Revised

Generation Interconnection

System Impact Study Report

for

Queue Project AE2-139

EAST TOWANDA-GROVER 230 KV

60.3 MW Capacity / 100.5 MW Energy

June 2022

Revision 1: July 2022

Revision 2: September 2022

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1 Introduction

This System Impact Study has been prepared in accordance with the PJM Open Access Transmission Tariff, 205, as well as the System Impact Study Agreement between the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is PENELEC.

2 Preface

The intent of the 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 will be deferred until the System Impact Study is performed.

The System Impact 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.

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.

An Interconnection Customer with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

3 Revision History

This SIS report was revised in September 2022 to reflect the results of PJM's retool analysis based on recent changes and withdrawals within prior queues. Physical interconnection scope and costs will be updated in the Facilities Study.

4 General

The Interconnection Customer (IC), has proposed a Solar generating facility located in McKean County, Pennsylvania. The installed facilities will have a total capability of 100.5 MW with 60.3 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is May 31, 2022. This study does not imply a TO commitment to this in-service date.

Queue Number	**AE2-139**
Project Name	EAST TOWANDA-GROVER 230 KV
State	Pennsylvania
County	McKean
Transmission Owner	PENELEC
MFO	100.5
MWE	100.5
MWC	60.3
Fuel	Solar
Basecase Study Year	2022

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.

5 Point of Interconnection

The interconnection of the project AE2-139 at the Primary POI will be accomplished by constructing a new 230 kV three (3) breaker ring bus substation and looping the East Towanda to Grover 230 kV line into the new station. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection switching station and the associated facilities. The IC will also be responsible for the rough grade of the property and an access road to the proposed three breaker ring bus site. The project will also require non-direct connection upgrades at East Towanda substation.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AE2-139 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.

6 Cost Summary

The AE2-139 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$296,100
Direct Connection Network Upgrade	$7,219,600
Non Direct Connection Network Upgrades	$829,300
System Upgrades	$1,360,869[1]
Total Costs	**$9,705,869**

*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.

[1] This project contributes to overloads on the existing network. Two of the reinforcements are covered under Baseline RTEP projects (b3137 & b2952). Though this project does not have cost responsibility for the RTEP projects, this project may need the baseline RTEP reinforcements in place prior to being commercially operable. If Queue Project AE2-139 desires to come into service prior to completion of the upgrades, Queue Project AE2-139 will need an interim study. See "System Reinforcements" Section 12.6 of this report.

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 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.

7 Transmission Owner Scope of Work

The interconnection of the project at the Primary POI will be accomplished by constructing a new 230 kV three (3) breaker ring bus substation and looping the East Towanda - Marshall 230 kV line (future Bridge Street – Marshall 230 kV line) into the new station. The new substation will be located approximately 18 miles from Grover substation. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection switching station and the associated facilities. The IC will also be responsible for the rough grade of the property and an access road to the proposed three-breaker ring bus site. The project will also require Non-Direct Connection upgrades at Bridge Street (AA1-144) and Marshall Substations.

Attachment 1 shows a one-line diagram of the proposed primary Direct Connection facilities for the AE2-139 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 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.

7.1 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 230 kV line terminal at new interconnection substation for the AE2-224 generator lead line.	$242,700
Review drawings, nameplates, and relay settings for customer substation.	$53,400
Total Attachment Facility Costs	**$296,100**

7.2 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 new three-breaker 230 kV ring bus interconnection substation.	$6,556,100
Project Management, Environmental, Forestry, and Real Estate	$663,500
Total Direct Connection Facility Costs	**$7,219,600**

7.3 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
Loop the East Towanda – Marshall 230 kV line into the new interconnection substation between Grover and the future AA1-144 substations.	$691,600
Drawing updates and nameplates for line name change at Marshall substation.	$45,900
Adjust relay settings and change line carrier frequencies at the future AA1-144 substation.	$45,900
Drawing updates and nameplates for line name change at Grover substation	$45,900
Total Non-Direct Connection Facility Costs	**$829,300**

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 **20 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 Attachment Facilities and Direct Connection work. Full initial deposit is required for the Non-Direct Connection work. 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

9.1 Power Flow Analysis

FE performed an analysis of its underlying transmission <100 kV system. The AE2-139 project did not contribute to any overloads on the FE transmission <100 kV system.

