Generation Interconnection

Combined Feasibility / System Impact Study Report

for

Queue Project AE2-054

WARFORDSBURG 34 KV

12 MW Capacity / 20 MW Energy

December 2019

Table Of Contents

1 Introduction

This Combined Feasibility/System Impact Study has been prepared in accordance with the PJM Open Access Transmission Tariff, 36.2, as well as the Feasibility Study Agreement between GPPT LLC (partnership between GlidePath & ProTech, GPPT), the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is West Penn Power Company (WPP).

2 Preface

The intent of the Combined Feasibility/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: 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 an Interconnection Customer 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 possibility of sharing the reinforcement costs with other projects may be identified in the Feasibility Study, but the actual allocation, if any, is included in the System Impact Study.

The Interconnection Customer seeking to interconnect a wind or solar generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per Schedule H to the Interconnection Service Agreement and Section 8 of Manual 14D.

The 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 associated with them will be addressed when seeking an Interconnection Agreement as outlined below. Developer will also be responsible for providing and installing metering equipment in compliance with applicable PJM and Transmission Owner standards.

3 General

The Interconnection Customer (IC) has proposed a Solar generating facility located in Franklin County, Mercersberg, Pennsylvania. The installed facilities will have a total capability of 20 MW with 12 MW of this output being recognized by PJM as Capacity. The proposed Commercial Operation Date for this project is December 31, 2020. (WMPA indicates March 31, 2021 for COD date to be conservative as it is an "on or before" date.)

Queue Number	AE2-054
Project Name	WARFORDSBURG 34 KV
Interconnection Customer	GPPT LLC (partnership between GlidePath & ProTech, GPPT)
State	Pennsylvania
County	Franklin
Transmission Owner	APS
MFO	20
MWE	20
MWC	12
Fuel	Solar
Basecase Study Year	2022

4 Point of Interconnection (POI)

The interconnection of the project at the Primary POI will be accomplished by tapping the Mercersburg – Snowmaker 34.5 kV line and constructing a one span tap. The transmission line tap will be located approximately 630 feet from Whitetail 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.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AE2-054 generation project to connect to the FirstEnergy ("FE") transmission system. Attachment 2 provides the proposed location for the point of interconnection. 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.

5 Cost Summary

The AE2-054 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$22,034
Direct Connection Network Upgrade	$44,066
Non Direct Connection Network Upgrades	$0
Contribution to Previously Identified Upgrades	$0[1]
Total Costs	$66,100

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 AE2-054 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.

[1] Note: This project contributes to an overload on the Roxbury 138/115 kV Transformer (See Network Impacts Section). There is a Supplemental Project s1643 with an expected in-service date of 11/24/2020 which will resolve this overload. Please note that the Transmission Owner is not obligated to meet their expected in-service date of 11/24/2020 for this Supplemental Project. The in-service date of s1643 is subject to change at the discretion of the Transmission Owner. The AE2-054 project will need this upgrade in-service to be deliverable to the system. If Queue Project AE2-054 desires to come into service prior to completion of the upgrade, they will need an interim deliverability study. The customer can request the Transmission Owner to accelerate the project but it is not guaranteed that the Transmission Owner will be able to accommodate the request.

6 Transmission Owner Scope of Work

The interconnection of the project at the Primary POI will be accomplished by tapping the Mercersburg – Snowmaker 34.5 kV line and constructing a one span tap. The transmission line tap will be located approximately 630 feet from Whitetail 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.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AE2-054 generation project to connect to the FirstEnergy ("FE") transmission system. Attachment 2 provides the proposed location for the point of interconnection. 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's direct connection facilities.

7 Attachment Facilities

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

Description	Total Cost
Install 34.5 kV Tap Switch and Provide Revenue Meter Package	$22,034
Total Direct Connection Facility Costs	$22,034

8 Direct Connection Cost Estimate

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

Description	Total Cost
Tap the Mercersburg – Snowmaker 34.5 kV Line and Install two 34.5 kV Line Switches	$44,066
Total Attachment Facility Costs	$44,066

9 Non-Direct Connection Cost Estimate

There is no Non-Direct Connection scope of work required.

10 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 **10 months** after the signing of an Interconnection Construction Service Agreement to complete the installation. This includes the requirement for the IC to make a preliminary payment that compensates FE for the first three months of the engineering design work that is related to the construction of the interconnection substation. 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 direct connection and network upgrades, and that all transmission system outages will be allowed when requested.

11 Transmission Owner Analysis

11.1 Power Flow Analysis

FE performed an analysis of its underlying transmission <100 kV system. The AE2-054 project did not contribute to any overloads on the FE transmission <100 kV system.

