TO BUS 206232 CKT 1 /* 28W WHARTN 115 28FRNKLN J 115 DISCONNECT BRANCH FROM BUS 206230 TO BUS 206254 CKT 1 /* 28FLANDERS 115 28W WHARTN 115 DISCONNECT BRANCH FROM BUS 206230 TO BUS 206216 CKT 1 /* 28FLANDERS 115 28FLANDERS 35 END
JC-P1-2-JCN-115-053	CONTINGENCY 'JC-P1-2-JCN-115-053' /* WEST WHARTON - FRANKLIN-VERNON-SUGRLOAF J932 DISCONNECT BRANCH FROM BUS 206254 TO BUS 206232 CKT 1 /* 28W WHARTN 115 28FRNKLN J 115 DISCONNECT BRANCH FROM BUS 206232 TO BUS 206253 CKT 1 /* 28FRNKLN J 115 28VERNON J 115 DISCONNECT BRANCH FROM BUS 206232 TO BUS 206208 CKT 2 /* 28FRNKLN J 115 28FRANKLIN 35 DISCONNECT BRANCH FROM BUS 206253 TO BUS 206210 CKT 1 /* 28VERNON J 115 28VERNON 35 DISCONNECT BUS 206232 /* 28FRNKLN J 115 DISCONNECT BUS 206253 /* 28VERNON J 115 END
JC-P2-2-JCN-115-003	CONTINGENCY 'JC-P2-2-JCN-115-003' /* WEST WHARTON 115 KV B BUS FAULT DISCONNECT BRANCH FROM BUS 206254 TO BUS 206231 CKT 1 /* 28W WHARTN 115 28FRNKLN D 115 REDUCE BUS 206254 SHUNT BY 100 PERCENT /* 28W WHARTN 115 END

Contingency Name	Contingency Definition
JC-P2-2-JCN-115-002	CONTINGENCY 'JC-P2-2-JCN-115-002' /* WEST WHARTON 115 KV A BUS FAULT DISCONNECT BRANCH FROM BUS 206254 TO BUS 206230 CKT 1 /* 28W WHARTN 115 28FLANDERS 115 DISCONNECT BRANCH FROM BUS 206254 TO BUS 206232 CKT 1 /* 28W WHARTN 115 28FRNKLN J 115 END
JC-P7-1-JCN-230-11	CONTINGENCY 'JC-P7-1-JCN-230-11' /* KITTATINNY-NEWTON & NEWTON-MONTVILLE 230 KV DISCONNECT BRANCH FROM BUS 206242 TO BUS 206260 CKT 1 /* 28KITATINY 230 28NEWTON 230 DISCONNECT BRANCH FROM BUS 206260 TO BUS 206211 CKT 1 /* 28NEWTON 230 28NEWTON 35 DISCONNECT BRANCH FROM BUS 206260 TO BUS 206264 CKT 1 /* 28NEWTON 230 28LK ILIFF 230 DISCONNECT BRANCH FROM BUS 206264 TO BUS 206244 CKT 1 /* 28LK ILIFF 230 28MONTVILE 230 DISCONNECT BRANCH FROM BUS 206260 TO BUS 206211 CKT 2 /* 28NEWTON 230 28NEWTON 35 DISCONNECT BUS 206260 /* 28NEWTON 230 DISCONNECT BUS 206211 /* 28NEWTON 35 DISCONNECT BUS 206264 /* 28LK ILIFF 230 END

Short Circuit

21 Short Circuit

The following Breakers are overduty:

None

22 Attachment One: One Line Diagram