10 Interconnection Customer Requirements

10.1 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.

10.2 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 230 kV circuit breaker to protect the AE2-139 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 AE2-139 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.

10.3 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.

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.

11.2 Meteorological Data Reporting Requirements

The solar generation facility shall provide the Transmission Provider with site-specific meteorological data including:

- Temperature (degrees Fahrenheit)
- Atmospheric pressure (hectopascals)

- Irradiance
- Forced outage data

11.3 Interconnected Transmission Owner 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 Summer Peak Analysis

The Queue Project AE2-139 was evaluated as a 100.5 MW (Capacity 60.3 MW) injection tapping the East Towanda to Grover 230kV line in the PENELEC area. Project AE2-139 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-139 was studied with a commercial probability of 100%. Potential network impacts were as follows:

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)

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC| DC	MW IMPACT
197309207	200674	26TOWANDA	115.0	PENELEC	200677	26NO MESHO	115.0	PENELEC	1	PN-P1-2-PN-230-013A	single	202.0	104.39	110.04	AC	11.43
1514362	200677	26NO MESHO	115.0	PENELEC	200706	26N.MESH PN	230.0	PENELEC	4	PN-P2-3-PN-230-17B19	breaker	189.0	171.85	180.99	DC	17.25
1514522	208009	LACK	230.0	PPL	200074	LACKAW	500.0	PJM	3	PL:02:P42:001057	breaker	1165.0	103.47	106.68	AC	22.85

12.4 Steady-State Voltage Requirements

None

12.5 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	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC| DC	MW IMPACT
40278500	200593	26GLADE	230.0	PENELEC	200811	26WARREN	230.0	PENELEC	1	Base Case	operation	520.0	99.9	100.81	DC	5.59
197309206	200674	26TOWANDA	115.0	PENELEC	200677	26NOMESHO	115.0	PENELEC	1	PN-P1-2-PN-230-013A	operation	202.0	125.04	134.51	AC	19.04
40278641	200675	26E.TWANDA	230.0	PENELEC	200924	26CANYON	230.0	PENELEC	1	Base Case	operation	515.0	99.93	107.15	AC	38.29
197317218	200675	26E.TWANDA	230.0	PENELEC	200924	26CANYON	230.0	PENELEC	1	PL_P12_001029	operation	615.0	101.46	107.51	AC	38.22
7046731	200676	26E.SAYRE	115.0	PENELEC	130836	N.WAV115	115.0	NYISO	1	PN-P1-2-PN-230-101T	operation	128.0	95.7	101.85	DC	9.22
1515224	200767	26HOMERCT	230.0	PENELEC	200795	26SHELOCTA	230.0	PENELEC	1	Base Case	operation	731.0	93.36	94.81	DC	12.15
7047403	200767	26HOMERCT	230.0	PENELEC	200795	26SHELOCTA	230.0	PENELEC	1	AP-P1-2-WP-345-311T	operation	917.0	103.88	105.24	DC	14.32
194703338	200924	26CANYON	230.0	PENELEC	200706	26N.MESHPN	230.0	PENELEC	1	Base Case	operation	546.0	93.11	99.93	AC	38.29
197317220	200924	26CANYON	230.0	PENELEC	200706	26N.MESHPN	230.0	PENELEC	1	PL:03:P12:001029	operation	666.0	92.75	98.34	AC	38.22

12.6 System Reinforcements

<table>
<tr><th>ID</th><th>Idx</th><th>Facility</th><th>Upgrade Description</th><th>Cost</th><th>Cost Allocated to AE2-139</th><th>Upgrade Number</th></tr>
<tr><td>197309207</td><td>1</td><td>26TOWANDA 115.0 kV - 26NO MESHO 115.0 kV Ckt 1</td><td>Project ID: b3137
Rebuild 20 miles of the East Towanda - North Meshoppen 115kV line. The baseline project has a projected in-service date of 12/01/2024. Project Type: FAC.

