Generation Interconnection

Feasibility Study Report

for

Queue Project AF1-136

WARFORDSBURG-PURCELL JUNCTION 34.5 KV

11.1 MW Capacity / 18.5 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 West Penn Power.

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.

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.

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 Solar generating facility located in Fulton County, Pennsylvania. The installed facilities will have a total capability of 18.5 MW with 11.1 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is June 1, 2022. This study does not imply a TO commitment to this in-service date.

Queue Number	AF1-136
Project Name	WARFORDSBURG-PURCELL JUNCTION 34.5 KV
State	Pennsylvania
County	Fulton
Transmission Owner	APS (West Penn Power)
MFO	18.5
MWE	18.5
MWC	11.1
Fuel	Solar
Basecase Study Year	2023

3.1 Point of Interconnection

The interconnection of the project at the Primary POI will be accomplished by tapping the McConnellsburg - Warfordsburg 34.5 kV line and constructing a one span tap. The transmission line tap will be located approximately 10.7 miles from Warfordsburg 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 McConnellsburg and Warfordsburg substations.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AF1-136 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 AF1-136 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 95,700
Direct Connection Network Upgrade	$ 65,200
Non Direct Connection Network Upgrades	$ 33,200
Total Costs	$ 194,100

In addition, the AF1-136 project may be responsible for a contribution to the following costs

Description	Total Cost
Reconductor the Warfordsburg – Hancock 34.5 kV Line	$ 2,170,000
Reconductor the AF1-136 Tap – Warfordsburg 34.5 kV Line	$ 7,080,000
Total Costs	$ 9,250,000

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

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 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 at the Primary POI will be accomplished by tapping the McConnellsburg - Warfordsburg 34.5 kV line and constructing a one span tap. The transmission line tap will be located approximately 10.7 miles from Warfordsburg 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 McConnellsburg and Warfordsburg substations.

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 one 34.5 kV tap switch and construct single span tap to customer's substation. Install 34.5 kV metering in customer's substation.	$32,500
Review drawings and provide nameplates for customer substation.	$63,200
Total Attachment Facility Costs	$95,700

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
Construct 34.5 kV tap with 2-46 kV line switches.	$65,200
Total Direct Connection Facility Costs	$65,200

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
Update relay settings @ Warfordsburg	$16,600
Update relay settings @ McConnellsburg	$16,600
Total Non-Direct Connection Facility Costs	$33,200

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 7 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.

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

FE performed an analysis of its underlying transmission <100 kV system. At the Primary POI, the AF1-136 project contributes to overloads on the FE <100 kV system as shown below. The estimated costs of system reinforcements necessary to mitigate these overloads is $9,250,000.

FirstEnergy Analysis:

Contingency Description	Overloaded Element	Rating (MVA)	% Loading After AF1	Final % Loading	AF1 MW Contrib.	FE Comments/Reinforcements
Guilford – Texas Eastern 6 138 kV Line	Warfordsburg – Hancock 34.5 kV Line	22	105.36	123.02	6.77	**Reconductor Line** Time Estimate : 18 months Cost : $2,170,000
Guilford #1 138/69 kV XFMR Fault			121.37	121.37	6.6	
Guilford – McConnellsburg 138 kV Line			105.36	123.02	6.77	
Base Case	AF1-136 Tap – Warfordsburg 34.5 kV Line	22	119.60	119.60	18.5	**Reconductor Line** Time Estimate : 18 months Cost : $7,080,000
Emmaville – Purcell Jct. 34.5 kV Line		26	106.84	106.84	18.5	
Clearville Jct. – Purcell Jct. 34.5 kV Line			103.91	103.91	18.5	
Clearville – AF1-131 Tap 34.5 kV Line			106.63	106.63	18.5	
					TOTAL COST	$9,250,000

PJM Summary of violations:

Id	Violation Description	kV
AF1-136-L1	Single Contingency Monitored Facility: 236686 01WARFORDS 34.5 237425 01HANCOCK 34.5 1 Contingency: '235189 01GUILFD 138 235285 01TEX E6 138 1' Final Loading %: 123.01	34.5 kV
AF1-136-L2	Single Contingency Monitored Facility: 236686 01WARFORDS 34.5 237425 01HANCOCK 34.5 1 Contingency: '235285 01TEX E6 138 938750 AE1-101 TAP 138 1' Final Loading %: 123.02	34.5 kV

