Generation Interconnection

Feasibility Study Report

for

Queue Project AG1-296

SNYDER TOWNSHIP 34.5 KV

6.5 MW Capacity / 10 MW Energy

January 2021

Table of Contents

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 a Solar generating facility located in Jefferson County, Pennsylvania. The installed facilities will have a total capability of 10 MW with 6.5 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is December 31, 2022. This study does not imply a TO commitment to this in-service date.

Queue Number	AG1-296
Project Name	SNYDER TOWNSHIP 34.5 KV
State	Pennsylvania
County	Jefferson
Transmission Owner	MAIT (PENELEC)
MFO	10
MWE	10
MWC	6.5
Fuel	Solar
Basecase Study Year	2024

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

AG1-296 will interconnect with the PENELEC on transmission system at the Brookville 138 kV substation via a tap on the Brookville Substation 34.5 kV 0101 ckt#123-23 near pole # B-164023 (Attachment 1). The IC's proposed generating unit site is located at GPC: 41.21206, -78.95809. Per FirstEnergy EP-02-280 (6/23/20) the maximum allowable single customer owned distributed energy resources (DER) located greater than 2 miles from the distribution substation shall be limited to 20% maximum DER capacity for a 34.5kV distribution circuit which is 11MW. Maximum DER at the point of interconnection shall therefore **not exceed 2.2MW for this point of interconnection.** DER exceeding 2.2MW will be required to have dedicated facilities from our substation.

The primary reason for this guideline is to maintain the operational flexibility of the distribution system. Large loads and large exports reduce the ability of distribution operations to reconfigure circuits during abnormal conditions, or maintenance scenarios. In addition, large loads and large exports from DER often require modifications to distribution system protection that may compromise system reliability.

5 Cost Summary

The AG1-296 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	$316,900
Total System Network Upgrade Costs	$23,419,398[1]
Total Costs	$23,736,298

*As your project progresses through the study process and other projects modify their request or withdraw, then your cost allocation could change.

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.

Note 1: PJM Open Access Transmission Tariff (OATT) section 217.3A outline cost allocation rules. The rules are further clarified in PJM Manual 14A Attachment B. The allocation of costs for a network upgrade will start with the first Queue project to cause the need for the upgrade. Later queue projects will receive cost allocation contingent on their contribution to the violation and are allocated to the queues that have not closed less than

[1] This project currently causes and/or contributes to overloads of the Transmission System (see Summer Peak Load Flow Analysis section below) and therefore has potential to have cost allocation for the system reinforcements listed in the report. This will be re-evaluated in the System Impact phase. The results may vary with queue customers withdrawing from the queue and other generators deactivating over time. If a customer is the first to cause the need for a project (causes loading to exceed 100% of rating), then the customer is responsible. If a customer contributes to a facility that is already overloaded by a prior queue, then they may receive cost allocation.

5 years following the execution of the first Interconnection Service Agreement which identifies the need for this upgrade.

Note 2: For customers with System Reinforcements listed: If your present cost allocation to a System Reinforcement indicates $0, then please be aware that as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, reducing in size, etc, the cost responsibilities can change and a cost allocation may be assigned to your project. In addition, although your present cost allocation to a System Reinforcement is presently $0, your project may need this system reinforcement completed to be deliverable to the PJM system. If your project comes into service prior to completion of the system reinforcement, an interim deliverability study for your project will be required.

6 Transmission Owner Scope of Work

AG1-296 will interconnect with the PENELEC on transmission system at the Brookville 138 kV substation via a tap on the Brookville Substation 34.5 kV 0101 ckt#123-23 near pole # B-164023 (Attachment 1). The IC's proposed generating unit site is located at GPC: 41.21206, -78.95809. Per FirstEnergy EP-02-280 (6/23/20) the maximum allowable single customer owned distributed energy resources (DER) located greater than 2 miles from the distribution substation shall be limited to 20% maximum DER capacity for a 34.5kV distribution circuit which is 11MW. Maximum DER at the point of interconnection shall therefore **not exceed 2.2MW for this point of interconnection.** DER exceeding 2.2MW will be required to have dedicated facilities from our substation.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AG1-296 generation project to connect to the Penelec distribution system.

