Second Revised

Generation Interconnection

System Impact Study Report

for

Queue Project AE2-074

POTTER 46 KV

15.11 MW Capacity / 35 MW Energy

March 2022

Revision 2

Table of Contents

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 Potter Solar LLC, the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is West Penn Power ("WPP" in APS).

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.

3 Revisions Since December 2021 System Impact Study Report

The AE2-074 System Impact Study has been revised to reflect the results from a recent retool analysis by PJM. No other changes were made.

- The analysis results show contribution to a previously identified overload that leads to the requirement for baseline project b2952.

4 Revisions Since February 2020 System Impact Study Report

The AE2-074 System Impact Study has been revised to reflect that this project no longer requires a NYISO Affected systems study. No other changes were made. West Penn Power will provide more detailed scope, cost and schedule in the Interconnection Agreement.

- The Affected Systems section was updated to reflect there are no impacts. (See Affected Systems section 19).

5 General

The Interconnection Customer (IC), has proposed a Solar generating facility located in Potter County, Pennsylvania. The installed facilities will have a total capability of 35 MW with 15.11 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is December 31, 2020. This study does not imply a TO commitment to this in-service date.

Final attachment facilities and local upgrades (if required) along with terms and conditions to interconnect AE2-074 will be specified in a separate two party Interconnection Agreement (IA) between WPP and the Interconnection Customer as this project is considered FERC non-jurisdictional per the PJM Open Access Transmission Tariff (OATT).

The customer will be required to mitigate for a Reactive Power Deficiency prior to becoming commercially operable.

Queue Number	**AE2-074**
Project Name	POTTER 46 KV
Interconnection Customer	Potter Solar LLC
State	PA
County	Potter
Transmission Owner	APS (West Penn Power)
MFO	35
MWE	35
MWC	15.11
Fuel	Solar
Basecase Study Year	2022

6 Point of Interconnection

AE2-074 will interconnect with the West Penn Power system by constructing a new breaker position at Potter 46 kV substation. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new breaker position and the associated facilities. The IC will also be responsible for the rough grade of the property and any necessary access roads.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AE2-074 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 Cost Summary

Total estimated cost for the required Interconnection Facilities is **$1,160,553**[1]. 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.

The customer will be required to mitigate for a Reactive Power Deficiency prior to becoming commercially operable.

[1] Please note in Section 21 of this report for "Stability and Reactive Power Assessment" that the customer will be required to have additional reactive power capabilities to fulfill the power factor requirement. The customer will be responsible for the cost of achieving the power factor requirement. The customer's mitigation will need to be tested by PJM and the TO prior to commercial operation.

8 Transmission Owner Scope of Work

AE2-074 will interconnect with the West Penn Power system by constructing a new breaker position at Potter 46 kV substation. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new breaker position and the associated facilities. The IC will also be responsible for the rough grade of the property and any necessary access roads.

Attachment 1 shows a one-line diagram of the proposed connection facilities for the AE2-074 generation project to connect to the FirstEnergy ("FE") transmission system. 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 facilities.

Description	Total Cost
Provide attachment facilities for AE2-074 – 46 kV Meter, CTs/PTs, and Switch	$31,953
Estimated SCADA work at Potter substation to support relay and breaker installation. Estimated (1) in-sub fiber run from Potter Control House to the developer-built fiber run for communications to AE2-074.	$55,900
New expansion for AE2-074 at Potter including 46 kV breaker and terminal equipment	$993,100
Project Management and Environmental.	$79,600
Total Estimated Facility Costs	**$1,160,553**

9 Schedule

Based on the scope of work for the interconnection facilities, it is expected to take a minimum of **12 months** after the signing of an Interconnection Agreement with FirstEnergy. 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 interconnection work, and that all transmission system outages will be allowed when requested.

10 Transmission Owner Analysis

FE performed an analysis of its underlying transmission <100 kV system. The AE2-074 project did not contribute to any overloads on the FE transmission <100 kV system.

11 Interconnection Customer Requirements

11.1 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 original one-line diagram provided by the IC depicted a non-standard GSU transformer winding configuration. This transformer is in violation of section 14.2.6 of FE's "Requirements for Transmission Connected Facilities" document and will not be accepted. The GSU transformer must have a delta or ungrounded-wye connection on the high (utility) side, with a low (generator) side connection at the discretion of the IC.

11.2 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 46 kV circuit breaker to protect the AE2-074 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 AE2-074 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.

11.3 Power Factor Requirements

The IC shall design its Solar 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.

12 Revenue Metering and SCADA Requirements

12.1 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.