New Ratings: 202/245 MVA SN/SE

Note: Although Queue Project AE2-139 may not have cost responsibility for this upgrade, Queue Project AE2-139 may need this upgrade in-service to be deliverable to the PJM system. If Queue Project AE2-139 comes into service prior to completion of the upgrade, Queue Project AE2-139 will need an interim study.</td><td>$58,600,000</td><td>$0</td><td>b3137</td></tr>
<tr><td>1514522</td><td>3</td><td>LACK 230.0 kV - LACKAW 500.0 kV Ckt 3</td><td>Re-terminate Lackawanna 500/230 kV T4 Transformer. Move the 230kV termination point of the Lackawanna 500-230kV transformer #4 from the 230kV East Bus to Bay #1. Build out 230kV Bay #1 and populate with three (3) new circuit breakers and associated terminal equipment. Modify the 500kV and 230kV relaying and controls as needed. Project Type: CON.

Time Estimate: 24 months

<table><tr><th>Queue Project</th><th>MW Impact</th><th>Cost</th></tr><tr><td>AE1-059</td><td>67.82</td><td>$ 4,039,131</td></tr><tr><td>AE2-139</td><td>22.85</td><td>$ 1,360,869</td></tr></table></td><td>$5,400,000</td><td>$1,360,869</td><td>n6167</td></tr>
<tr><td>1514362</td><td>2</td><td>26NO MESHO 115.0 kV - 26N.MESHPN 230.0 kV Ckt 4</td><td>Replace the North Meshoppen #3 230/115kV transformer eliminating the old reactor and installing two breakers to complete a 230kV ring bus at North Meshoppen. Project is currently under construction with a projected in-service date of 6/1/2022. Project Type: CON.

Note: Although Queue Project AE2-139 may not have cost responsibility for this upgrade, Queue Project AE2-139 may need this upgrade in-service to be deliverable to the PJM system. If Queue Project AE2-139 desires to come into service prior to completion of the upgrade, Queue Project AE2-139 will need an interim study.</td><td>$11,600,000</td><td>$0</td><td>b2952</td></tr>
<tr><td></td><td></td><td></td><td>TOTAL COST</td><td>$75,600,000</td><td>$1,360,869</td><td></td></tr>
</table>

Note: 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.

12.7 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".

12.7.1 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
197309207	200674	26TOWANDA	PENELEC	200677	26NO MESHO	PENELEC	1	PN-P1-2-PN-230-013A	single	202.0	104.39	110.04	AC	11.43

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
200823	26MHP_X3-003	-12.0662	Adder	-14.2
200887	26ARMNA MT	0.6178	80/20	0.6178
200949	26X1-109	27.4914	80/20	27.4914
203261	26BLOSSBCT	0.5071	80/20	0.5071
203283	26MANOR_T86	0.0545	80/20	0.0545
916201	Z1-069 C	0.2606	80/20	0.2606
916361	Z1-092	0.6356	80/20	0.6356
916541	Z1-110	0.5932	80/20	0.5932
917072	Z2-011	0.5932	80/20	0.5932
921642	**AA2-000 (Suspended)**	**42.4803**	**80/20**	**42.4803**
930511	**AB1-092 (Suspended)**	**1.5598**	**80/20**	**1.5598**
931091	AB1-160 C	0.0745	80/20	0.0745
934801	AD1-108	0.0447	80/20	0.0447
934811	AD1-109	0.0328	80/20	0.0328
935061	AD1-142	0.0351	80/20	0.0351
936421	**AD2-055 (Suspended)**	**3.2113**	**80/20**	**3.2113**
940861	AE2-074 C	1.2300	80/20	1.2300
941191	AE2-113 C	3.4144	80/20	3.4144
941421	AE2-139 C	11.4269	80/20	11.4269
LGEE	LGEE	0.4257	Confirmed LTF	0.4257
CIN	CIN	1.5067	Confirmed LTF	1.5067
CPLE	CPLE	0.2467	Confirmed LTF	0.2467
CBM-N	CBM-N	1.3999	Confirmed LTF	1.3999
NYISO	NYISO	5.9906	Confirmed LTF	5.9906
CBM-W2	CBM-W2	13.5349	Confirmed LTF	13.5349
CBM-W1	CBM-W1	3.7635	Confirmed LTF	3.7635
MECS	MECS	2.5305	Confirmed LTF	2.5305
WEC	WEC	0.4163	Confirmed LTF	0.4163
CBM-S2	CBM-S2	0.6921	Confirmed LTF	0.6921
CBM-S1	CBM-S1	1.7774	Confirmed LTF	1.7774
MEC	MEC	2.7997	Confirmed LTF	2.7997
IPL	IPL	0.9718	Confirmed LTF	0.9718

