



**Generation Interconnection
Feasibility Study Report
for
Queue Project AG1-247
EAST SAYRE 34.5KV
4.9 MW Capacity / 7.5 MW Energy**

January 2021

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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.

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 Bradford County, Pennsylvania. The installed facilities will have a total capability of 7.5 MW with 4.9 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	AG1-247
Project Name	EAST SAYRE 34.5 KV
State	Pennsylvania
County	Bradford
Transmission Owner	MAIT (PENELEC)
MFO	7.5
MWE	7.5
MWC	4.9
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

AG1-247 (North Orwell 12.47kV) will be required to interconnect with the PENELEC distribution system at a yet to be determined POI on the 34.5kV Milan feeder at East Sayre substation. This feeder is offered as a suggestion due to its proximity to the generation site. The developer initially requested to interconnect at POI pole 6W24661, which is located on the 12.47kV Windham feeder at the North Orwell substation; however, this is problematic for a couple of reasons.

First, due to the existence of a previously approved IPP facility on the Windham feeder, the addition of AG1-247 is not permitted since it will cause this feeder to exceed the threshold for the maximum allowed aggregate generation permitted.

These thresholds were adopted as of June 23, 2020 and are now being enforced to limit exposure to the inherent voltage fluctuations the could impact the distribution customers directly sourced from the generation hosting circuit. Having large quantities of generation tied to a given feeder limits the ability of system operators to quickly respond to the switching for planned or emergent events. Having IPP's sourced from a dedicated feeder will offer some level of isolation due to voltage fluctuations stemming from the generator, will provide heightened visibility for the system operators to identify the presence of an IPP and streamline their efforts to isolate the same IPP by opening the substation breaker sourcing the express feeder. Protection coordination between the transmission operator and the IPP will be easier to implement at the substation level.

Secondly, Penelec has a set of voltage regulators installed on the 12.47kV side of the substation transformer at North Orwell. The addition of AG1-247 from a dedicated developer constructed, owned, and maintained express feeder that would terminate at the 12.47kV bus at the North Orwell substation, causes the potential for a back-feed which, when coupled with approved IPP facility, exceeds the ampacity rating for these regulators. Penelec does not stock a regulator with the required ampacity rating needed to support all this generation. The existing regulators cannot simply be removed; they are needed if/when this generation is not available.

For these reasons, a tap to the nearby 34.5kV Milan feeder at East Sayre is suggested as an alternative¹.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AG1-247 generation project to connect to the Penelec distribution system. NOTE: POI indicated is only a suggestion. **An analysis will be completed if/when developer is able to secure right of way for their new line extension, which will in turn determine the most likely coordinates for the POI.** 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 Penelec distribution system's direct connection facilities.

¹ Any change in POI would require a formal Material Modification review by PJM to determine whether such change would impact other Interconnection Customers.

5 Cost Summary

The AG1-247 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	\$142,100
Total System Network Upgrade Costs	\$2,500,000 ²
Total Costs	\$2,642,100

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 2016-36, 2016-25 I.R.B. (6/20/2016). 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.

² 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.

6 Transmission Owner Scope of Work

Minimum physical interconnection costs are given in the table below and are subject to change once an analysis of an interconnect to the 34.5kV Milan ckt#00518-61 @ East Sayre is completed.³

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

Description	Total Cost
Tap the existing 34.5kV Milan ckt#00518-61 @ East Sayre at a yet-to-be determined POI and install a SCADA controlled 34.5kV recloser to interconnect queue project AG1-247. Install 34.5kV metering in customer's facilities. The customer is responsible to build their own line from their site to Penelec's existing facilities	\$102,500
NPs & Cust Dwg Review @ AG1-247	\$ 25,200
East Sayre 34.5kV SS. Adjust Remote Relay and Metering Settings.	\$ 14,400
Total Physical Interconnection Costs	\$142,100

³ The physical interconnection costs will be examined in more detail by FirstEnergy during the System Impact Study phase.

7 Schedule

This will be evaluated during the System Impact Study phase.

8 Transmission Owner Analysis

Penelec has not performed an analysis on the 34.5kV system since an agreed POI needs to be established, which will only occur after the developer decides to proceed with this 34.5kV option. Once the POI has been determined, Penelec will be able to accurately determine any system upgrades between the POI and the East Sayre substation during the System Impact Study phase.

9 Interconnection Customer Requirements

9.1 System Protection

Proposed single line diagram show the developer constructing a generation facility (North Orwell 12.47kV AG1-247) tapping Penelec's 34.5kV Milan ckt#00518-31 @ East Sayre substation via a yet to be determined POI.