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

Description	Total Cost
Proposed line tap near existing pole #B-164023on existing Brookville 34.5kV distribution circuit, add new SCADA switch, add new primary metering. The customer is responsible to build their own line from their site to Penelec's existing facilities.	$137,000
Reconductor 1300' 4CU (.25 miles) conductor between B-146923 and B-147423 due to overloaded condition.	$128,200
Relay settings at sub for AG1-296 tap MW injection. @Brookville	$51,700
Total Physical Interconnection Costs	$316,900

7 Schedule

Based on the scope of work for the interconnection facilities, it is expected to take a minimum of **14 months** after the signing of an Interconnection Construction Service Agreement and construction kickoff call 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 work and that any system outages will be allowed when requested.

If the customer is ultimately responsible for network upgrades, then the schedule for those upgrades will be refined in future study phases. The customer would need to wait for those upgrades to be completed prior to commercial operation unless determined deliverable by an interim deliverability study. The elapsed time to complete any network upgrades is provided in the System Reinforcements table of this report[1].

8 Transmission Owner Analysis

Penelec performed an analysis of its distribution system. The AG1-296 project did contribute to overloads on the distribution system. The project would require reconductoring 1300' 4CU (.25 miles) conductor between B-146923 and B-147423 due to overloaded condition.

9 Interconnection Customer Requirements

9.1 System Protection

An analysis was conducted to assess the impact of the AG1-296 "Snyder Township 34.5 kV" 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 IC constructing a generation facility tapping the Brookville Substation 34.5 kV 0101 ckt#123-23 near pole # B-164023.

The 34.5kV interconnection proposal will require Developer 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, Developer 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

Interconnection Customer (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. Interconnection Customer (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) - (Required for plants with Maximum Facility Output of 3 MW or higher)
- Irradiance (Watts/meter^2) - (Required for plants with Maximum Facility Output of 3 MW or higher)
- 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:

http://www.pjm.com/planning/design-engineering/to-tech-standards/

11 Summer Peak - Load Flow Analysis

The Queue Project AG1-296 was evaluated as a 10.0 MW (Capacity 6.5 MW) injection at the Brookville 138 kV substation in the PENELEC area. Project AG1-296 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AG1-296 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	CKT ID	CONTNAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
16737287 1	235174	01ELKO	138.0	AP	235237	01RIDGWY	138.0	AP	1	AP-P2-3-WP-230-447	breaker	133.0	139.4	140.51	DC	1.49

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.

None

11.5 System Reinforcements - Summer Peak Load Flow - Primary POI

ID	Idx	Facility	Upgrade Description	Cost
167372871	1	01ELKO 138.0 kV - 01RIDGWY 138.0 kV Ckt 1	**AP** **WP-AG1-F-0015A (246) : Replace 4/0 CU bus conductor at Ridgway substation.** **Project Type : FAC** **Cost : $130,252** **Time Estimate : 12.0 Months** **WP-AG1-F-0015B (247) : Replace 4/0 CW line riser at Ridgway substation.** **Project Type : FAC** **Cost : $130,252** **Time Estimate : 12.0 Months** **WP-AG1-F-0015C (248) : Reconductor 8.89 miles of 4/0 CW. (63 spans).** **Project Type : FAC** **Cost : $23,158,894** **Time Estimate : 48.0 Months**	$23,419,398
			TOTAL COST	**$23,419,398**[1]

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
167372871	235174	01ELKO	AP	235237	01RIDGWY	AP	1	AP-P2-3-WP-230-447	breaker	133.0	139.4	140.51	DC	1.49