12.7.2 Index 2

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
1514362	200677	26NO MESHO	PENELEC	200706	26N.MESHPN	PENELEC	4	PN-P2-3-PN-230-17B19	breaker	189.0	171.85	180.99	DC	17.25

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
200823	26MHP_X3-003	30.9039	50/50	30.9039
200851	26MEHOOP3	5.3188	50/50	5.3188
200887	26ARMNA MT	0.5869	50/50	0.5869
200894	26K02	6.5126	Adder	7.66
200917	26MTNTP_P28	2.7045	50/50	2.7045
200949	26X1-109	24.7727	50/50	24.7727
203283	26MANOR_T86	0.0526	50/50	0.0526
203999	P-047 E	13.0619	50/50	13.0619
294573	P-028 E	59.8140	50/50	59.8140
913191	Y1-047 OP1	1.7940	50/50	1.7940
916202	Z1-069 E	5.4740	Adder	6.44
916361	Z1-092	0.6578	50/50	0.6578
917072	Z2-011	0.5531	50/50	0.5531
920351	AA2-133	1.0761	50/50	1.0761
921642	**AA2-000 (Suspended)**	**36.6120**	**Adder**	**43.07**
930511	**AB1-092 (Suspended)**	**1.3443**	**Adder**	**1.58**
931092	AB1-160 E	1.5640	Adder	1.84
934821	AD1-110	0.1352	50/50	0.1352
935061	AD1-142	0.0364	50/50	0.0364
936421	**AD2-055 (Suspended)**	**2.7676**	**Adder**	**3.26**
940861	AE2-074 C	1.1400	Adder	1.34
940862	AE2-074 E	1.5006	Adder	1.77
941421	AE2-139 C	10.3523	50/50	10.3523
941422	AE2-139 E	6.9015	50/50	6.9015
LGEE	LGEE	0.4699	Confirmed LTF	0.4699
CIN	CIN	1.6660	Confirmed LTF	1.6660
CPLE	CPLE	0.2639	Confirmed LTF	0.2639
G-007	G-007	2.3173	Confirmed LTF	2.3173
CBM-N	CBM-N	2.3575	Confirmed LTF	2.3575
NYISO	NYISO	10.0295	Confirmed LTF	10.0295
SANTEETLA /* 35% REVERSE 4609189	SANTEETLA /* 35% REVERSE 4609189	0.0000	LTF	0.0000
CBM-W2	CBM-W2	14.9261	Confirmed LTF	14.9261
CBM-W1	CBM-W1	4.1746	Confirmed LTF	4.1746
MECS	MECS	2.8245	Confirmed LTF	2.8245
WEC	WEC	0.4608	Confirmed LTF	0.4608
O-066	O-066	15.9972	Confirmed LTF	15.9972
CBM-S2	CBM-S2	0.7478	Confirmed LTF	0.7478
CBM-S1	CBM-S1	1.9545	Confirmed LTF	1.9545
MEC	MEC	3.0908	Confirmed LTF	3.0908
IPL	IPL	1.0741	Confirmed LTF	1.0741

12.7.3 Index 3

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
1514522	208009	LACK	PPL	200074	LACKAW	PJM	3	PL:02:P42:001057	breaker	1165.0	103.47	106.68	AC	22.85

