



**Generation Interconnection
Feasibility Study Report
for
Queue Project AF2-089
TITUSVILLE 34.5 KV
3.2 MW Capacity / 5 MW Energy**

July 2020

Table of Contents

- 1 Introduction..... 3
- 2 Preface..... 3
- 3 General 4
- 4 Point of Interconnection..... 5
- 5 Cost Summary 5
- 6 Transmission Owner Scope of Work..... 6
- 7 Schedule..... 7
- 8 Transmission Owner Analysis..... 7
- 9 Interconnection Customer Requirements..... 7
 - 9.1 System Protection..... 7
 - 9.2 General Concerns 8
 - 9.3 Requirements for Owner’s/Developer’s generation IPP Facility..... 8
 - 9.4 Compliance Issues 8
- 10 Revenue Metering and SCADA Requirements 9
 - 10.1 PJM Requirements..... 9
 - 10.2 Meteorological Data Reporting Requirements 9
 - 10.3 PENELEC Requirements..... 9
- 11 Summer Peak - Load Flow Analysis 10
 - 11.1 Generation Deliverability 11
 - 11.2 Multiple Facility Contingency 11
 - 11.3 Contribution to Previously Identified Overloads..... 11
 - 11.4 Potential Congestion due to Local Energy Deliverability..... 11
 - 11.5 System Reinforcements - Summer Peak Load Flow - Primary POI..... 13
 - 11.6 Flow Gate Details..... 14
 - 11.6.1 Index 1 15
 - 11.7 Queue Dependencies 16
 - 11.8 Contingency Descriptions..... 17
- 12 Short Circuit Analysis..... 18
- 13 Affected Systems 18
 - 13.1 NYISO 18
- 14 Attachment 1: One Line Diagram 19

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.

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 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 Solar generating facility located in Venango, Pennsylvania. This project is an increase to the Interconnection Customer's AE1-160 project, which will share the same point of interconnection. The AF2-089 queue position is a 5 MW uprate (3.2 MW Capacity uprate) to the previous project. The total installed facilities will have a capability of 25 MW with 15.9 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this uprate project is December 31, 2021. This study does not imply a TO commitment to this in-service date.

Queue Number	AF2-089
Project Name	TITUSVILLE 34.5 KV
State	Pennsylvania
County	Venango
Transmission Owner	MAIT-PENELEC Zone
MFO	25
MWE	5
MWC	3.2
Fuel	Solar
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

AF2-089 will interconnect with the PENELEC distribution system as an uprate to AE1-160 via a tap on the Titusville Substation 34.5 kV Colonel Drake circuit #00517-51 at pole # T1-35751 (Attachment 1). The IC's proposed generating unit site is approximately 3.8 miles south of Titusville, PA., off William Flinn Highway.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AF2-089 generation project to connect to the Penelec distribution system. IC will be responsible for constructing all the facilities on its side of the POI, including the attachment facilities which connect the generator to the Penelec distribution system's direct connection facilities.

5 Cost Summary

The AF2-089 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	\$50,400
Total Transmission Owner Analysis Impacts (<100 kV/Non-BES)	\$885,000 ¹
Total System Reinforcement Costs	\$0
Total Costs	\$935,400

This cost excludes a Federal Income Tax Gross Up charges. This tax may or may not be charged based on whether this project meets the eligibility requirements of IRS Notice 88-129. If at a future date it is determined that the Federal Income Tax Gross charge is required, the Transmission Owner shall be reimbursed by the Interconnection Customer for such taxes.

Cost allocations for any System Upgrades will be provided in the System Impact Study Report.

¹ The transmission owner identified overloads will be reviewed by PJM and FirstEnergy in the Impact Study phase to determine whether the queue customer has a cost responsibility for any reinforcements.

6 Transmission Owner Scope of Work

AF2-089 will interconnect with the PENELEC distribution system as an uprate to AE1-160 via a tap on the Titusville Substation 34.5 kV Colonel Drake circuit #00517-51 at pole # T1-35751 (Attachment 1). The IC's proposed generating unit site is approximately 3.8 miles south of Titusville, PA., off William Flinn Highway (Attachment 2).

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AF2-089 generation project to connect to the Penelec distribution system. IC will be responsible for constructing all the facilities on its side of the POI, including the attachment facilities which connect the generator to the Penelec distribution system's direct connection facilities.

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

Description	Total Cost
Titusville 34.5kV SS. Adjust Remote Relay and Metering Settings.	\$25,200
Review customer drawings, create nameplates and update CD drawing.	\$25,200
Total Physical Interconnection Costs	\$50,400

7 Schedule

Based on the scope of work for the Direct and Non-Direct Connection facilities, it is expected to take a minimum of **6 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 that any distribution system outages will be allowed when requested.

8 Transmission Owner Analysis

Penelec performed an analysis of its distribution system. The AF2-089 contributed to the following overloads on the distribution system.

These transmission owner identified overloads will be reviewed by PJM and FirstEnergy in the Impact Study phase to determine whether the queue customer has a cost responsibility to these overloads.