12 Interconnection Customer Requirements

12.1 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.

12.2 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 AE2-054 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 AE2-054 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.

12.3 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.

13 Revenue Metering and SCADA Requirements

13.1 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.

13.2 FE 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

14 Network Impacts

The Queue Project AE2-054 was evaluated as a 20.0 MW (Capacity 12.0 MW) injection at the Whitetail 34.5kV substation in the APS area. Project AE2-054 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-054 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Load Flow

15 Generation Deliverability

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

None

16 Multiple Facility Contingency

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

None

17 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	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
1354793	200532	26ROXBURY	PENELEC	200520	26ROXBURY	PENELEC	2	ME_P4-500-002H	breaker	150.0	114.34	115.79	AC	2.22

18 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	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
1355759	200532	26ROXBURY	PENELEC	200520	26ROXBURY	PENELEC	2	Base Case	operation	124.0	103.11	104.84	DC	2.15
6863095	200532	26ROXBURY	PENELEC	200520	26ROXBURY	PENELEC	2	AP-P1-2-WP-138-109	operation	150.0	102.87	105.02	DC	3.23

19 Steady State Voltage Requirements

None

20 Stability

Not required for this project.

21 System Reinforcements:

ID	Index	Facility	Upgrade Description	Cost
1354793	1	26ROXBURY 138.0 kV - 26ROXBURY 115.0 kV Ckt 2	PENELEC Existing PJM Supplemental Upgrade S1643 - Replace the existing Roxbury 100 MVA 138/115 kV transformer with a 224 MVA unit. Convert Roxbury 115 kV substation into a four (4) breaker ring bus. IS Date: 11/24/2020 Note: AE2-054 does not have a cost responsibility for this upgrade. AE2-054 will need this upgrade in-service to be deliverable to the PJM system. If AE2-054 intends to come into service prior to completion of the upgrade, they will need an interim study.	$0
			TOTAL COST	$0

22 Light Load Analysis

Not required.

23 Flow Gate Details

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.

23.1 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
1354793	200532	26ROXBURY	PENELEC	200520	26ROXBURY	PENELEC	2	ME_P4-500-002H	breaker	150.0	114.34	115.79	AC	2.22

Bus #	Bus	MW Impact
235723	01GUILF1	0.83
235724	01GUILF2	0.83
237329	01CHBRG_I12	0.77
905554	W4-102 E	0.64
918731	AA1-092 C	0.52
918732	AA1-092 E	0.26
918761	AA1-095 C	0.36
918762	AA1-095 E	0.18
923871	AB2-027 C	0.17
923872	AB2-027 E	0.29
924482	AB2-097 E	0.61
930781	AB1-123 C O1	0.38
930782	AB1-123 E O1	0.62
930821	AB1-127 C	1.02
930822	AB1-127 E	1.66
930831	AB1-128 C	1.02
930832	AB1-128 E	1.66
933251	AC2-136 C	0.32
933252	AC2-136 E	0.36
933973	AD1-020 BAT	1.13
934362	AD1-060 E	0.85
934371	AD1-061 C	0.85
934372	AD1-061 E	1.39
936061	AD2-009 C	5.79
936062	AD2-009 E	2.64
936471	AD2-062 C O1	20.79
936472	AD2-062 E O1	10.42
936871	AD2-110	1.85
938751	AE1-101 C	13.54
938752	AE1-101 E	6.67
939031	AE1-132 C O1	6.14
939032	AE1-132 E O1	4.09
939591	AE1-188 C	1.55
939592	AE1-188 E	0.91
940671	AE2-054 C	1.33
940672	AE2-054 E	0.89
942541	AE2-269 C	1.77
942542	AE2-269 E	2.44
CARR	CARR	0.44
CBM-S1	CBM-S1	1.76
CBM-S2	CBM-S2	1.09

Bus #	Bus	MW Impact
CBM-W1	CBM-W1	2.71
CBM-W2	CBM-W2	12.47
CIN	CIN	1.21
CPLE	CPLE	0.47
G-007	G-007	1.26
IPL	IPL	0.77
LGEE	LGEE	0.35
MEC	MEC	2.32
MECS	MECS	1.45
O-066	O-066	8.22
RENSSELAER	RENSSELAER	0.35
WEC	WEC	0.32

