Generation Interconnection

Feasibility Study Report

for

Queue Project AF2-141

LICK RUN 115 KV

8 MW Capacity / 0 MW Energy

July 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 Mid-Atlantic Interstate Transmission, LLC (MAIT) (PENELEC Zone).

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.

An Interconnection Customer 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.

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 an uprate to a planned/existing Storage generating facility located in Somerset, Pennsylvania. This project is an increase to the Interconnection Customer's AF1-143 project, which will share the same point of interconnection. The AF2-141 queue position is an 8 MW Capacity uprate (0 MW Energy uprate) to the previous project. The total installed facilities will have a capability of 100 MW with 68 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this uprate project is July 01, 2023. This study does not imply a TO commitment to this in-service date.

Queue Number	**AF2-141**
Project Name	LICK RUN 115 KV
State	Pennsylvania
County	Somerset
Transmission Owner	PENELEC
MFO	100
MWE	0
MWC	8
Fuel	Storage
Basecase Study Year	2023

Any new service customers who can feasibly be commercially operable prior to June 1st of the basecase study year are required to request interim deliverability analysis.

4 Point of Interconnection

The AF2-141 project is a capacity-only uprate to the proposed AF1-143 project and the Point of Interconnection will remain unchanged. The IC will not incur any connection facility upgrade costs for this project.

Attachment 1 shows a one-line diagram of the proposed primary Direct Connection facilities for the AF2-141 generation project to connect to the FirstEnergy ("FE") Transmission System. The IC will be responsible for constructing the facilities on its side of the POI, including the Attachment Facilities which connect the generator to the FE Transmission System's Direct Connection facilities.

5 Cost Summary

The AF2-141 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	$0
Total System Network Upgrade Costs	$0
Total Costs	$0

6 Transmission Owner Scope of Work

The AF2-141 project is a capacity-only uprate to the proposed AF1-143 project and the Point of Interconnection will remain unchanged. The IC will not incur any connection facility upgrade costs for this project.

The total physical interconnection costs is given in the table below:

Description	Total Cost
Total Physical Interconnection Costs	$0

7 Schedule

There is no scope of work for the interconnection facilities. The schedule for the required Network Impact Reinforcements will be more clearly identified in future study phases.

8 Transmission Owner Analysis

FE performed an analysis of its underlying transmission <100 kV system. The AF2-141 project did not contribute to any overloads on the <100 kV FE transmission system.

9 Interconnection Customer Requirements

9.1 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.

The IC has requested a non-standard GSU transformer winding configuration. This transformer is in violation of section 14.2.6 of FE's "Requirements for Transmission Connected Facilities" document and will not be accepted. The GSU transformer must have a grounded wye connection on the high (utility) side and a delta connection on the low (generator) side.

9.2 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 115 kV circuit breaker to protect the 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 AF2-141 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 Transmission System.

9.3 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.

10 Revenue Metering and SCADA Requirements

10.1 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.

10.2 Meteorological Data Reporting Requirements

The solar generation facility shall provide the Transmission Provider with site-specific meteorological data including:

- Back Panel temperature (Fahrenheit)
- Irradiance (Watts/meter2)
- Ambient air temperature (Fahrenheit) – (Accepted, not required)
- Wind speed (meters/second) – (Accepted, not required)
- Wind direction (decimal degrees from true north) – (Accepted, not required)

10.3 Interconnected Transmission Owner Requirements

The IC will be required to comply with all Interconnected Transmission Owner's revenue metering requirements for generation interconnection customers located at the following link:

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

11 Summer Peak - Load Flow Analysis

The Queue Project AF2-141 was evaluated as a 0.0 MW (Capacity 8.0 MW) injection at the Lick Run 115 kV substation in the PENELEC area. Project AF2-141 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF2-141 was studied with a commercial probability of 53.0 %. Potential network impacts were as follows:

11.1 Generation Deliverability

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

None

11.2 Multiple Facility Contingency

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

None

11.3 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

11.4 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
101064963	200742	26TOWER 51	115.0	PENELEC	200741	26SEWARD	115.0	PENELEC	1	AP-P1-3-PN-115-010	operation	185.0	113.63	115.09	DC	2.71