Facility: 18630' overloaded 1/0CU 360Amps– 92 spans T1--36751 to T1-46551

Reinforcement Project: Mitigation is replace 34.5kV overloaded conductor from T1-36751 to T1-46551 with 336.4 ACSR back to Titusville Substation.

Cost: \$885,000

Time Estimate: 12 months

9 Interconnection Customer Requirements

9.1 System Protection

An analysis was conducted to assess the impact of the Titusville 34.5 kV (AF2-089) Project on the system protection requirements in the area. The results of this review show that the following relay additions will be required:

Proposed single line diagrams show the Interconnection Customer constructing a generation facility tapping Penelec's Titusville-34.5kV Colonel Drake circuit #00517-51 at pole T1-35751.

The 34.5kV interconnection proposal will require IC to meet applicable "Technical Requirements" as outlined in First Energy's document titled "Technical Requirements for the Interconnection of Customer-Owned Generation to the FirstEnergy Distribution System". Anti-islanding system shall meet IEEE 1547 and UL 1741 Therefore no Direct Transfer Trip (DTT) will be required.

9.2 General Concerns

It is to be understood, for abnormal operation of the Penelec system, which could cause Developer's generation facility to be electrically isolated from the Penelec system synchronous source via the tripping of a interconnecting primary voltage line or device, IC will, via Penelec's direction, be required to disconnect the generation from Penelec's system and remain disconnected (**units are required to be OFF LINE**), until the Penelec system normal circuitry is restored. These abnormal conditions will be reviewed by Penelec system operators as to the need for the generation facility to be disconnected.

9.3 Requirements for Owner's/Developer's generation IPP Facility

The proposed interconnection Owner's/Developer's facilities must be designed in accordance with the document titled *FirstEnergy Distribution Engineering Practices Interconnection of Customer-Owned Generation to the FirstEnergy Distribution System* dated 11/17/14 located at the following link:

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

The document is referred to as engineering practice EP (# 02-280) with section 4, part C specifically referencing the "interconnection technical requirements". Certain protection requirements are shown.

Additionally, Owner/Developer is responsible to provide adequate protection (for their equipment) under any distribution system operating condition' - which includes 'Separation from supply' (i.e. tripping of F.E. circuit breakers) and 'resynchronizing the generation after electric restoration of the supply' (i.e. reclosing of F.E. circuit breakers).

Owner's/Developer's protection must be designed to coordinate with the reclosing practices of FirstEnergy line protective devices. The generator must cease to energize the FirstEnergy circuit to which it is connected prior to reclosing of any (FE) automatic reclosing devices.

Owners/Developer's electrical protection and control schematics shall be provided to FE for consideration. FE may request modifications, if required, to meet the technical requirements.

9.4 Compliance Issues

IC will be responsible for meeting a power factor between 0.90 lagging (producing MVARs) to 0.95 leading (absorbing MVARs) and assure that voltage deviation will be less than 1.0 volt as measured at the POI under all Solar Gen operating conditions due to the inherent dynamic reactive power capability of this solar facility.

Generators with no inherent VAR (reactive power) control capability, or those that have a restricted VAR capability less than the defined requirements, must provide dynamic supplementary reactive support located at the generation facility with electrical characteristics equivalent to that provided by a similar sized synchronous generator. A Dynamic Reactive Compensation (either Static VAR Compensator (SVC) or STATCOM) or other method be applied in order to maintain the required specifications at the POI. IC is responsible for the installation of equipment on its side of the POI in order to adhere to the criteria stated above by FirstEnergy.

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 PENELEC Requirements

The Interconnection Customer will be required to comply with all FE Revenue Metering Requirements for Generation Interconnection Customers. These FE requirements are the following:

The FE operating company (Penelec) shall provide, own, operate, test, and maintain the revenue metering equipment at the Interconnection Customer's (IC) expense. The revenue metering equipment includes, but is not limited to, current transformers, voltage transformers, secondary wires, meter socket, bidirectional revenue meter, and associated devices. The IC shall mount the instrument transformers unless otherwise agreed to by Penelec. The instrument transformers and meter socket shall be installed in a location that is readily accessible to authorized Penelec representatives. Penelec will provide the IC access to bidirectional kWh and kVARh pulses from the Penelec meter at the IC's expense if requested. The IC shall, at its expense, install, own, operate, test, and maintain any metering and telemetry equipment that may be required to provide real-time meter data to FE or PJM.