12.1.1 Meteorological Data Reporting Requirement

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

12.2 FirstEnergy Requirements

The IC will be required to comply with all FE revenue metering requirements for generation interconnection customers which can be found in FE's "Requirements for Transmission Connected Facilities" document located at: http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx

13 Network Impacts

The Queue Project AE2-074 was evaluated as a 35.0 MW (Capacity 15.1 MW) injection at the Potter 46 kV substation in the APS area. Project AE2-074 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-074 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Load Flow

14 Generation Deliverability

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

None

15 Multiple Facility Contingency

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

None

16 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)

Contingency					Bus				Loading %		Rating			
No.	Type	Name	Affected Area	Facility Description	From	To	Circuit	Power Flow	Initial	Final	Type	MVA	MW Contribution	Flowgate Appendix
1	LFFB	PN-P2-3-PN-230-17B19	PENELEC - PENELEC	26N.MESHPN 230/115 kV transformer	200677	200706	4	DC	179.27	180.62	ER	189	3	1

17 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.

Contingency					Bus				Loading %		Rating			
No.	Type	Name	Affected Area	Facility Description	From	To	Circuit	Power Flow	Initial	Final	Type	MVA	MW Contribution	Flowgate Appendix
2	N-1	200675(26E.TWANDA)-200924(26CANYON)_1	PENELEC - PENELEC	26TOWANDA-26NOMESHO 115 kV line	200674	200677	1	AC	127.08	128.26	ER	202	2.77	

18 System Reinforcements

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost	Cost Allocated to AE2-074
#1	26N.MESHPN 230/115 kV transformer #4	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. Baseline project is currently under construction and has a projected in-service date of 6/1/2022. Note: Although Queue Project AE2-074 does not have cost responsibility for this upgrade, Queue Project AE2-074 may need this upgrade in-service to be deliverable to the PJM system. If Queue Project AE2-074 comes into service prior to completion of the upgrade, Queue Project AE2-074 will need an interim study.	b2952	$11,600,000	**$0**

19 Appendices

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information 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 Appendices. Please note that there may be contributors that are subsequently queued after the queue under study that are not listed in the Appendices. 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 and appendices sections are full contributions, whereas the loading percentages reported in the body of the report, take into consideration the commercial probability of each project as well as the ramping impact of "Adder" contributions.

19.1 Appendix 1

(PENELEC - PENELEC) The 26N.MESHPN 230/115 kV transformer (from bus 200677 to bus 200706 ckt 4) loads from 179.27% to 180.62% (**DC power flow**) of its emergency rating (189 MVA) for the line fault with failed breaker contingency outage of 'PN-P2-3-PN-230-17B19'. This project contributes approximately 3.0 MW to the thermal violation.