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

The Developer will be responsible for meeting a power factor between 0.95 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. The Developer 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/meter²) - (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 AG1-247 was evaluated as a 7.5 MW (Capacity 4.9 MW) injection at the East Sayre⁴ 34.5 kV substation in the PENELEC area. Project AG1-247 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AG1-247 was studied with a commercial probability of 53.0 %. Potential network impacts were as follows:

⁴ PJM studied AG1-247 at East Sayre 34.5 kV. The 12.47 kV circuit is not modeled in the load flow case, therefore, AG1-247 would be modeled in the same manner whether the POI is on the 12.47 kV or 34.5 kV. The proposed alternate POI by the TO will not change the load flow results presented herein.

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 PROJE T LOADIN G %	POST PROJE T LOADIN G %	AC D C	MW IMPAC T
167645316	200676	26E.SAYRE	115.0	PENELE C	130836	N.WAV115	115.0	NYIS O	1	PL:03:P12:000193	single	128.0	196.43	198.89	DC	3.15
167645317	200676	26E.SAYRE	115.0	PENELE C	130836	N.WAV115	115.0	NYIS O	1	PN-P1-2-PN-230-102AT	single	128.0	196.43	198.89	DC	3.15
167645320	200676	26E.SAYRE	115.0	PENELE C	130836	N.WAV115	115.0	NYIS O	1	Base Case	single	108.0	135.28	137.97	DC	2.9

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	CONT NAME	Type	Rating MVA	PRE PROJE T LOADIN G %	POST PROJE T LOADIN G %	AC D C	MW IMPAC T
167645315	200676	26E.SAYRE	115.0	PENELE C	130836	N.WAV115	115.0	NYIS O	1	PN-P1-2-PN-230-101T	operation	128.0	205.0	208.33	DC	4.26
167645319	200676	26E.SAYRE	115.0	PENELE C	130836	N.WAV115	115.0	NYIS O	1	Base Case	operation	108.0	135.93	140.05	DC	4.45

11.5 System Reinforcements - Summer Peak Load Flow - Primary POI

ID	Idx	Facility	Upgrade Description	Cost
167645320,167645316,167645317	1	26E.SAYRE 115.0 kV - N.WAV115 115.0 kV Ckt 1	<p><u>PENELEC</u> PN-AG1-F-0014A (2236) : Replace relay at East Sayre on North Waverly terminal Note: PJM to coordinate with NYSEG on miscellaneous relay replacement Project Type : FAC Cost : \$800,000 Time Estimate : 12.0 Months</p> <p>PN-AG1-F-0014B (2237) : NYSEG would need to replace their section of the limiting conductor/ equipment and provide estimates for their replacement. Project Type : FAC Cost : \$0 Time Estimate : N/A Months</p> <p>PN-AG1-F-0014C (2238) : Replace line relaying at East Sayre . Project Type : FAC Cost : \$800,000 Time Estimate : 12.0 Months</p> <p>PN-AG1-F-0014D (2239) : Adjust CT ratios at East Sayre Project Type : FAC Cost : \$900,000 Time Estimate : 12.0 Months</p>	\$2,500,000
			TOTAL COST	\$2,500,000¹

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
167645317	200676	26E.SAYRE	PENELEC	130836	N.WAV115	NYISO	1	PN-P1-2-PN-230-102AT	single	128.0	196.43	198.89	DC	3.15

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
200823	26MHP_X3-003	7.2435	80/20	7.2435
200851	26MEHOOP3	1.0875	80/20	1.0875
200887	26ARMNA MT	0.1807	80/20	0.1807
200917	26MTNTP_P28	0.4037	80/20	0.4037
203261	26BLOSSBCT	0.1609	80/20	0.1609
203283	26MANOR_T86	0.0348	80/20	0.0348
203347	26NME_Y1-047	0.3944	80/20	0.3944
203350	26MILZ1-092	2.1274	80/20	2.1274
203351	26GROZ1-110	0.2849	80/20	0.2849
203352	26CANZ2-011	0.2795	80/20	0.2795
203907	26Y2-042	0.3918	80/20	0.3918
203922	X1-109 G1	6.8300	80/20	6.8300
203923	X1-109 G2	6.8300	80/20	6.8300
203932	AA2-133 GEN	3.0058	80/20	3.0058
919201	AA1-144 OP	18.1223	80/20	18.1223
921642	AA2-000	23.9047	80/20	23.9047
930511	AB2-092	0.8777	80/20	0.8777
936421	AD2-055	1.8071	80/20	1.8071
941421	AE2-139 C	6.4895	80/20	6.4895
943751	AF1-043	5.4211	80/20	5.4211
944411	AF1-106 O1	12.8424	80/20	12.8424
945331	AF1-198	0.0212	80/20	0.0212
946211	AF1-286 C	5.2012	80/20	5.2012
959061	AF2-197 C O1	7.0040	80/20	7.0040
959471	AF2-238 C	1.0085	80/20	1.0085
959481	AF2-239 C	1.8808	80/20	1.8808
959491	AF2-240 C	2.4272	80/20	2.4272
959501	AF2-241 C	7.2560	80/20	7.2560
959741	AF2-265 C	0.7227	80/20	0.7227
960271	AF2-318 C	2.0333	80/20	2.0333
961141	AF2-405	6.4212	80/20	6.4212
961151	AF2-406	48.1590	80/20	48.1590
961451	AF2-436	0.2267	80/20	0.2267
961461	AF2-437	0.0321	80/20	0.0321
963941	AG1-247 C	3.1464	80/20	3.1464
CALDERWOOD	CALDERWOOD	0.0263	Confirmed LTF	0.0263
NY	NY	0.7089	Confirmed LTF	0.7089
PRAIRIE	PRAIRIE	0.1369	Confirmed LTF	0.1369
SIGE	SIGE	0.0083	Confirmed LTF	0.0083
CHEOAH	CHEOAH	0.0265	Confirmed LTF	0.0265
COTTONWOOD	COTTONWOOD	0.1113	Confirmed LTF	0.1113