11 Summer Peak - Load Flow Analysis

The Queue Project AF2-089 was evaluated as a 5.0 MW (Capacity 3.2 MW) uprate to AE1-160 at the Titusville 34.5 kV substation in the PENELEC area. Project AF2-089 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF2-089 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)

ID	FROM BUS#	FROM BUS	KV	FROM BUS AREA	TO BUS#	TO BUS	KV	TO BUS AREA	CK T ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADIN G %	POST PROJECT LOADIN G %	AC D C	MW IMPACT
100992486	957160	AF2-010 TAP	115.0	PENELEC	200571	26UNION CY	115.0	PENELEC	1	PN-P2-2-PN-115-039	bus	120.0	158.17	162.33	DC	5.0

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	CK T ID	CON T NAME	Type	Rating MVA	PRE PROJEC T LOADIN G %	POST PROJEC T LOADIN G %	AC D C	MW IMPACT
100993323	200585	26TITUSVIL	115.0	PENELEC	957160	AF2-010 TAP	115.0	PENELEC	1	PN-P1-2-PN-345-001	operatio n	120.0	101.45	102.96	DC	1.8
100993160	946400	AF1-304 TAP	115.0	PENELEC	200584	26GRANDV W	115.0	PENELEC	1	PN-P1-2-PN-115-022	operatio n	149.0	123.83	127.18	DC	5.0
100993102	957160	AF2-010 TAP	115.0	PENELEC	200571	26UNION CY	115.0	PENELEC	1	PN-P1-2-PN-345-001	operatio n	120.0	146.34	147.84	DC	1.8

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CK T ID	CON T NAME	Type	Ratin g MVA	PRE PROJEC T LOADIN G %	POST PROJEC T LOADIN G %	AC D C	MW IMPAC T
100993105	957160	AF2-010 TAP	115.0	PENELE C	200571	26UNION CY	115.0	PENELE C	1	Base Case	operatio n	120.0	104.39	105.86	DC	1.76

11.5 System Reinforcements - Summer Peak Load Flow - Primary POI

ID	Idx	Facility	Upgrade Description	Cost
100992486	1	AF2-010 TAP 115.0 kV - 26UNION CY 115.0 kV Ckt 1	<u>PENELEC</u> s1887.1_s1887.2 (1872) : Replace line relaying and line trap on the Titusville 115 kV Line exit at the Union City Substation (s1887.1) Replace line relaying and line trap on the Union City 115 kV line exit at the Titusville substation. (s1887.2) Project Type : FAC Cost : \$0	\$0
			TOTAL COST	\$0

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".

11.6.1 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
100992486	957160	AF2-010 TAP	PENELEC	200571	26UNION CY	PENELEC	1	PN-P2-2-PN-115-039	bus	120.0	158.17	162.33	DC	5.0

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
939291	AE1-160 C	12.7000	50/50	12.7000
939292	AE1-160 E	7.3000	50/50	7.3000
944281	AF1-096 C	12.0000	50/50	12.0000
944282	AF1-096 E	8.0000	50/50	8.0000
946401	AF1-304 C	60.0000	50/50	60.0000
946402	AF1-304 E	40.0000	50/50	40.0000
957161	AF2-010 C	46.0000	50/50	46.0000
957162	AF2-010 E	31.0000	50/50	31.0000
957951	AF2-089 C	3.2000	50/50	3.2000
957952	AF2-089 E	1.7000	50/50	1.7000
959441	AF2-235 C	6.0000	50/50	6.0000
959442	AF2-235 E	4.0000	50/50	4.0000

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.

Queue Number	Project Name	Status
AE1-160	Venango 34.5 kV	Engineering and Procurement
AF1-096	Titusville-Oil Creek 34.5 kV	Active
AF1-304	Titusville-Grandview 115 kV	Active
AF2-010	Union City-Titusville 115 kV	Active
AF2-089	Titusville 34.5 kV	Active
AF2-235	Titusville-Oil Creek 34.5 kV	Active

11.8 Contingency Descriptions

Contingency Name	Contingency Definition
Base Case	
PN-P1-2-PN-345-001	CONTINGENCY 'PN-P1-2-PN-345-001' /* ERIE WEST - WAYNE 345KV DISCONNECT BRANCH FROM BUS 200599 TO BUS 200595 CKT 1 /* 26ERIE W 345 26WAYNE 345 END
PN-P2-2-PN-115-039	CONTINGENCY 'PN-P2-2-PN-115-039' /* GRANDVIEW #2 115KV BUS FAULT DISCONNECT BRANCH FROM BUS 200584 TO BUS 200587 CKT 1 /* 26GRANDVW 115 26CLRK SUM 115 DISCONNECT BRANCH FROM BUS 200584 TO BUS 946400 CKT 1 /* 26GRANDVW 115 AF1-304 TAP 115 DISCONNECT BRANCH FROM BUS 200584 TO BUS 200592 CKT 2 /* 26GRANDVW 115 26GRNDVW#2 35 END
PN-P1-2-PN-115-022	CONTINGENCY 'PN-P1-2-PN-115-022' /* ERIE SOUTH - UNION CITY 115KV DISCONNECT BRANCH FROM BUS 200567 TO BUS 200571 CKT 1 /* 26ERIE SO. 115 26UNION CY 115 END

12 Short Circuit Analysis

To be performed in System Impact phase.

13 Affected Systems

13.1 NYISO

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

14 Attachment 1: One Line Diagram