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
200649	26PENNTECH	0.8436	50/50	0.8436
941191	AE2-113 C	4.8293	Adder	5.68
941192	AE2-113 E	5.1996	Adder	6.12
941321	AE2-126 C	0.5959	Adder	0.7
941322	AE2-126 E	0.3973	Adder	0.47
942961	AE2-316 C	7.4122	50/50	7.4122
942962	AE2-316 E	10.5698	50/50	10.5698
944381	AF1-103 O1	1.2182	Adder	1.43
944901	AF1-155 C	-4.4987	Adder	-5.29
945451	AF1-210 C	-0.4081	Adder	-0.48
946111	AF1-276 C	3.5759	Adder	4.21
946112	AF1-276 E	1.7613	Adder	2.07
946121	AF1-277 C	3.5759	Adder	4.21
946122	AF1-277 E	1.7613	Adder	2.07
946131	AF1-278 C	2.8522	Adder	3.36
946132	AF1-278 E	1.4175	Adder	1.67
946381	AF1-302 C	3.2368	50/50	3.2368
946382	AF1-302 E	4.3157	50/50	4.3157
946421	AF1-306 C	9.5632	50/50	9.5632
946422	AF1-306 E	38.2529	50/50	38.2529
959823	AF2-273 BAT	0.0820	Merchant Transmission	0.0820
963571	AG1-206 C	0.2247	Adder	0.5
963572	AG1-206 E	0.1210	Adder	0.27
964341	AG1-296 C	0.9657	50/50	0.9657
964342	AG1-296 E	0.5200	50/50	0.5200
965203	AG1-385 BAT	3.3649	50/50	3.3649
966121	AG1-481	0.5014	Adder	1.11
WEC	WEC	0.0296	Confirmed LTF	0.0296
LGEE	LGEE	0.0528	Confirmed LTF	0.0528
CPLE	CPLE	0.0116	Confirmed LTF	0.0116
CBM-W2	CBM-W2	0.6720	Confirmed LTF	0.6720
TVA	TVA	0.0910	Confirmed LTF	0.0910
O-066	O-066	1.3797	Confirmed LTF	1.3797
SIGE	SIGE	0.0304	Confirmed LTF	0.0304
CBM-S2	CBM-S2	0.3236	Confirmed LTF	0.3236
CBM-S1	CBM-S1	0.0258	Confirmed LTF	0.0258
G-007	G-007	0.2153	Confirmed LTF	0.2153
MEC	MEC	0.1382	Confirmed LTF	0.1382
LAGN	LAGN	0.1172	Confirmed LTF	0.1172
CBM-W1	CBM-W1	1.5001	Confirmed LTF	1.5001

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
AE2-113	Farmers Valley-Ridgeway 115 kV	Active
AE2-126	Dubois-Curwensville 34.5 kV	Engineering and Procurement
AE2-316	Brookville-Squab Hollow 138 kV	Active
AF1-103	Warren 34.5 kV	Active
AF1-155	Paper City-Wilcox 46 kV	Engineering and Procurement
AF1-210	Burma 23 kV	Engineering and Procurement
AF1-276	Lewis Run-Pierce Brook 230 kV	Active
AF1-277	Lewis Run-Pierce Brook 2 230 kV	Active
AF1-278	Lewis Run-Pierce Brook 3 230 kV	Active
AF1-302	Brookville-Squab Hollow 138 kV	Active
AF1-306	Squab Hollow 230 kV	Active
AF2-273	Sligo 25 kV	Engineering and Procurement
AG1-206	Snyder Twp 34.5 kV	Active
AG1-296	Snyder Township 34.5 kV	Active
AG1-385	Motion-Ridgeway 46 kV	Active
AG1-481	Warren 34.5 kV	Active

11.8 Contingency Descriptions

Contingency Name	Contingency Definition
AP-P2-3-WP-230-447	CONTINGENCY 'AP-P2-3-WP-230-447' /* 456 DISCONNECT BRANCH FROM BUS 235971 TO BUS 235175 CKT 1 /* 01SQUABHLLW 230 01ELKO 230 DISCONNECT BRANCH FROM BUS 235174 TO BUS 235175 CKT 1 /* 01ELKO 138 01ELKO 230 DISCONNECT BRANCH FROM BUS 235157 TO BUS 235159 CKT 1 /* 01CARB 138 01CARB J 138 DISCONNECT BRANCH FROM BUS 235159 TO BUS 235174 CKT 1 /* 01CARB J 138 01ELKO 138 DISCONNECT BRANCH FROM BUS 235159 TO BUS 235286 CKT 1 /* 01CARB J 138 01WILLAM 138 END

12 Short Circuit Analysis

The following Breakers are overdutied:

None

13 Affected Systems

13.1 NYISO

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

13.2 MISO

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

14 Attachment 1: One Line Diagram