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
HAMLET	HAMLET	0.0306	Confirmed LTF	0.0306
GIBSON	GIBSON	0.0289	Confirmed LTF	0.0289
BLUEG	BLUEG	0.0920	Confirmed LTF	0.0920
TRIMBLE	TRIMBLE	0.0295	Confirmed LTF	0.0295
CATAWBA	CATAWBA	0.0186	Confirmed LTF	0.0186

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
AA1-144	East Towanda-Grover 230kV	Engineering and Procurement
AA2-000	N/A	N/A
AA2-133	Wyalusing 34.5kV	In Service
AB2-092	Bergen 138kV	Partially in Service - Under Construction
AD2-055	Moshannon-East Towanda 230 kV	Active
AE2-139	East Towanda-Grover 230 kV	Active
AF1-043	Moshannon-East Towanda 230 kV	Active
AF1-106	East Sayre 34.5 kV	Active
AF1-198	Blossburg #1 CT 34.5 kV	Partially in Service - Under Construction
AF1-286	East Sayre 34.5 kV II	Active
AF2-197	East Towanda 115 kV	Active
AF2-238	Mansfield-South Troy 34.5 kV	Active
AF2-239	Wyalusing-Hollenback WRC 34.5 kV	Active
AF2-240	North Orwell 12.47 kV	Active
AF2-241	Athens-Milan 34.5 kV	Active
AF2-265	South Troy-Athens 34.5 kV	Active
AF2-318	East Towanda-New Albany 34.5 kV	Active
AF2-405	East Sayre 34.5 kV III	Active
AF2-406	Sayre 115 kV	Active
AF2-436	Wyalusing 34.5 kV II	Engineering and Procurement
AF2-437	Oxbow 34.5 kV III	In Service
AG1-247	North Orwell 12.47 kV	Active
X1-109	E. Towanda 230kV	In Service
X3-003	Mehoopany II 115 kV	In Service
Y1-047	North Meshoppen 34.5kV	In Service
Y2-042	Oxbow 25kV	In Service
Z1-092	Milan 34kV	In Service
Z1-110	Grover 34kV	In Service
Z2-011	Canton 34.5kV	In Service

11.8 Contingency Descriptions

Contingency Name	Contingency Definition
Base Case	
PN-P1-2-PN-230-101T	CONTINGENCY 'PN-P1-2-PN-230-101T' /* EAST TOWANDA - HILLSIDE 230KV DISCONNECT BRANCH FROM BUS 200675 TO BUS 130763 CKT 1 /* 26E.TWANDA 230 HILSD230 230 END
PL:03:P12:000193	CONTINGENCY 'PL:03:P12:000193' /* NMES-LACK 230KV LINE DISCONNECT BRANCH FROM BUS 200706 TO BUS 200677 CKT 4 /* DISCONNECT BUS 200708 /* OXBOW 230KV BUS END
PN-P1-2-PN-230-102AT	CONTINGENCY 'PN-P1-2-PN-230-102AT' /* NORTH MESHOPPEN - LACKAWANNA 230KV RTEP B2952 DISCONNECT BRANCH FROM BUS 200706 TO BUS 200708 CKT 1 /* 26N.MESHPN 230 26OXBOW 230 DISCONNECT BRANCH FROM BUS 200708 TO BUS 208009 CKT 1 /* 26OXBOW 230 LACK 230 DISCONNECT BRANCH FROM BUS 200708 TO BUS 200709 CKT 1 /* 26OXBOW 230 26OXBOW 35 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