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
200823	26MHP_X3-003	15.6013	Adder	18.35
200894	26K02	8.3700	Adder	9.85
203999	P-047 E	12.2994	Adder	14.47
208055	LAEN	112.3758	50/50	112.3758
209009	PEIP 2	3.5845	50/50	3.5845
210706	HOLD	7.6716	Adder	9.03
294573	P-028 E	30.1961	Adder	35.52
916202	Z1-069 E	6.0706	Adder	7.14
917661	WAYM E	21.4343	Adder	25.22
918601	AA1-077 C	2.7889	50/50	2.7889
918602	AA1-077 E	30.4552	Adder	35.83
921642	**AA2-000 (Suspended)**	**44.0776**	**Adder**	**51.86**
930511	**AB1-092 (Suspended)**	**1.6184**	**Adder**	**1.9**
931092	AB1-160 E	1.7345	Adder	2.04
931942	**AB1-182 E (Suspended)**	**4.6986**	**Merchant Transmission**	**4.6986**
936421	**AD2-055 (Suspended)**	**3.3320**	**Adder**	**3.92**
938331	AE1-051	3.8551	Adder	4.54
938401	AE1-059 C O1	59.1073	Adder	69.54
941421	AE2-139 C	11.6549	Adder	13.71
941422	AE2-139 E	7.7699	Adder	9.14
LGEE	LGEE	0.1854	Confirmed LTF	0.1854
CIN	CIN	0.6786	Confirmed LTF	0.6786
G-007	G-007	4.7008	Confirmed LTF	4.7008
CBM-N	CBM-N	0.5540	Confirmed LTF	0.5540
NYISO	NYISO	2.2123	Confirmed LTF	2.2123
CBM-W2	CBM-W2	5.0933	Confirmed LTF	5.0933
CBM-W1	CBM-W1	1.9049	Confirmed LTF	1.9049
MECS	MECS	1.5225	Confirmed LTF	1.5225
WEC	WEC	0.1948	Confirmed LTF	0.1948
O-066	O-066	32.6001	Confirmed LTF	32.6001
CBM-S1	CBM-S1	0.5893	Confirmed LTF	0.5893
HAMLET	HAMLET	0.0299	Confirmed LTF	0.0299
MEC	MEC	1.2151	Confirmed LTF	1.2151
IPL	IPL	0.4410	Confirmed LTF	0.4410

12.8 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
AA1-077	Lackawanna 230kV	In Service
AA2-000 (AA1-111)	Moshannon-East Towanda 230kV	Suspended
AA2-133	Wyalusing 34.5kV	In Service
AB1-092	Moshannon-East Towanda 230kV	Suspended
AB1-160	Gold-Sabinsville 115kV	In Service
AB1-182	Bear Creek	Suspended
AD1-108	Grover 34 kV	In Service
AD1-109	Canton 34.5 kV	In Service
AD1-110	North Meshoppen 34.5 kV	In Service
AD1-142	Milan 34.5 kV	In Service
AD2-055	Moshannon-East Towanda 230 kV	Suspended
AE1-051	East Carbondale-Lackawanna 69kV	Active
AE1-059	Stanton-Summit 230 kV	Active
AE2-074	Potter 46 kV	Engineering and Procurement
AE2-113	Farmers Valley-Ridgeway 115 kV	Active
AE2-139	East Towanda-Grover 230 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
Z1-069	Gold-Sabinsville 115kV	In Service
Z1-092	Milan 34kV	In Service
Z1-110	Grover 34kV	In Service
Z2-011	Canton 34.5kV	In Service

12.9 Contingency Descriptions

Contingency Name	Contingency Definition
PL:03:P12:001029	CONTINGENCY 'PL:03:P12:001029' /* LACK-LAEN 230KV LINE DISCONNECT BRANCH FROM BUS 208009 TO BUS 208054 CKT 1 /* LACK-LAEN 230 DISCONNECT BUS 208054 /* LACKAWANNA ENERGY GEN BUS END
AP-P1-2-WP-345-311T	CONTINGENCY 'AP-P1-2-WP-345-311T' /* ARMSTRONG -HOMERCITY 345KV DISCONNECT BRANCH FROM BUS 235129 TO BUS 200769 CKT 1 /* 01ARMSTRONG 345 26HOMER CY 345 END
PN-P2-3-PN-230-17B19	CONTINGENCY 'PN-P2-3-PN-230-17B19' /* NORTH MESHOPPEN 230KV SB 19 DISCONNECT BRANCH FROM BUS 200677 TO BUS 200706 CKT 3 /* 26NO MESHO 115 26N.MESHPN 230 DISCONNECT BRANCH FROM BUS 200706 TO BUS 200924 CKT 1 /* 26N.MESHPN 230 26CANYON 230 DISCONNECT BRANCH FROM BUS 200675 TO BUS 200924 CKT 1 /* 26E.TWANDA 230 26CANYON 230 END
PL_P12_001029	CONTINGENCY 'PL_P12_001029' /* LACK-LAEN 230KV LINE DISCONNECT BRANCH FROM BUS 208009 TO BUS 208054 CKT 1 /* LACK-LAEN 230 DISCONNECT BUS 208054 /* LACKAWANNA ENERGY GEN BUS END
PN-P1-2-PN-230-013A	CONTINGENCY 'PN-P1-2-PN-230-013A' /* EAST TOWANDA - NORTH MESHOPPEN 230KV DISCONNECT BRANCH FROM BUS 200675 TO BUS 200924 CKT 1 /* 26E.TWANDA 230 26CANYON 230 DISCONNECT BRANCH FROM BUS 200924 TO BUS 200706 CKT 1 /* 26CANYON 230 26N.MESHPN 230 END
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