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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
```

Bus Number	*Bus Name*	*Full Contribution*
200887	*26ARMNA MT*	*0.49*
200894	*26K02*	*7.45*
203283	*26MANOR_T86*	*0.04*
200851	*26MEHOOP3*	*4.52*
200823	*26MHP_X3-003*	*29.37*
200917	*26MTNTP_P28*	*2.3*
200949	*26X1-109*	*20.78*
934821	*AD1-110*	*0.12*
935061	*AD1-142*	*0.03*
936421	*AD2-055*	*3.35*
940861	*AE2-074 C*	*1.3*

940862	*AE2-074 E*	*1.71*
941421	*AE2-139 C*	*10.13*
941422	*AE2-139 E*	*6.76*
LTF	*CBM-N*	*2.16*
LTF	*CBM-S1*	*2.06*
LTF	*CBM-S2*	*0.77*
LTF	*CBM-W1*	*4.46*
LTF	*CBM-W2*	*15.82*
LTF	*CIN*	*1.77*
LTF	*CPLE*	*0.27*
LTF	*G-007*	*2.32*
LTF	*IPL*	*1.14*
LTF	*LGEE*	*0.5*
LTF	*MEC*	*3.29*
LTF	*MECS*	*3.04*
LTF	*NYISO*	*9.12*
LTF	*O-066*	*16.04*
294573	*P-028 E*	*59.43*
203999	*P-047 E*	*12.83*
LTF	*WEC*	*0.49*
913191	*Y1-047 OP1*	*1.53*
916202	*Z1-069 E*	*6.28*
916361	*Z1-092*	*0.55*
917072	*Z2-011*	*0.46*
918682	*AA1-082 E*	*10.09*
921642	*AA2-000*	*44.29*
920351	*AA2-133*	*0.91*
930511	*AB1-092*	*1.63*
931092	*AB1-160 E*	*1.8*

Affected Systems

21 Affected Systems

21.1 NYISO

None.

22 Contingency Descriptions

Contingency Name	Description
200675(26E.TWANDA)-200924(26CANYON)_1	CONTINGENCY '200675(26E.TWANDA)-200924(26CANYON)_1' OPEN BRANCH FROM BUS 200675 TO BUS 200924 CKT 1 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

Short Circuit

23 Short Circuit

The following Breakers are overduty:

None

Stability

24 Stability Analysis and Reactive Power Assessment

24.1 Executive Summary

24.1.1 Stability Analysis

Generator Interconnection Request AE2-074 is for a 35 MW Maximum Facility Output (MFO) solar generating facility, which consists of 14 X 2.75 MVA SC2750-EV-US. Project AE2-074 will be connected to the West Penn Power Company (West Penn) transmission system by constructing a new 46 kV terminal at Potter substation via a 0.02 miles 46 kV transmission line. The Point of Interconnection (POI) will be where the Interconnection Customer gen-tie line attaches to the line terminal dead-end structure. The generating facility will be located in Potter County, Pennsylvania.

This report describes a dynamic simulation analysis of AE2-074 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. AE2-074 has been dispatched online at maximum power output with 1.01 pu voltage at the interconnection point.

AE2-074 was tested for compliance with NERC, PJM, Transmission Owner, and other applicable criteria. 55 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 55 fault contingencies tested on the 2022 peak load case:

a) AE2-074 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.

No mitigations required for Stability.

24.1.2 Reactive Power Assessment

Please note that the solar generating facility AE2-074 does not meet the maximum reactive power requirement at the High Side of Main Transformer. Reactive power compensation is required for this project.

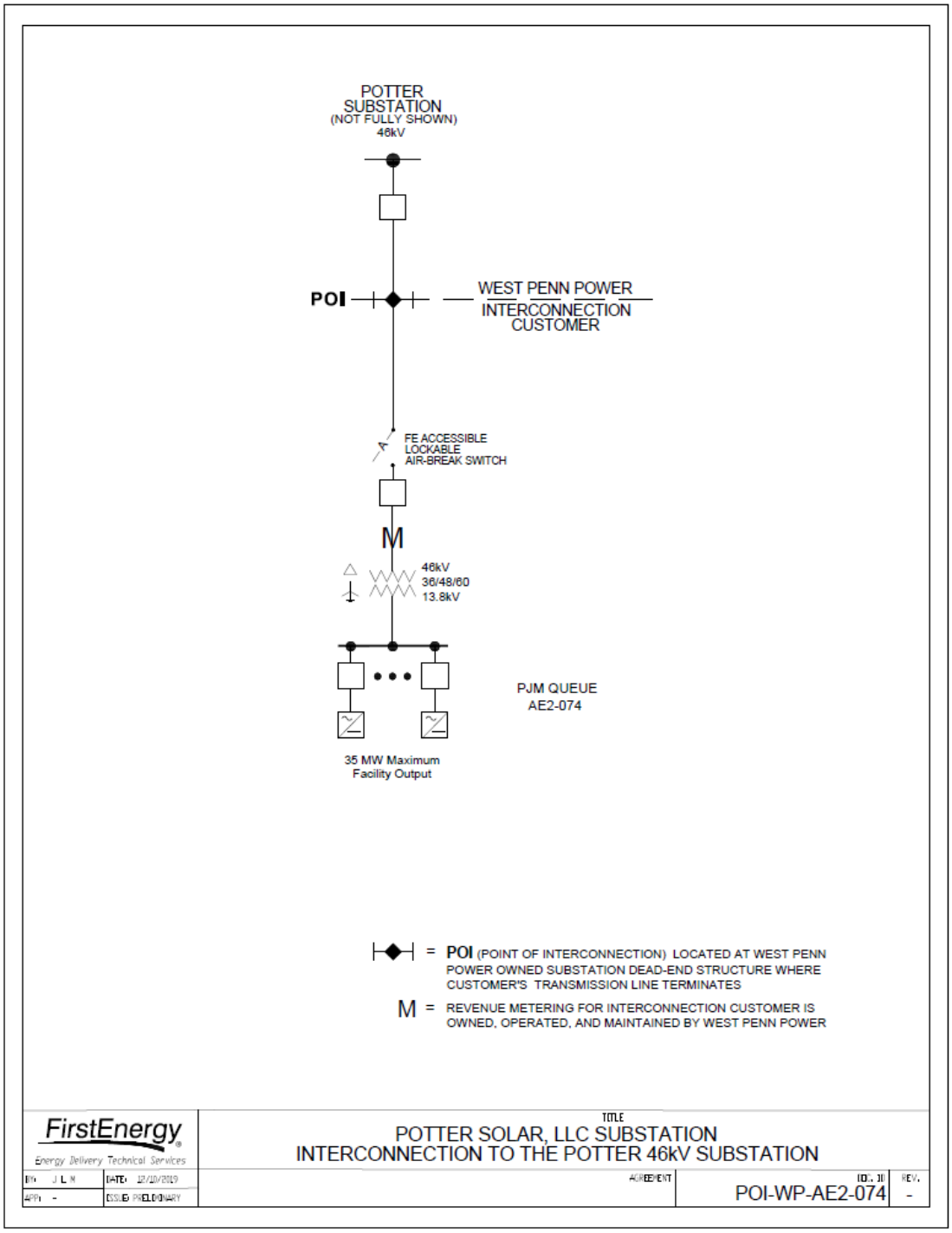
This project needs to have additional reactive power capabilities to fulfill the power factor requirement. The estimated required additional capacitive reactive power is 1.56 MVAR.

Light Load

25 Light Load Analysis

Not applicable to solar projects.

26 Attachment One: One Line Diagram



27 Attachment Two: Project Location