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
101064916	200743	26HOOVERSV	115.0	PENELEC	200742	26TOWER 51	115.0	PENELEC	1	AP-P1-3-PN-115-010	operation	172.0	135.75	137.34	DC	2.74
101064921	200743	26HOOVERSV	115.0	PENELEC	200742	26TOWER 51	115.0	PENELEC	1	Base Case	operation	137.0	114.74	116.13	DC	1.91
101065103	200744	26SOMERST	115.0	PENELEC	200743	26HOOVERSV	115.0	PENELEC	1	AP-P1-3-PN-115-010	operation	190.0	113.74	115.64	DC	3.61
101065158	200744	26SOMERST	115.0	PENELEC	200802	26RALPHTON	115.0	PENELEC	1	PN-P1-2-PN-115-066	operation	185.0	104.49	106.48	DC	3.7
101065184	200745	26ALLEGHEN	115.0	PENELEC	200884	26NEW BALT	115.0	PENELEC	1	Base Case	operation	133.0	99.37	100.08	DC	0.95
101064910	200746	26ROCKWOOD	115.0	PENELEC	200744	26SOMERST	115.0	PENELEC	1	AP-P1-3-PN-115-010	operation	179.0	169.78	174.25	DC	8.0
101064915	200746	26ROCKWOOD	115.0	PENELEC	200744	26SOMERST	115.0	PENELEC	1	Base Case	operation	148.0	121.29	125.05	DC	5.56
101064989	200746	26ROCKWOOD	115.0	PENELEC	202650	26HIGHPOINT	115.0	PENELEC	1	PN-P1-3-PN-115-029	operation	179.0	125.18	126.83	DC	2.96
101064990	200746	26ROCKWOOD	115.0	PENELEC	202650	26HIGHPOINT	115.0	PENELEC	1	Base Case	operation	148.0	131.47	133.12	DC	2.44
101064904	200747	26PENN-MAR	115.0	PENELEC	200762	26GARRETT	115.0	PENELEC	1	PN-P1-3-PN-115-025	operation	167.0	170.61	175.4	DC	8.0
101064906	200747	26PENN-MAR	115.0	PENELEC	200762	26GARRETT	115.0	PENELEC	1	Base Case	operation	137.0	158.02	159.8	DC	2.44
98718328	200762	26GARRETT	115.0	PENELEC	235470	01GARRET	115.0	AP	1	PN-P1-3-PN-115-025	operation	160.0	189.94	194.94	DC	8.0
98718330	200762	26GARRETT	115.0	PENELEC	235470	01GARRET	115.0	AP	1	Base Case	operation	133.0	176.33	178.16	DC	2.44
101064899	200856	26LICK RUN	115.0	PENELEC	200746	26ROCKWOOD	115.0	PENELEC	1	Base Case	operation	137.0	170.24	176.08	DC	8.0
101064949	202637	26PRIDE	115.0	PENELEC	200744	26SOMERST	115.0	PENELEC	1	Base Case	operation	133.0	149.11	150.89	DC	2.37
101064946	202647	26KIMRUN TAP	115.0	PENELEC	202637	26PRIDE	115.0	PENELEC	1	Base Case	operation	133.0	151.52	153.3	DC	2.37
101064952	202650	26HIGHPOINT	115.0	PENELEC	200747	26PENN-MAR	115.0	PENELEC	1	Base Case	operation	137.0	154.48	156.26	DC	2.44
101064953	202650	26HIGHPOINT	115.0	PENELEC	200747	26PENN-MAR	115.0	PENELEC	1	PN-P1-3-PN-115-025	operation	174.0	160.29	164.88	DC	8.0
100562483	235469	01GARRET	138.0	AP	934440	AD1-068 TAP	138.0	AP	1	PN-P1-3-PN-115-025	operation	191.0	128.99	131.81	DC	5.37

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
100562434	235470	01GARRET	115.0	AP	235469	01GARRET	138.0	AP	1	PN-P1-3-PN-115-025	operation	196.0	155.05	159.13	DC	8.0
100562437	235470	01GARRET	115.0	AP	235469	01GARRET	138.0	AP	1	Base Case	operation	169.0	138.76	140.21	DC	2.44
100562424	934440	AD1-068 TAP	138.0	AP	235120	01ALBRIG	138.0	AP	1	PN-P1-3-PN-115-025	operation	191.0	163.45	166.27	DC	5.37
101064943	945670	AF1-232 TAP	115.0	PENELEC	202647	26KIMRUN TAP	115.0	PENELEC	1	Base Case	operation	133.0	151.52	153.3	DC	2.37

11.5 System Reinforcements - Summer Peak Load Flow

None

11.6 Flow Gate Details

The following indices contain additional information about each facility presented in the body of the report. For each index, a description of the flowgate and its contingency was included for convenience. The intent of the indices is to provide more details on which projects/generators have contributions to the flowgate in question. All New Service Queue Requests, through the end of the Queue under study, that are contributors to a flowgate will be listed in the indices. Please note that there may be contributors that are subsequently queued after the queue under study that are not listed in the indices. Although this information is not used "as is" for cost allocation purposes, it can be used to gage the impact of other projects/generators. It should be noted the project/generator MW contributions presented in the body of the report are Full MW Impact contributions which are also noted in the indices column named "Full MW Impact", whereas the loading percentages reported in the body of the report, take into consideration the PJM Generator Deliverability Test rules such as commercial probability of each project as well as the ramping impact of "Adder" contributions. The MW Impact found and used in the analysis is shown in the indices column named "Gendeliv MW Impact".