Affected Systems

24 Affected Systems

None

25 Contingency Descriptions

Contingency Name	Contingency Definition
Base Case	
AP-P1-2-WP-138-109	CONTINGENCY 'AP-P1-2-WP-138-109' /* GUILFORD - REID 138KV DISCONNECT BRANCH FROM BUS 235189 TO BUS 235136 CKT 1 /* 01GUILFD 138 01ANTRIM 138 DISCONNECT BRANCH FROM BUS 235136 TO BUS 235503 CKT 1 /* 01ANTRIM 138 01REID 138 REMOVE LOAD 1 FROM BUS 235136 /* 01ANTRIM 138 END
ME_P4-500-002H	CONTINGENCY 'ME_P4-500-002H' /* HUNTERSTOWN 500 KV STUCK CB - CBB11392 DISCONNECT BRANCH FROM BUS 200026 TO BUS 200004 CKT 1 /* HUNTERTN 500 CNASTONE 500 DISCONNECT BRANCH FROM BUS 200026 TO BUS 204501 CKT 1 /* HUNTERTN 500 27HUNTRSTN 230 END

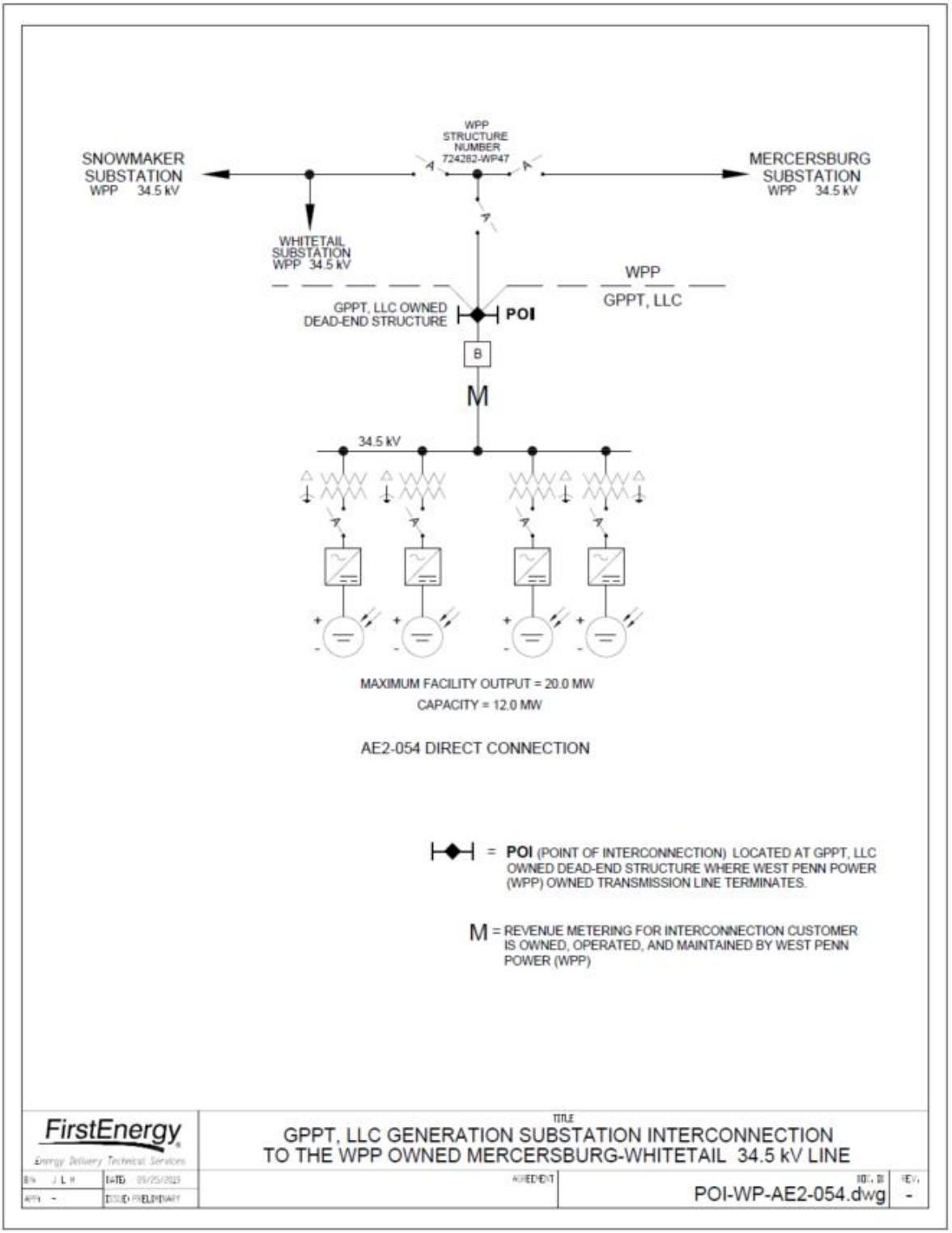
Short Circuit

26 Short Circuit

The following Breakers are overduty:

None

27 Attachment 1 – One Line



28 Attachment 2 – Project Location