Contingency Name	Contingency Definition
PL:02:P42:001057	CONTINGENCY 'PL:02:P42:001057' /* LACK-PAUP 230KV; PAUP_E CB @ LACK DISCONNECT BRANCH FROM BUS 208009 TO BUS 925950 CKT 1 /* LACK-AC1-071 TAP 230 /* CONTINGENCY LINE ADDED FOR AE1 BUILD DISCONNECT BRANCH FROM BUS 208009 TO BUS 211681 CKT 2 /* LACK-LACK 230/69KV T2 DISCONNECT BRANCH FROM BUS 208009 TO BUS 200074 CKT 4 /* LACK-LACKAW 500/230KV T4 END

13 Light Load Analysis

Not applicable to Solar projects

14 Short Circuit Analysis

No impacts.

15 Stability and Reactive Power

15.1 Executive Summary

Generator Interconnection Request AE2-139 is for a 100.5 MW Maximum Facility Output (MFO) solar facility consisting of 38 x FS2800 PV inverters connecting to the FirstEnergy ("FE") transmission system, Pennsylvania Electric Company (PENELEC) zone. The interconnection of the project at the Point of Interconnection (POI) will be accomplished by constructing a new 230 kV three breaker ring bus substation and looping the AA1-144 Tap - Marshall 230 kV line into the new station. The new substation will be located approximately 17.8 miles from Grover substation and 3.9 miles from AA1-144 Tap substation. The generating facility is located at Bradford County, Pennsylvania.

This report describes a dynamic simulation analysis of AE2-139 as part of the overall system impact study. The load flow scenario for the analysis was based on the RTEP 2022 peak load case, modified to include applicable queue projects. AE2-139 has been dispatched online at maximum power output with 1.01 pu scheduled voltage at the generator terminal.

AE2-139 was tested for compliance with NERC, PJM, Transmission Owner, and other applicable criteria. 60 contingencies were studied, each with a 20 second simulation time period (with 1.0 second initial run prior to any events). Studied faults included:

a) Steady state operation (Category P0);

b) Three phase faults with normal clearing time on the intact network (Category P1);

c) Single phase to ground faults with delayed clearing due to a stuck breaker (Category P4);

d) Single phase faults placed at 80% of the line with delayed (Zone 2) clearing at line end remote from the fault due to primary communications/relay failure (Category P5);

For all 60 fault contingencies tested on the 2022 peak load case:

a) AE2-139 was able to ride through the faults (except for faults where protective action trips a generator(s)).

b) Post-contingency oscillations were positively damped with a damping margin of at least 3%.

c) Following fault clearing, all bus voltages recover to a minimum of 0.7 per unit after 2.5 seconds (except where protective action isolates that bus).

d) No transmission element trips, other than those either directly connected or designed to trip as a consequence of that fault.

15.2 Reactive Power

AE2-139 was assessed for compliance with reactive power capability requirements using the supplied capability curves. Please note this is a new facility.

- Generation shall have the ability to maintain a power factor of at least 0.95 leading to 0.95 lagging at high side of main transformer or the result of the System Impact Study indicated that, for the safety and reliability of the Transmission System, no power factor requirement is required[2,3].

Generator	MFO	Required PF Range		Maximum (Lagging)	Minimum (Leading)
		Lagging	Leading		
AE2-139	100.5	0.95	0.95		
Total MVAR Required				33.03	-33.03
MVAR from Generators				Qmax	Qmin
				60.248	-60.248
Customer Planned Compensation				0	0
Qloss				-18.531	-28.379
Total Available MVAR at High Side of Main Transformer (Qpoi)				41.717	-88.627
Deficiency in MVAR				**Meet**	**Meet**

The solar generating facility AE2-139 **meets** the reactive power requirement at POI.