Id	Violation Description	kV
AF1-136-L3	Single Contingency Monitored Facility: 236686 01WARFORDS 34.5 237425 01HANCOCK 34.5 1 Contingency: 'AP-P1-2-WP-138-110-A' Final Loading %: 123.02	34.5 kV
AF1-136-L4	Single Contingency Monitored Facility: 236686 01WARFORDS 34.5 237425 01HANCOCK 34.5 1 Contingency: 'AP-P1-3-WP-138-056' Final Loading %: 121.37	34.5 kV
AF1-136-L5	Single Contingency Monitored Facility: 236686 01WARFORDS 34.5 237425 01HANCOCK 34.5 1 Contingency: 'APS-P1-2-WP-138-0214-C' Final Loading %: 123.02	34.5 kV
AF1-136-L6	Single Contingency Monitored Facility: 944710 AF1-136 TAP 34.5 236686 01WARFORDS 34.5 1 Contingency: '236681 01EMMAVILL 34.5 236689 01PURCEL J 34.5 1' Final Loading %: 106.84	34.5 kV
AF1-136-L7	Single Contingency Monitored Facility: 944710 AF1-136 TAP 34.5 236686 01WARFORDS 34.5 1 Contingency: '236690 01CLEARV J 34.5 237693 01PURCELL 34.5 1' Final Loading %: 103.91	34.5 kV
AF1-136-L8	Single Contingency Monitored Facility: 944710 AF1-136 TAP 34.5 236686 01WARFORDS 34.5 1 Contingency: '236691 01CLEARVIL 34.5 944660 AF1-131 TAP 34.5 1' Final Loading %: 106.63	34.5 kV
AF1-136-L9	Single Contingency Monitored Facility: 944710 AF1-136 TAP 34.5 236686 01WARFORDS 34.5 1 Contingency: Base Case Final Loading %: 119.60	34.5 kV

10 Interconnection Customer Requirements

System Protection

The IC must design it's 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 delta or ungrounded wye connection on the high (utility) side.

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 AF1-136 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 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.

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.

1.1 FirstEnergy 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 AF1-136 was evaluated as an 18.5 MW (Capacity 11.1 MW) injection at Warfordsburg – Purcell Junction in the APS area. Project AF1-136 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-136 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Load Flow

12.1 Generation Deliverability

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

None

12.2 Multiple Facility Contingency

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

None

12.3 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

12.4 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.

None

12.5 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
AF1-136-L1	N/A	Warfords - Hancock 34.5 kV Line	WP-AF1-F-0011 : Reconductor Warfords - Hancock 34.5 kV Project Type : FAC Cost : $2,170,000 Time Estimate : 18.0 Months	$2,170,000
AF1-136-L2	N/A	Warfords - Hancock 34.5 kV Line	WP-AF1-F-0011 : Reconductor Warfords - Hancock 34.5 kV Project Type : FAC Cost : $2,170,000 Time Estimate : 18.0 Months	$2,170,000
AF1-136-L3	N/A	Warfords - Hancock 34.5 kV Line	WP-AF1-F-0011 : Reconductor Warfords - Hancock 34.5 kV Project Type : FAC Cost : $2,170,000 Time Estimate : 18.0 Months	$2,170,000
AF1-136-L4	N/A	Warfords - Hancock 34.5 kV Line	WP-AF1-F-0011 : Reconductor Warfords - Hancock 34.5 kV Project Type : FAC Cost : $2,170,000 Time Estimate : 18.0 Months	$2,170,000
AF1-136-L5	N/A	Warfords - Hancock 34.5 kV Line	WP-AF1-F-0011 : Reconductor Warfords - Hancock 34.5 kV Project Type : FAC Cost : $2,170,000 Time Estimate : 18.0 Months	$2,170,000
AF1-136-L6	N/A	AF1-136 Tap - Warfords 34.5 kV Line	WP-AF1-F-0018 : Reconductor AF1-136 - Warfords 34.5 kV Project Type : FAC Cost : $7,080,000 Time Estimate : 18.0 Months	$7,080,000
AF1-136-L7	N/A	AF1-136 Tap - Warfords 34.5 kV Line	WP-AF1-F-0018 : Reconductor AF1-136 - Warfords 34.5 kV Project Type : FAC Cost : $7,080,000 Time Estimate : 18.0 Months	$7,080,000
AF1-136-L8	N/A	AF1-136 Tap - Warfords 34.5 kV Line	WP-AF1-F-0018 : Reconductor AF1-136 - Warfords 34.5 kV Project Type : FAC Cost : $7,080,000 Time Estimate : 18.0 Months	$7,080,000
AF1-136-L9	N/A	AF1-136 Tap - Warfords 34.5 kV Line	WP-AF1-F-0018 : Reconductor AF1-136 - Warfords 34.5 kV Project Type : FAC Cost : $7,080,000 Time Estimate : 18.0 Months	$7,080,000
			TOTAL COST	**$9,250,000**

Affected Systems

12.6 Affected Systems

None.

Short Circuit

12.7 Short Circuit

The following Breakers are overdutied:

None.

13 Attachment 1 – One Line