None

11.7 Queue Dependencies

The Queue Projects below are listed in one or more indices for the overloads identified in your report. These projects contribute to the loading of the overloaded facilities identified in your report. The percent overload of a facility and cost allocation you may have towards a particular reinforcement could vary depending on the action of these earlier projects. The status of each project at the time of the analysis is presented in the table. This list may change as earlier projects withdraw or modify their requests.

None

11.8 Contingency Descriptions

Contingency Name	Contingency Definition
PN-P1-3-PN-115-029	CONTINGENCY 'PN-P1-3-PN-115-029' /* HOOVERSVILLE #2 XFMR FAULT DISCONNECT BRANCH FROM BUS 200743 TO BUS 200789 CKT 2 /* 26HOOVERSV 115 26HOOVER#2 23 DISCONNECT BRANCH FROM BUS 200743 TO BUS 200742 CKT 1 /* 26HOOVERSV 115 26TOWER 51 115 DISCONNECT BRANCH FROM BUS 200743 TO BUS 200744 CKT 1 /* 26HOOVERSV 115 26SOMERST 115 END
AP-P1-3-PN-115-010	CONTINGENCY 'AP-P1-3-PN-115-010' /* GARRETT 138/115KV XFMR FAULT OPEN BRANCH FROM BUS 235469 TO BUS 235470 CKT 1 /* 01GARRET 138.00 01GARRET 115.00 END
PN-P2-3-PN-115-35E	CONTINGENCY 'PN-P2-3-PN-115-35E' /* #14 STUCK TIE BREAKER BETWEEN BUSES 1 AND 2 DISCONNECT BRANCH FROM BUS 200734 TO BUS 200743 CKT 1 /* 26SCALP L. 115 26HOOVERSV 115 DISCONNECT BRANCH FROM BUS 200743 TO BUS 200802 CKT 1 /* 26HOOVERSV 115 26RALPHTON 115 DISCONNECT BRANCH FROM BUS 200743 TO BUS 200776 CKT 1 /* 26HOOVERSV 115 26HOOVER#1 23 DISCONNECT BRANCH FROM BUS 200743 TO BUS 200744 CKT 1 /* 26HOOVERSV 115 26SOMERST 115 DISCONNECT BRANCH FROM BUS 200742 TO BUS 200743 CKT 1 /* 26TOWER 51 115 26HOOVERSV 115 DISCONNECT BRANCH FROM BUS 200743 TO BUS 200789 CKT 2 /* 26HOOVERSV 115 26HOOVER#2 23 END
PN-P1-3-PN-115-025	CONTINGENCY 'PN-P1-3-PN-115-025' /* SOMERSET #1 XFMR FAULT DISCONNECT BRANCH FROM BUS 200744 TO BUS 200774 CKT 1 /* 26SOMERST 115 26SOMRSET1 23 DISCONNECT BRANCH FROM BUS 200744 TO BUS 200746 CKT 1 /* 26SOMERST 115 26ROCKWOOD 115 DISCONNECT BRANCH FROM BUS 200744 TO BUS 202637 CKT 1 /* 26SOMERST 115 26PRIDE 115 DISCONNECT BRANCH FROM BUS 202637 TO BUS 202647 CKT 1 /* 26PRIDE 115 26KIMRUN TAP 115 DISCONNECT BRANCH FROM BUS 200744 TO BUS 200743 CKT 1 /* 26SOMERST 115 26HOOVERSV 115 END
PN-P1-2-PN-115-066	CONTINGENCY 'PN-P1-2-PN-115-066' /* HOOVERSVILLE - SOMERSET 115KV DISCONNECT BRANCH FROM BUS 200743 TO BUS 200744 CKT 1 /* 26HOOVERSV 115 26SOMERST 115 END

Contingency Name	Contingency Definition
Base Case	
PN-P7-1-PN-230-001	CONTINGENCY 'PN-P7-1-PN-230-001' /* HOMER CITY - HOOVERSVILLE 230KV & SEWARD - TOWER 51 115KV DISCONNECT BRANCH FROM BUS 200767 TO BUS 200768 CKT 1 /* 26HOMER CT 230 26QUEMAHON 230 DISCONNECT BRANCH FROM BUS 200768 TO BUS 200796 CKT 1 /* 26QUEMAHON 230 26HOOVRSVL 230 DISCONNECT BRANCH FROM BUS 200796 TO BUS 200743 CKT 3 /* 26HOOVRSVL 230 26HOOVERSV 115 DISCONNECT BRANCH FROM BUS 200741 TO BUS 200742 CKT 1 /* 26SEWARD 115 26TOWER 51 115 END

12 Short Circuit Analysis

To be performed in the System Impact phase.

13 Affected Systems

None

14 Attachment 1: One Line Diagram