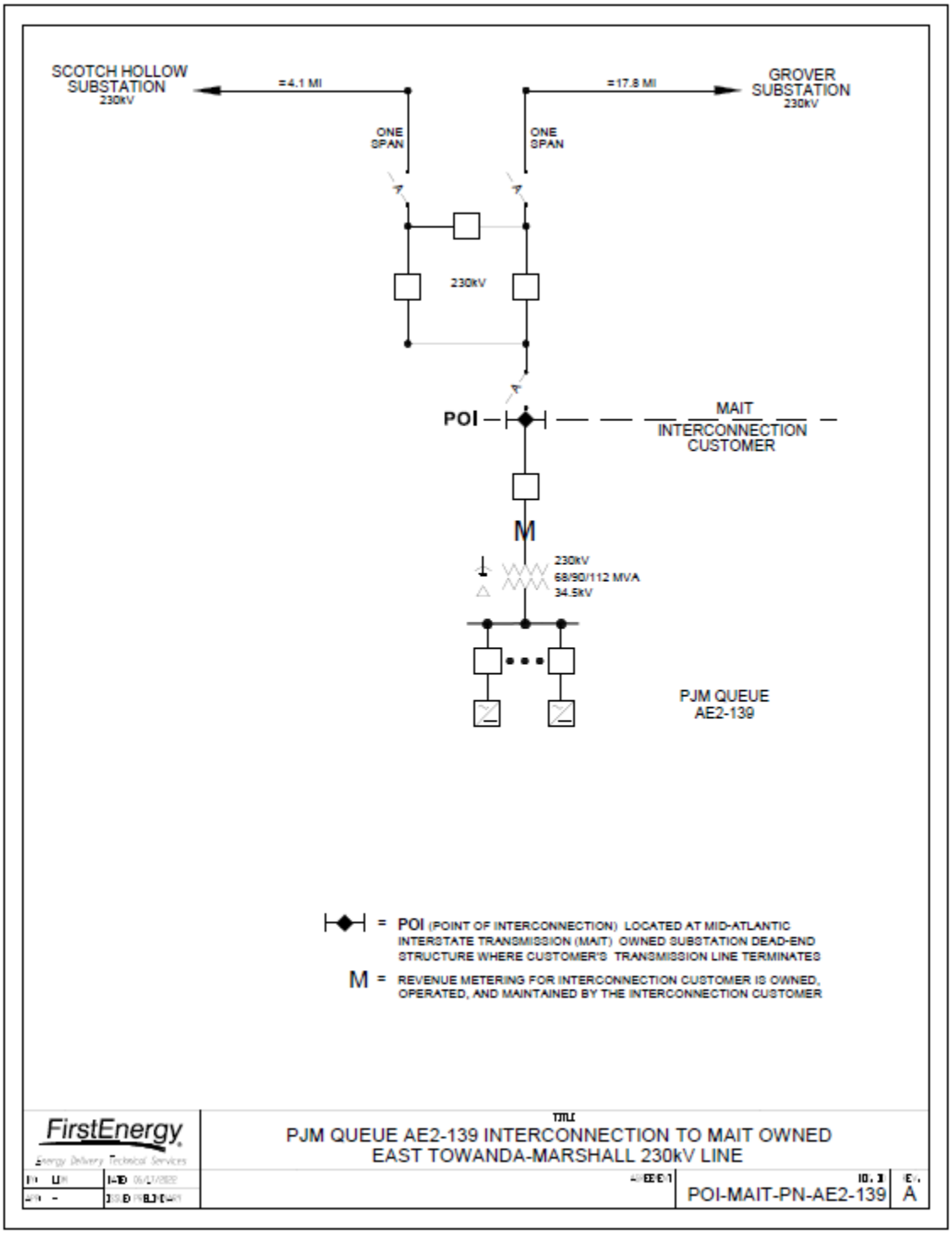
[2] As specified in the document "Reactive Power Requirements.doc", Date: 6/15/2018.
[3] As specified in Attachment O of the document "PJM Open Access Transmission Tariff" Effective Date: 4/23/2018.

16 Affected Systems

16.1 NYISO

A NYISO Affected System Study was completed for the AE2 cluster in October 2021 and AE2-139 did not have any impacts.

17 Attachment 1: One Line Diagram



18 Attachment 2: Project Location